Stag Field Environment Plan Permit WA-15-L

GF-70-PLN-I-00002

Rev 17

FACILITY	Stag
REVIEW INTERVAL	60 Months

Rev No	Date	Approvals		
		Owner	Reviewer	Approver
		OIM - Stag	Environment Lead	Operations Manager
14	14/12/2017	A. Klompmaker	J. Williams	M. Robertson
14A	01/03/18	J. Parry	J. Williams	M. Robertson
14B	05/07/18	K. Grjlusich	J. Williams	M. Robertson
14.01	02-Jul-19	B. Spargo	H. Astill	O. Hobbs
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15	11-Sep-20	D. Harms	M. Patt	T. Coolican
16	19-Jan-21	K. Grljusich	M. Patt	T. Coolican
17	16-Mar-21	A. Klompmaker	M. Patt	T. Coolican
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Stag Central Production Facility – Offshore Installation Manager

Any hard copy of this document, other than those identified above, are uncontrolled. Please refer to the Jadestone MIS for the latest revision.

REVISION HISTORY

Revision	Author / Editor	Amendment
9	Apache / Quadrant Energy	In-force accepted EP at change of title, 10 July 2017
10	M. Patt M. Walker G. Starling	Proposed revision for submission to NOPSEMA
11	M. Patt M. Walker G. Starling	Proposed revision for submission to NOPSEMA
12	M. Patt M. Walker G. Starling	Proposed revision for submission to NOPSEMA
13	M. Patt M. Walker G. Starling	Proposed revision for submission to NOPSEMA
14	H. Astill M. Patt	Accepted EP for use, including revisions to reflect responses to NOPSEMA RFFWI (Ref. No. 4051).
14A	J. Williams	MOC 2018-005. Replace references to Marine Logistics Procedure with Stag Marine Facility Operating Manual
14B	H. Astill	Update after review of legislative framework elements. No MoC required.
14.01	M. Patt	Minor editorial changes from annual review and biannual legislative review and MoC -2019-070 (removal of PS 026)
14.01	M. Patt	Minor editorial changes from 2020 annual review and biannual legislative review. No MOC required
14.02	H. Astill	EP performance standards for marine biosecurity revised to reflect updates to Marine Biosecurity Manual (JS-70-MN-G-00001)
15	L. Muir H. Astill	Revision for submission to NOPSEMA for tanker operations
16	L. Muir H. Astill	Revision for submission to NOPSEMA in response to NOPSEMA RFFWI

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Acronyms and Abbreviations

Abbreviation	Description
AFFF	Aqueous Film Forming Foam
AFZ	Australian Fishing Zone
AHV	Anchor handling vehicle
ALARP	as low as reasonably practicable
AMP	Australian Marine Parks
AMSA	Australian Maritime Safety Authority
API	American Petroleum Institute
APPEA	Australian Petroleum Production and Exploration Association
AQIS	Australian Quarantine and Inspection Service
AUV	Autonomous underwater vehicle
BCF	Bioconcentration Factor
BOP	Blowout preventer
Bq/g	Becquerel per gram
CAA	Civil aviation authority
CALM	Catenary Anchor Leg Mooring
CCTV	Closed circuit television
CGFU	Compact gas floatation unit
CHARM	Chemical Hazard and Risk Management
CMMS	Computerised Maintenance Management System
CP	Cathodic Prevention
CPF	Central Production Facility
CPI	Corrugated plate interceptor
DA	Designated Authority
DAWE	Department for Agriculture, Water and Environment (previously DoEE)
DBCA	Department of Biodiversity, Conservation and Attractions
DBCA	Department of Parks and Wildlife (now DBCA)
DEC	Department of Environment and Conservation (now DBCA)
DEWHA	Department of the Environment, Water, Heritage and the Arts (now DoEE)
DIIS	Department of Industry, Innovation and Science
DMIRS	Department of Mines, Industry Regulation and Safety (previously Department of Mines and Petroleum, DMP)
DoC	Document of Compliance

Abbreviation	Description
DOEE	Department of the Environment and Energy (now DAWE)
DoF	Department of Fisheries (now DPIRD)
DP	Dynamically Positioned
DPIRD	Department of Primary Industries and Regional Development (previously Department of Fisheries)
DSMS	Diving safety management system
DSV	Diving support vessel
DSV	Dive Support Vessel
DSWEPaC	Department of Sustainability, Environment, Water, Population and Communities (now DAWE)
dwt	Dry weight tonnes
EEZ	Economic Exclusion Zone
EH&S	Environmental Health & Safety
EMBA	Environment that may be affected
EP	Environment Plan
EP Act	Environmental Protection Act 1986
EPA	Environmental Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ESD	Emergency Shut-Down system
ESP	Electric Submersible Pump
GFU	Gas floatation unit
HLO	Helicopter landing officer
HVAC	Heating ventilation air conditioning (system)
HWU	Hydraulic Workover Unit
ICAO	International civil aviation organisation
IMO	International Maritime Organisation
IMS	Invasive Marine Species
IMR	Integrity, maintenance and repair
IWC	International Whaling Commission
KEFs	Key Ecological Features
Kl	Kilolitre
Ksm^3	Thousand Standard Cubic Metres
LAT	Lowest astronomical tide

Abbreviation	Description
LC50	Lethal concentration of a compound at which 50% of test species dies within a specified time frame
MAOP	Maximum Allowable Operating Pressure
MCR	Marine Conservation Reserve
mg/L	Milligrams per litre
MMA	Marine Management Area
mmscfd	Million Standard Cubic Feet per Day
MOPU	Mobile offshore production unit
MPRA	Marine Parks Reserves Authority
MSDS	Material safety data sheet
NCB	North Coast Bioregion
NDT	Non-Destructive Testing
NEBA	Net Environmental Benefit Assessment
NES	National Environmental Significance
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NORMs	Naturally Occurring Radioactive Materials
NSF	Northern Shark Fishery
NWS	North-West Shelf
NWSTF	North-West Slope Trawl Fishery
OCIMF	Oil Companies International Marine Forum
OCNS	Offshore Chemical Notification Scheme
ODS	Ozone Depleting Substances
OGP	Oil and gas producers (association)
OIM	Offshore Installation Manager
OIW	Oil-in-water
OPGGS (E) Regs	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
OPGGS Act	Offshore Petroleum and Greenhouse Gas Storage Act 2006
OPMF	Onslow Prawn Managed Fishery
OSCP	Oil Spill Contingency Plan
PAH	Polycyclic aromatic hydrocarbons
PLEM	Pipeline end manifold
ppm	parts per million
PRS	Production Reporting System

Abbreviation	Description
PTS	Permanent Threshold Shift
PW	Produced water
RO	Reverse Osmosis Plant
ROV	Remote Operated Vehicle
SBFTF	Southern Bluefin Tuna Fishery
SCM	Subsea control module
SRB	Sulphur Reducing Bacteria
SSS	Side-Scan sonar
SSWI	Ship Specific Work Instructions
STP	Sewage Treatment Plant
SWL	Safe Working Load
TPH	Total petroleum hydrocarbons
TTS	Temporary Threshold Shift
VBSA	Vessel based support activity
WA	Western Australia
WAF	Water accommodated fraction
WOMP	Well Operations Management Plan
WSTF	Western Skipjack Tuna Fishery
WTBF	Western Tuna and Billfish Fishery

1. OVERVIEW OF THE ACTIVITY

1.1 This Document

Historical operations at the Stag Field have seen the inclusion of a floating, storage and offtake (FSO) vessel that has been moored in field and receives produced oil from the central production facility (CPF), and then offtake of the cargo to a third-party tanker.

Recent operational and commercial developments have seen a shift to an operating model that requires only a third-party tanker and thereby permanent relinquishment of the FSO from the field.

To support this change, the Stag Field Environment Plan has been revised. Revision of the EP has resulted in the following changes presented in this document:

- Section 3.1.5 – description of the jurisdictional arrangements under which the third-party tanker operates;
- Sections 3.2.3 and 7.4 – no further discharge of produced water from the third party tanker;
- Section 8.1 – further information provided on the risk management associated with invasive marine species introduction;
- Section 8.5 – reduction in the spill volume in the scenario of a vessel collision resulting in release of crude oil to sea due to the FSO not being in field; and
- OPEP – minor changes including updates to priority receptors, volumes ashore and resourcing of response strategies to reflect revised modelling for the worst-case credible spill scenario.

Included in the changes identified above, an evaluation of the associated impacts and risks with the changed operations has been made. The evaluation has determined that there has been no significant increase in impacts or risks, and no introduction of new impacts and/ or risks due to the changed operations.

As such, the EP has been revised and is submitted for assessment under sub-regulation 17(6) of the OPGGS(E)R. The minor changes that have been made are detailed in Table 1-1.

Table 1-1: Minor changes to EP to reflect tanker operations at the Stag Field

Section	Topic	Modification
All	Cessation of FSO operations	References to the FSO have been removed throughout as applicable
3.2.3 3.2.10	Description of Activity	No discharge of produced water from the FSO Incineration of waste
4.3.1	Evaluation of environmental impacts and risks	Update to align with NOPSEMA's Environment Bulletin on Oil Spill Modelling (April 2019)
5	Description of the Environment	As a result of a change in the spill scenarios and impact thresholds used for spill modelling, this chapter has been updated to document potential receptors within the EMBA.
6	Consultation	Updates to document consultation with AMSA, DoT and DAWE.
7.3 7.4	Hazard Assessment of Planned Activities	Changes to: No produced water discharges from the third-party tanker
8.1	Hazard Assessment of Unplanned Events	Added detail on management controls for marine biosecurity management Updated information on the worst-case spill scenarios during operations.
9	Implementation Strategy	Updates to reflect third-party tanker operating in field

In addition to the changes made providing for tanker operations in the field, administrative updates have also been included. These are:

- Section 2.5 – updates to information referenced in legislative framework; and
- Section 3.2.5 and 3.4 – inclusion of reference to the requirements of OPGGS Act (s.572(2)).

1.2 Overview of Operations

Jadestone Energy (Australia) Pty Ltd ('Jadestone') is the operator and titleholder of the Stag Field Production and Export Facility (Stag Facility) located in permit area WA-15-L, approximately 60 km northwest of Dampier (**Figure 1-1**). The facility, located in approximately 49 m water depth, produces oil from the Stag Reservoir.

The Stag Facility, shown in **Figure 1-1** and **Figure 1-2** includes:

- A fixed Central Production Facility (CPF), producing and processing oil from a number of wells;
- A single 2 km long carbon steel export oil pipeline on the northeast side of the CPF connecting to a Catenary Anchor Leg Mooring (CALM) buoy via a flexible submarine hose (underbuoy hose);
- A third-party tanker receives oil through a flexible offtake hose from the CALM buoy. Once loading is complete, the tanker departs the field for delivery of cargo to market. No offtake activity from the third party tanker occurs in field;
- Water injection flowlines and wells to assist reservoir fluid recovery;
- Support/ supply vessels, work vessels and tug boats/ static tow vessels supporting third-party tanker movement, facility logistics, maintenance and provisioning; and
- Helicopter support.

Oil is loaded continuously to the third-party tanker at a production rate of up to 5,000 bbl/d. The CPF has been in production since 1998 with only minor modifications carried out during this time.

Stag oil is a medium crude (API 19) with a very low proportion of volatile compounds due to microbial degradation within the reservoir.

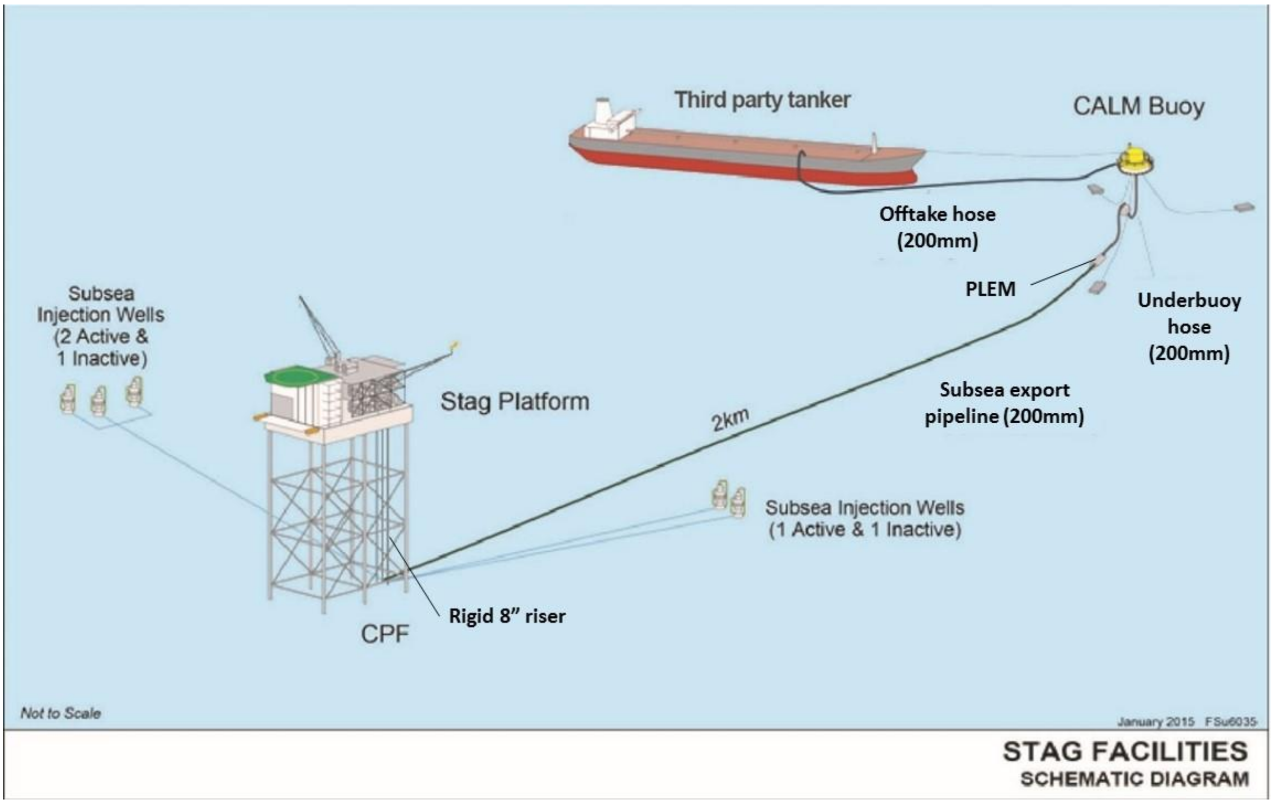


Figure 1-1: Schematic of the Stag Facility

Figure 1-2: Aerial view of Stag Facility

1.3 Stag CPF Location

The Stag CPF is located on the North-West Shelf (NWS) area off Western Australia (WA), approximately 60 km north-west of Dampier (**Table 1-2**, **Figure** 1-3).

Table 1-2: Distances from Stag Facility to Key Regional Features

Regional Feature	Distance from Stag CPF
Dampier Archipelago	32 km (17.3 Nm)
Closest Montebello Island	75 km (40.5 Nm)
Varanus Island	82 km (44.3 Nm)
Barrow Island	96 km (51.8 Nm)
Glomar Shoals	100 km (54 Nm)

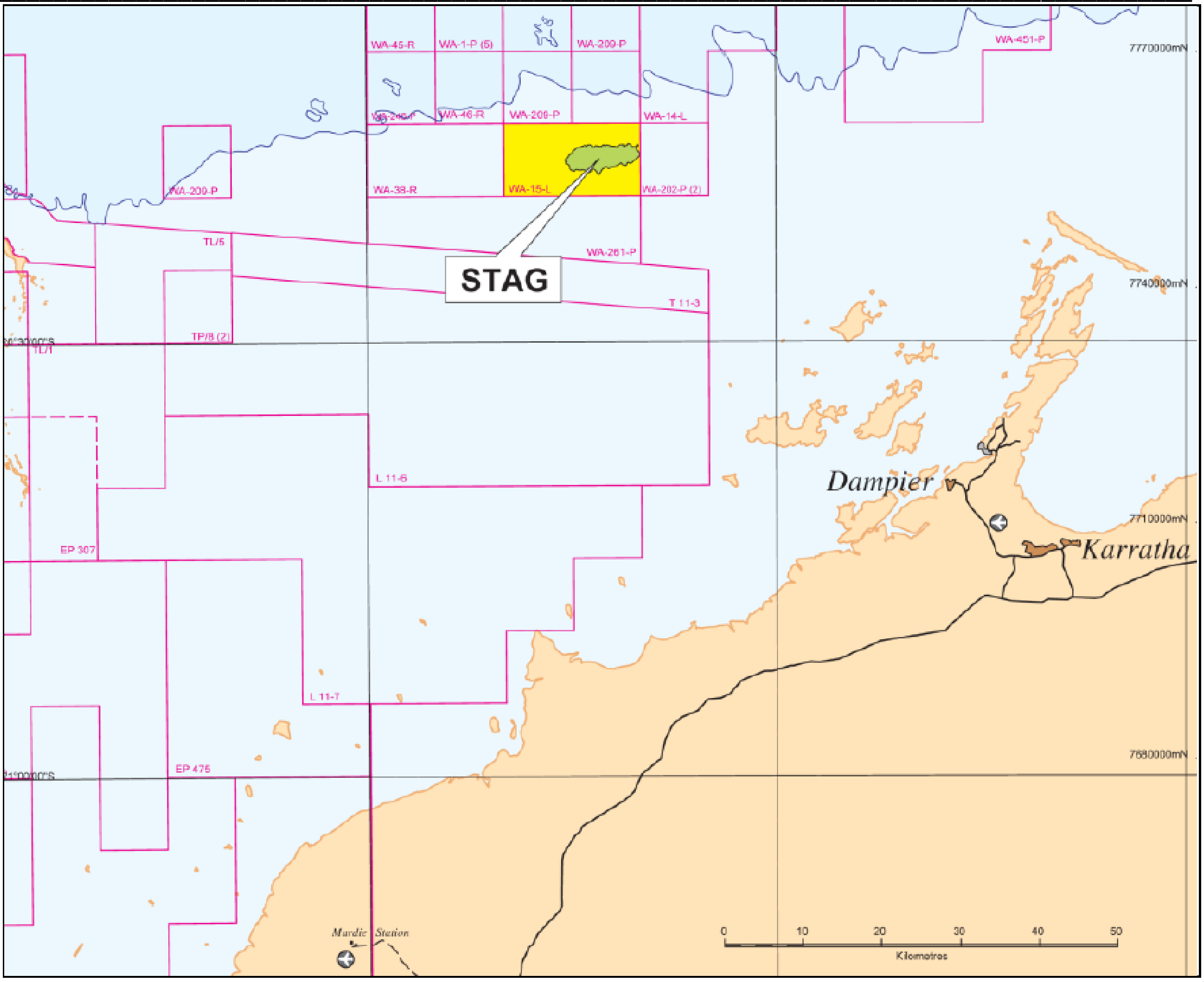


Figure 1-3: Location of the Stag Field

The CPF is located above the original Stag-6H well. The subsea export pipeline runs due north from the north-west side of the CPF to the CALM buoy. The CALM buoy is located in a water depth of approximately 49 m below lowest astronomical tide (LAT), approximately 2 km to the north of the Stag CPF (**Table 1-1**).

Table 1-3: Stag CPF and the CALM Buoy Coordinates

Facility	Latitude	Longitude
Stag CPF	20º 17.413' South	116º 16.517' East
CALM Buoy	20° 16.315' South	116° 16.571' East

Water injection flowlines run 1,100 m off the north-eastern corner of the CPF where they connect to two sub-surface wellheads. A further three sub-surface water injection wellheads are located approximately 3 km west of the facility.

1.3.1 Restricted Zones and Cautionary Areas

A cautionary area is charted for Stag field facilities, a circle of 2.5 NM (approx. 5 km) radius around the facilities, with the centre located 1.4 km due north of the CPF. In addition, there is an exclusion zone of 500 m radius around the CPF, CALM buoy (and moorings) and pipeline. Vessels operating within this exclusion zone must not exceed a speed of five (5) knots. .

1.4 Structure and Layout

The CPF is a fixed oil production platform. It comprises a jacket, which is secured to the seabed by six drilled and grouted piles, a hull, which is supported on tubular legs, a process module and an accommodation module. The platform has accommodation, offices, medical and mess facilities for a maximum overnight manning level of 58 personnel onboard.

The CPF stands approximately 20 m above sea surface level in a water depth of approximately 49 m LAT. The maximum topsides area is 37 m x 57 m (2,109 m^2). The structure, including topsides and piles, weighs approximately 6,500 tonnes.

The platform is located over a pre-installed mudline template as a guide and supports 12 well slots and five subsea water injection wells. Two subsea water injection wells are located approximately 1,100 m north-east of the facility, with the other three being located approximately 3,200 m west of the facility.

The topsides equipment includes the following process activities:

- Separation and processing of produced oil, gas and water;
- Produced water treatment and disposal;
- Sand separation;
- Seawater treatment and pumping for water injection wells; and
- Gas flaring.

The topsides also include the following utilities:

- Power generation and distribution;
- Potable and utility water;
- Utility and instrument air;
- Heating, Ventilation and Air Conditioning (HVAC) system; and
- Hydraulic Workover Unit (HWU) for well maintenance.

The platform has a helideck and a boat landing area. Helicopter is the normal means of transport for personnel. The platform is serviced by a single crane, with a boom length adequate to reach all required laydown areas, located on a pedestal on the west side of the process module.

Produced oil from the CPF is exported via an 8”, 2 km rigid steel oil subsea export pipeline to a pipeline end manifold (PLEM) and then an 85 m long flexible submarine hose (underbuoy hose) to the CALM buoy. A flexible 200 mm offtake hose connects the CALM buoy to a third-party tanker.

There is associated gas production, which is used as fuel for the boiler and process blanketing with the excess being flared. Water and oil are separated throughout the process and directed to the produced water package for treatment prior to discharge or injection.

1.5 Operator and Titleholder Details

Jadestone is engaged in exploration, appraisal and pre-development activities in South East Asia, with a portfolio of 10 exploration and pre-development assets. Jadestone is an active operator within the region and the company's principal focus is on assets in Australia, Indonesia, Vietnam and the Philippines.

Jadestone has an experienced management team that prides itself on technical excellence. This robust technical core to the business underpins Jadestone’s ability to:

- Operate safely;
- Optimise production from existing assets; and
- Identify, capture and maximise the value of its portfolio of assets.

The company recognises that local presence is essential to create, build and maintain partnerships in the region. To this end, Jadestone established its corporate headquarters in Singapore and principal technical teams in Kuala Lumpur and Perth, with country operational offices in New Plymouth, Jakarta, and Ho Chi Minh City.

Jadestone is firmly committed to be a responsible corporate citizen. The company places safety, environmental and social responsibility considerations at the core of its business and operational decision-making.

Jadestone's Australian office is located at:

Level 8, 1 William Street
Perth, Western Australia, 6000.
ACN 613 671 819

Jadestone's contact for the Stag Facility is:

Owen Hobbs, Country Manager
Phone: +61 8 9486 6600
Email: ohobbs@jadestone-energy.com

In the event contact details for Jadestone or the liaison contact change within the timeframe of this EP, NOPSEMA will be advised of the updated details.

2. OVERVIEW OF THE ENVIRONMENT PLAN

2.1 Objective

This Environment Plan (EP) has been prepared in accordance with the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Environment Regulations) under the Offshore Petroleum and Greenhouse Gas Storage Act 2006 (OPGGS Act) and as administered by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA). **Table** 2-1 provides EP section references against the requirements of the OPGGS (E) Regulations.

The objectives of this EP are to ensure that:

- All operational activities associated with the Stag Facility are planned and conducted in accordance with Jadestone's Environmental Management Policy;
- Potential adverse environmental impacts and risks associated with the proposed activities, during both routine and non-routine operations, are continuously reduced to as low as reasonably practicable (ALARP) and of acceptable levels; and
- That the environmental performance outcomes (EPO) and environmental performance standards (EPS) outlined in this EP are met.

This EP contains the environmental impact assessment for Stag Facility operations. The assessment aims to systematically identify and assess the potential environmental impacts associated with operational activity and to stipulate mitigation measures to avoid and/ or reduce any adverse impacts to the marine environment to ALARP and acceptable levels. The implementation of the EPOs specified within this document will provide Jadestone with the required level of assurance that the activities are being managed in an environmentally responsible manner.

This EP is written to allow for the continuation of production at the Stag Facility for a period of five (5) years from the date of its acceptance by NOPSEMA.

Table 2-1: Requirements of the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 and EP Summary

Reg	Requirement	Section
13(1) 11(4)(a)(i) 11(4)(a)(iii)	*Description of the activity* The environment plan must contain a comprehensive description of the activity including the following: a) the location or locations of the activity; b) general details of the construction and layout of any facility or other structure; c) an outline of the operational details of the activity (for example, seismic surveys, exploration drilling or production) and proposed timetables; d) any additional information relevant to consideration of environmental impacts and risks of the activity.	**2.5**
13(2) 11(4)(a)(ii)	*Description of the environment* The environment plan must: a) describe the existing environment that may be affected by the activity, as well as any relevant cultural, social and economic aspects of the environment that may be affected; and b) include details of the particular relevant values and sensitivities (if any) of that environment.	**5**
13(3) 11(4)(a)(iv)	*Description of environmental impacts and risks* The environment plan must include: a) details of the environmental impacts and risks for the activity; and b) an evaluation of all the impacts and risks.	**7, 8**
13(3a)	For the avoidance of doubt, the evaluation mentioned in paragraph (3)(b) must evaluate all the significant impacts and risks arising directly or indirectly from: a) all operations of the activity, including construction; and b) potential emergency conditions, whether resulting from accident or any other reason.	**7, 8**
13(4) 11(4)(a)(v)	*Environmental performance objectives and standards* The environment plan must include environmental performance objectives, environmental performance standards and measurement criteria that: a) address legislative and other controls that manage environmental features of the activity; and b) define the objectives, and set the standards, against which performance by the operator in protecting the environment is to be measured; and c) include measurement criteria for determining whether the objectives and standards have been met.	**7, 8**
13(5)	Requirements: The environment plan must describe the requirements that: a) apply to the activity; and b) are relevant to the environmental management of the activity	**7, 8**
14(1)	The environment plan must contain an implementation strategy for the activity in accordance with this regulation.	**9**
14(2) 11(4)(a)(vi)	The implementation strategy must include measures to ensure that the environmental performance objectives and standards in the environment plan are met.	**9**
14(3)	The implementation strategy must identify the specific systems, practices and procedures to be used to ensure that the environmental impacts and risks of the activity are continuously reduced to as low as reasonably practicable and that the environmental performance objectives and standards in the environment plan are met.	**9**
14(4)	The implementation strategy must establish a clear chain of command, setting out the roles and responsibilities of personnel in relation to the implementation, management and review of the environment plan.	**9**

Reg	Requirement	Section
14(5)	The implementation strategy must include measures to ensure that each employee or contractor working on, or in connection with, the activity is aware of his or her responsibilities in relation to the environment plan and has the appropriate competencies and training.	**9**
14(6)	The implementation strategy must provide for the monitoring, audit, management of non-conformance and review of the operator's environmental performance and the implementation strategy.	**9**
14(7)	The implementation strategy must provide for the maintenance of a quantitative record of emissions and discharges (whether occurring during normal operations or otherwise) to the air, marine, seabed and sub-seabed environment, that is accurate and can be monitored and audited against the environmental performance standards and measurement criteria.	**9**
14(8) 11(4)(a)(vii)	The implementation strategy must contain an oil pollution emergency plan and provide for the maintenance of the plan.	**OPEP**
14(8AA)	The oil pollution emergency plan must: a) be kept up-to-date; and b) include emergency response arrangements.	**OPEP**
14(8A)	The response arrangements in the oil spill contingency plan must be tested: a) when they are introduced; and b) when they are significantly amended; and c) not later than 12 months after the most recent test; and d) for a new location for the activity that is added to the environment plan after the response arrangements have been tested and before the next test is conducted — when the location is added to the plan; and e) for a facility or other structure that becomes operational after the response arrangements have been tested and before the next test is conducted — when the facility or structure becomes operational.	**OPEP**
14(9) 11(4)(a)(viii)	The implementation strategy must provide for appropriate consultation with: a) relevant authorities of the Commonwealth, a State or territory; and b) other relevant interested persons or organisations	**9**
14(10)	The implementation strategy must comply with the Act, the regulations and any other environmental legislation applying to the activity.	**9**
15	The environment plan must include arrangements for: a) recording, monitoring and reporting information about the activity (including information required to be recorded under the Act, the regulations and any other environmental legislation applying to the activity) sufficient to enable the Regulator to determine whether the environmental performance objectives and standards in the environment plan are met; and b) reporting to the Regulator at intervals agreed with the Regulator, but not less often than annually.	**9**
15(1) 11(4)(a)(ix)	The environment plan must include the details for the titleholder and nominated liaison person	**1.5**
16 11(4)(a)(viii)	The environment plan must contain the following: a) a statement of the operator's corporate environmental policy;	**2**
	b) a report on all consultations between the operator and relevant authorities, interested persons and organisations in the course of developing the environment plan;	**6**
	c) details of all reportable incidents in relation to the proposed activity.	**9**

2.2 Scope

The scope of this EP covers the following activities associated with the Stag Facility:

- Routine production;
- Crude oil loading activities to the third-party tanker;

- Routine inspection, maintenance and repair (IMR) of the CPF, subsea export pipeline, wells and associated subsea infrastructure (including use of remotely operated vehicle (ROV) and diving activities); and
- Non-routine and unplanned activities and incidents associated with the above.

The infrastructure covered by this EP includes the following as located within the defined Operational Area:

- Stag CPF;
- Pipelines and hoses;
- Subsea infrastructure tied back to the Stag CPF (including wells, wellheads, manifolds, risers, flowlines, etc.);
- CALM buoy;
- Support vessels assisting with activities defined above within the defined Operational Area; and
- Helicopter activity within the Operational Area.

This EP applies to activities undertaken within the Operational Area only as defined in the description of the activity (**Section 2.5**).

Activities that are not covered in this EP include third-party offtake tankers, nearby shipping activity, drilling or intervention activities undertaken by a mobile offshore drilling unit (MODU), or decommissioning. Vessels associated with Stag Operations when outside the Operational Area adhere to all applicable maritime regulations, and Commonwealth and State environmental management obligations, as relevant.

Activities proposed within the Operational Area outside the scope of this EP will be the subject of a separate EP or a revision.

2.3 Operational Area

The Operational Area is defined as the area within the 500 m radius Restricted Zone that extends around the CPF, subsea export pipeline, and CALM buoy.

2.4 HSE Policy

Protecting the environment, valuing cultural heritage and maintaining open stakeholder communication are an integral part of Jadestone's business approach. This is reflected in Jadestone's Health Safety and Environmental (HSE) Policy (**Figure** 2-1) and this EP.

HEALTH, SAFETY & ENVIRONMENT POLICY

Respect | Integrity | Safety | Results-oriented | Sustainability | Passion

PHILOSOPHY

Jadestone's philosophy is to ensure that health, safety and environmental protection is intrinsic to, and embedded within, our operating activities. The business focusses on those things that deliver top performance and value optimisation while eliminating waste. A focus on HSE performance provides a safe and rewarding work environment for Jadestone employees, and the achievement of sustainable business activities in the local and global communities where they work.

EXECUTION

Within the HSE Policy, Jadestone has committed to:

- Promote a strong HSE culture through visible leadership and an engaged, competent workforce aligned with Jadestone's Shared Values
- Assess all risks and manage them to as low as reasonably practicable
- Maintain an ever-improving HSE management system through setting and monitoring performance targets to achieve our aims within a framework of continuous improvement
- Take all necessary actions to prevent incidents, with an aspiration of targeting zero. Investigate and apply learnings
- Encourage and promote the ownership of HSE performance by all employees and contractors
- Ensure all contractor companies working with us have a management system that either equals or exceeds Jadestone's own management system
- Manage and maintain plant, equipment and machinery to achieve required performance, safety and integrity
- Openly monitor, evaluate and report HSE performance, and communicate to all relevant stakeholders, and
- Comply with all regulatory requirements as an absolute minimum.

RESPONSIBILITY

Everyone who is engaged to work for Jadestone shall be familiar with this policy and its contents.

Everyone must take responsibility for ensuring their own safety, the safety of those around them, and the protection of the environment, by following Jadestone's policies and procedures. That includes taking all necessary precautions and immediately acting upon and reporting any HSE concerns they may have.

Everyone has the right to stop the job and a responsibility to intervene in work fronts or activities if they feel there is a risk to themselves, their workmates or to the environment.

A. Paul Blakeley OBE
President & Chief Executive Officer

April 2020

Figure 2-1: Jadestone Energy (Australia) Pty Ltd HSE Policy

2.5 Legislative Framework

2.5.1 International Legislation

Australia is signatory to numerous international conventions and agreements that obligate the Commonwealth government to prevent pollution and protect specified habitats, flora and fauna. Those which are relevant to the operation of the Stag Facility are detailed in **Appendix A.**

2.5.2 Commonwealth Legislation

All activities conducted during the operation of the Stag Facility will comply with legislative requirements established under relevant Commonwealth legislation, and in line with applicable best practice guidelines and management procedures. These are further detailed in **Appendix A.**

2.5.3 Other Guidelines

Other guidelines applicable to Stag operations include:

- NOPSEMA Guidance: Environment plan content requirements (N04750-GN1344 Rev 4, April 2019);
- NOPSEMA Guidance: Responding to public comment on environment plans guidance note (N-04750-GN1847, Rev 0, April 2019);
- NOPSEMA Guidance: Oil pollution risk management (GN1488 Rev 2, February 2018);
- NOPSEMA Guidance: Notification and Reporting of Environmental Incidents (N-03000-GN0926 Rev 4, 8 June 2020);
- NOPSEMA Guideline: Consultation with Commonwealth agencies with responsibilities in the marine area (N-06800-GL1887 A705589, 3 July 2020);
- National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Commonwealth of Australia, 2009); and

Australian Ballast Water Management Requirements (Version 8, Department of Agriculture and Water Resources 2020).

2.5.4 EPBC Act

The *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* provides for the protection of the environment, especially those aspects of the environment that are matters of National Environmental Significance (NES); and promotes ecologically sustainable development through the conservation and ecologically sustainable use of natural resources. Under streamlining arrangements, impacts on the following matters protected under Part 3 of the EPBC Act are now assessed through NOPSEMA:

- World Heritage properties;
- National Heritage places;
- Wetlands of international importance;
- Listed threatened species and ecological communities;
- Listed migratory species; and
- Commonwealth marine areas.

Jadestone shall have regard to all matters pertaining to the above by ensuring that activities are managed to ALARP and acceptable levels through a robust evaluation process and the implementation of identified control measures and mitigation as identified in this EP.

2.5.5 Maritime Operations

The *Navigation Act 2012* is legislation which covers international ship and seafarer safety, protect the marine environment where it relates to shipping, and the actions of seafarers in Australian waters. Under the Commonwealth Administrative Arrangements Order, the *Navigation Act 2012* is administered by the Minister for and the Department of Infrastructure, Regional Development and Cities.

The Navigation Act gives effect to international conventions for maritime issues where Australia is signatory and provides the legislative power for Australia to implement treaties including the International Convention for the Prevention of Pollution from Ships (MARPOL) developed by the International Maritime Organisation. IMO MARPOL requirements for the discharge of pollution are implemented by the *Protection of the Sea (Prevention of Pollution From Ships) Act 1983*.

The Australian Maritime Safety Authority (AMSA) is a statutory authority established under the *Australian Maritime Safety Act 1990*. AMSA is Australia's national agency responsible for maritime safety, protection of the marine environment, and maritime aviation search and rescue.

Thus, the legislative requirements of environmental management of the maritime operation, which includes operation of the offtake tanker and its receipt of cargo from the Stag CPF, falls under these Acts and AMSA's statutory authority.

Administrative management of commercial vessels, which includes evidencing compliance with environmental requirements under AMSA's jurisdiction, is addressed through vessel vetting processes completed by third party independent agents.

2.5.6 MOU between AMSA and NOPSEMA

In March 2019, a Memorandum of Understanding was established between AMSA and NOPSEMA to guide cooperation and mutual assistance between AMSA and NOPSEMA in relation to carrying out their respective statutory functions for safety and environmental management in the offshore petroleum sector, including how the parties will respond to the interaction between vessels and offshore petroleum facilities.

Section 5.2 of the MOU provides the following:

In the context of this MOU the above legislation [Navigation Act 2012 and Marine Safety (Domestic Commercial Vessel) National Law Act 2012] *will generally apply to the transfer of goods and persons between a vessel and an offshore facility, noting there may be areas of joint interest where some transfers are managed from the offshore facility.*

Jadestone interprets 'joint interest' to include an offtake activity in which a tanker is transferred cargo from an offshore facility. The transfer of cargo from the Stag CPF to the offtake tanker is an activity that occurs under legislative instruments for which AMSA is the statutory authority, and this activity is not a petroleum activity as defined by the OPGGS Act nor therefore an activity for which NOPSEMA is considered the statutory authority.

The interface therefore of the offtake activity within the context of a petroleum activity and a maritime operation is that the transfer of hydrocarbon through the offtake hose is a petroleum activity to the point in the hose that connects at the offtake tanker (the manifold), and once the hydrocarbon cargo has passed the manifold to the tanker, this is now associated with the maritime operation for which AMSA is the recognised statutory authority.

2.5.7 Industry Codes of Practice

In Australia, the petroleum exploration and production industry operates within an industry code of practice developed by the Australian Petroleum Production and Exploration Association (APPEA); the APPEA Code of Environmental Practice (2008). This code provides guidelines for activities that are not formally regulated and have evolved from the collective knowledge and experience of the oil and gas industry, both nationally and internationally.

The APPEA Code of Practice covers general environmental objectives for the industry, including planning and design, assessment of environmental risks, emergency response planning, training and inductions, auditing and consultation and communication. The 'offshore development and production' section of the Code is of particular relevance to the operations undertaken at the Stag facility. As an APPEA member, Jadestone adheres to this Code of Environmental Practice when undertaking offshore exploration and production activities.

3. DESCRIPTION OF THE ACTIVITY

Provided herein is a description of the activities, equipment and operations that Jadestone has responsibility for at the Stag Field. For noting, activities and equipment precluded from this EP are described in Section 2.2.

3.1 Facility Layout and Description

3.1.1 Central Processing Facility

The CPF is a fixed oil production platform. It comprises a jacket, which is secured to the seabed by six drilled and grouted piles, a hull, which is supported on tubular legs, a process module and an accommodation module. The platform has accommodation, offices, medical and mess facilities for a maximum overnight manning level of 58 personnel on board.

The CPF stands approximately 20 m above sea level in a water depth of approximately 49 m LAT. The maximum topsides area is approximately 37 m x 57 m (2,109 m^2). The structure, including topsides and piles, weighs approximately 6,500 tonnes.

The CPF is located over a pre-installed mudline template as a guide and supports 12 well slots; in addition, five subsea water injection wells. Two subsea water injection wells are located approximately 1,100 m off the north-eastern corner of the facility, with the other three being located approximately 3,200 m west of the facility.

The topsides equipment includes the following process activities:

- Separation and processing of produced oil, gas and water;
- Produced water treatment and disposal offshore;
- Sand separation;
- Seawater treatment and pumping for water injection wells; and
- Gas flaring.

The topsides also include the following utilities:

- Power generation and distribution;
- Potable and utility water;
- Utility and instrument air;
- Heating, Ventilation and Air Conditioning (HVAC) system; and
- Hydraulic Workover Unit (HWU) for well intervention.

The CPF has a helideck and a boat landing area. Helicopter is the normal means of transport for personnel (refer Section 3.2.14). The CPF is serviced by a single crane, with a boom length adequate to reach all required laydown areas (refer Section 3.2.11**)**

3.1.2 Wells and Subsea Infrastructure

The scope of this EP includes all subsea infrastructure associated with production and water injection, including:

- Trees/ wells;
- Manifolds;
- Rigid spools;
- Flexible flowlines;
- Electric submersible pumps; and
- Chemical injection system.

Hydrocarbons from the reservoir are pumped to the topside manifolds via the wells for processing at the CPF. The production wells are completed with electric submersible pumps (ESP). Provision has been made for the downhole injection of chemicals beneath the pump intake, including demulsifier, scale inhibitor and corrosion inhibitor.

Water injection is required to maintain bottom hole pressure and to aid recovery.

The current estimated end of field life for Stag is 2035. The current wells in use on title are expected to produce until end of field life and therefore a firm date for cessation of production is not currently available. Noting that on the CPF are 12 slots for platform wells, over time wells are abandoned as they water out and the slots are required for infill drilling from the same slot. Therefore, the number of platform wells active at any one time is 12. There are also five subsea water injection wells with wellheads, two of these are inactive. At the end of field life, all wells shall be abandoned.

The wells authorised by title WA-15-L (or previous titles and within current title boundary) are provided in the table below, along with their status, type and other relevant information.

Table 3-1: Status of wells within WA-15-L

Well	Type	Status	Maintenance and monitoring
Antler 1, Centaur 1, Roebuck 1, Stag 1, Stag 16, Stag 2, Stag 22, Stag 3, Stag 34 Stag 35, Stag 4, Stag 41, Stag 42, Stag 5, Stag 7, Stag 8	Exploration/ Appraisal	Abandoned with wellhead removed and conductor / casing strings cut below the mudline.	N/a – no maintenance required as no wellhead in place
Stag-12H, Stag-15H, Stag-21H, Stag-25H, Stag-36H, Stag-37H, Stag-38H, Stag-43H, Stag-44H, Stag-45H, Stag-48H	CPF	Active Production well	Wells are maintained and monitored in accordance with the accepted WOMP (GF-50-PLN-W-00001 Revision 3)
Stag 49H	CPF	Active Production well	A minor revision to the in-force WOMP (GF-50-PLN-W-00001) was made to reflect the addition of 49H
Stag-17H, Stag-29H	Subsea	Inactive Injection well with wellhead and tree in situ. Stag 17H still has the flowline connected to the CPF, Stag 29H no longer has flowline attached (re-purposed on adjacent well)	Wells are maintained and monitored in accordance with the accepted WOMP (GF-50-PLN-W-00001 Revision 3)
Stag-18H, Stag-32H, Stag-40H	Subsea	Active Injection well with wellhead and tree in situ	Wells are maintained and monitored in accordance with the accepted WOMP (GF-50-PLN-W-00001 Revision 3)

3.1.3 Subsea Export Pipeline

The Stag 8" oil subsea export pipeline is a single 200 mm carbon steel pipeline that runs approximately 2 km from the Stag CPF to the Stag PLEM. A flexible underbuoy hose of 300 mm diameter connects the PLEM to the CALM Buoy.

The pipeline was installed in 1998 and was subject to a design life extension in 2013, extending the service life by 10 years to 2023. The pipeline has been designed and constructed to all necessary Australian and International standards.

The primary means of stabilising the pipeline is self-weight by the application of concrete weight coating along its length. Remotely operated vehicle/ autonomous underwater vehicle (ROV/ AUV) (refer **Section 3.2.15**) surveys are undertaken of the pipeline to identify possible span exceedance or buckling.

The subsea property described here as the subsea export pipeline (that is, property starting at the CPF and terminated at the PLEM) is operated under pipeline license WA-6-PL. For information in relation to the WA-6-PL instrument, refer to Pipeline Licence WA-6-PL (nopta.gov.au).

3.1.4 CALM Buoy

The Stag CALM buoy is located approximately 2 km to the north of the CPF and is linked by the subsea export pipeline and the PLEM. Oil from the subsea export pipeline passes through the CALM buoy product piping, swivel and valve isolation system, and into the floating offtake hose and the third-party tanker.

The product swivel ensures that a leak free, rotational connection is achieved between the buoy product piping and the offtake hose.

The buoy consists of six watertight compartments and is constructed so that in the event of damage and flooding of one compartment, it remains stable.

It is moored by a six-chain catenary anchor system which is secured by means of gravity anchors covered by rock berms. It is designed for securing third-party tankers up to 150,000 dwt.

Access to the buoy for maintenance and servicing is via a boat landing.

3.1.5 Third-party tanker

The tanker is operated by a third-party contracted to Jadestone and operates under International Safety Management (ISM) code. The tanker while in field, is moored to the CALM buoy and receives oil continuously from the CPF.

The following operations are carried out on or by the third-party tanker:

- Connection and disconnection from the CALM Buoy;
- Crude oil loading operations;
- Maintenance operations as per planned maintenance system for third party tanker; and
- Accommodation facilities for up to 30 persons.

Arrangements for the arrival, connection and disconnection of the third-party tanker are described in Jadestone's Stag Marine Tanker Operations Manual (GF-00-MN-H-00037) which is provided to the Vessel Operator during the contract pre-award engagement.

Oil passes from the CALM buoy into the third-party tanker via a 200 mm (8") diameter, up to approximately 220 m long offtake hose of double carcass construction with built-in flotation. The tanker is double-hulled and stores crude in cargo tanks.

The third-party tanker will use low sulfur heavy fuel oil or Stag crude oil as a fuel supply for its engines.

3.2 Operations and Process Description

Primary operations at the Stag CPF entail production and maintenance activities including:

- Production including water reinjection;
- Operational and emergency flaring of excess gas through flare systems;
- Processing and discharge of produced water within discharge limits;
- Processing and discharge of drainage/ oily waters;
- Produced sand handling;
- Loading of crude oil onto the third-party tanker; and
- Inspection, Maintenance and Repair (IMR) activities (topsides and subsea) including well intervention, plant modification and diving/ ROV operations.

Supporting activities associated with the facility operations include:

- Utility systems such as lighting, heating, ventilation and air conditioning, water systems, power generation, safety system, and accommodation facilities;
- Collection, treatment and disposal of sewage;
- Support vessel operations;
- Lifting operations; and
- Helicopter operations for transporting personnel and urgent freight.

For noting, installation of new subsea equipment or the tie-in of new production or water injection wells is not covered by this EP.

3.2.1 Production

Production includes hydrocarbon recovery from the reservoir via subsea wells and equipment, topside separation and processing of fluids. Profitable production is expected to be achievable at the Stag Facility for another 8 to 10 years.

Oil is exported to the third-party tanker. Gas is utilised for steam generation in the boiler. Water is processed and is then either reinjected, discharged overboard or sent to the third-party tanker for storage.

<u>Crude oil production</u>

Oil is currently produced from eleven production wells and supported by seawater injected into dedicated injection wells. The current layout of the Stag production field is shown in **Figure** 3-1**.**

Due to the low pressure of the reservoir, the wells are sub-hydrostatic and electric submersible pumps have been installed in the wells to draw reservoir fluids to the surface. Water injection is required to maintain reservoir pressure and to control the movement of oil within the reservoir to maximise its recovery. Seawater for water injection is pumped through coarse and fine filtration systems and de-aerated before it is pumped under high pressure into the water injection wells.

Reservoir fluids from the wells are typically delivered into two parallel production headers and then two stage product separators that split the well production into oil, gas and water streams. Oil is split from water and gas in the first stage separators, then heated and further treated to remove entrained water during the second stage. Oil polishing takes place in the electrostatic coalescer prior to export to the third-party tanker. Hot crude ready for export is cooled by heat exchangers and pumped to the oil export system. Crude oil may be drawn from the export line, conditioned and used as fuel in the main power generators.

<u>Produced sand</u>

Produced sand from the Stag Reservoir consists of fine sand and glauconite containing traces of oil and some heavy metals. In normal operation, suspended solids in the separators are carried by process water to hydrocyclones removing solids greater than 20 µm from the water stream to the solids handling system for further processing. Larger particulates not carried through by the produced water stream accumulate in the separators requiring regular sparging. Solids are discharged into bulki bags (~1.7 t) ready to ship to shore for disposal and liquids discharged to the slops tanks for recycled processing.

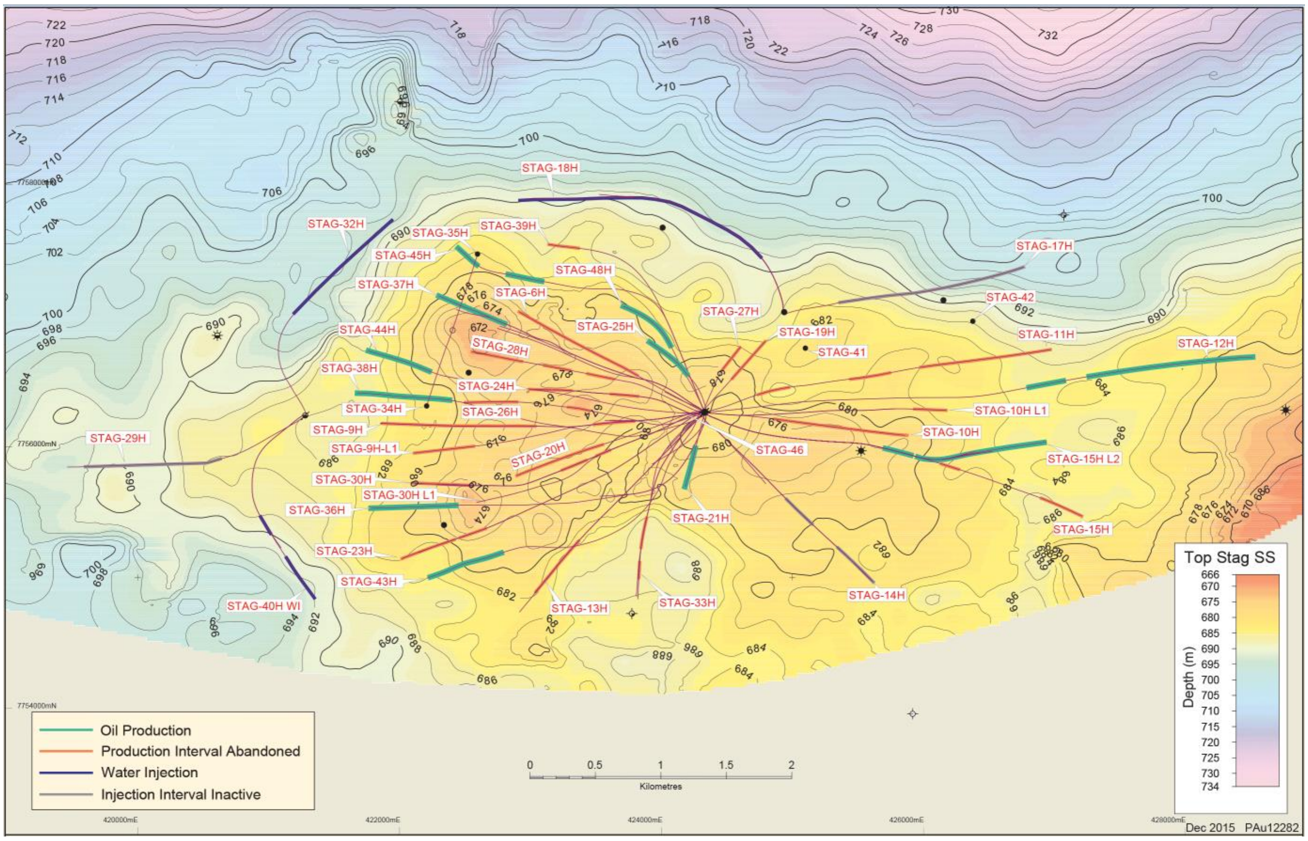


Figure 3-1: Stag Production Field Depth Structure

At the conclusion of the solids removal, some fine solids and oil may remain in the wash water and these are then tested before being pumped into deep water injectors 17H and 18H where they are returned to the reservoir.

Produced sands are not discharged to the marine environment.

3.2.2 Flaring

Gas that is excess to the fuel requirements for heating in the production process and excess blanket gas from the gas flotation unit, is burned as a continuous release through a flare system present on the CPF. Approximately 20% of the gas produced (current average flare rate of 300 sm^3/h) is used as fuel for equipment with the balance (80%) being flared.

The flare tip is supported on a 30 m boom attached to the side of the process module and is mounted to discharge vertically.

The gas flared on the CPF is primarily composed of methane and combustion releases carbon dioxide, carbon particles and water (**Table 3-2**).

Table 3-2: Composition of flaring gas

Element	Percentage
CH_4	96.08%
H_20	3.02%
N_2	0.67%
CO_2	0.16%
C_2H_6	0.07%

The flare system will accept the continuous release of:

- First stage separator gas in excess of fuel gas system demand;
- Off gas from the second stage separator;
- Excess blanket gas from the corrugated plate interceptors (CPIs); and
- Purge gas.

The flare system will also accept the intermittent release of gas from:

- Relief valves;
- Relief valve bypass vents;
- Flow-line vents;
- Blowdown valves; and
- Systems being prepared for maintenance.

The flare system is designed to handle a continuous flaring rate which may range between 0.3 and 10 million standard cubic feet per day (mmscfd); the flare typically operates at approximately 0.3 mmscfd. In addition, the flare system can accommodate an instantaneous flaring rate of 15 mmscfd.

3.2.3 Processing and Discharge of Produced Water

Production fluids from the reservoir arrive in a multi-phase state at the CPF where produced water is separated from the crude oil and treated. Provided below is a description of the stages of treatment of the original production fluid stream that results in the produced water discharge leaving the CPF.

The water flowing from the CPIs may be injected with an emulsion breaker and a polyelectrolyte before entering the Gas Flotation Unit (GFU), V203. The GFU is maintained under a fuel gas blanket at 100 kPag.

Cyclone turbine aerators within the flotation unit cause the entrainment of gas into the water. The gas bubbles preferentially attract the oil particles in the water stream which are floated to the surface where they coagulate/ coalesce and are skimmed from the water surface. The skimmed oil is drained into the Recovered Oil Vessel together with the oil from the CPIs.

The clarified water, which has an average residual oil content of less than 15 mg/l, flows to the environment via a pipe that discharges 0.5 m above mean sea level. The flow of clarified water is controlled by the water level in the Gas Flotation Unit.

Clarified water quality is continuously monitored by an in-line oil-in-water analyser AE2031. The monitor is integrated into the DCS to provide a continuous record of water quality and to alarm should water quality specifications be exceeded. Off-specification water will be redirected to the Open Hazardous Drain Slop Tank T 412.

A continuous produced water stream is discharged overboard at the CPF at a rate of approximately 3,816 m^3/d with an average oil-in-water (OIW) concentration of not greater than 15 mg/L over any 24-hour period.

Further information on produced water discharges made from the CPF is presented in Section 7.4.

On occasions, produced water is off-spec and is not able to be discharged overboard from the CPF. In these circumstances, the facility may either inboard the water to tanks on the CPF or push forward the water to the third party-tanker. If the water is inboarded on the facility, this water may later be cycled through the production process and cleaned to a quality that is then able to be discharged overboard at the CPF. If the water has been pushed forward to the third-party tanker, the water will remain in the tanker while it is on location at the CALM buoy and will not be discharged in field. Any water received by the third-party tanker during push forwards will be disposed of at the cargo receiving facility.

3.2.4 Drainage Systems

The Stag CPF drainage system collects hydrocarbon-based and other liquid wastes (rain and wash water etc.) from all areas across the facility via open (hazardous and non-hazardous) or closed drains.

Open drains

The Stag CPF open drains system consists of two separate collection systems, the hazardous open drain system and the non-hazardous open drain system. Hazardous areas and non-hazardous area drains are completely segregated to prevent ingress of hydrocarbons into a non-hazardous area via the drains system.

The hazardous open drains system is designed to remove and collect oily water from hazardous areas, such as wash down water and spillage of liquids on decks, detergents, equipment drip trays or bunded areas. Collected fluids are routed to two slops storage tanks with a total capacity of 250 m^3. All drains into the tanks are via standpipes into a water trap which prevents any back flow of oil/ gas. Liquids are recovered and processed through the second stage of the production separation system and treated prior to discharge.

Drainage from the helicopter landing deck is allowed to drain directly overboard.

The non-hazardous open drains system collects rainwater, wash down water and spillage of liquids from decks located in non-hazardous areas of the facility.

Closed drains

The closed drain system collects liquids from:

- Normally pressurised and hazardous equipment prior to maintenance;
- Flare drum liquids;
- Produced water degasser;
- Operational drainage from the oil separators;
- Liquid sampling draining from the oil separators; and
- Level bridle drains.

The closed drains system is combined with the flare system and consists of a flare knockout/ closed drain drum and transfer pumps. The hydrocarbon liquid drained from the process equipment is drained by gravity flow to the flare/ closed drains drum via drain headers. Under normal operations the liquids in the closed drains drum are pumped back under level control to the process upstream of the oil heaters.

3.2.5 Inspection, Maintenance and Repair Activities

IMR is undertaken at planned intervals to maintain performance, reliability and prevent deterioration or failure of equipment and ensure safe and reliable operation of the facility. IMR activities (including corrosion control; refer **Section 3.2.6**) are scheduled through Bassnet and generally involve up to four campaigns per year and is conducted on all operating assets included suspended infrastructure at appropriate frequencies.

IMR activities include maintenance of the topside equipment and structural components of the CPF, all subsea infrastructure and crude oil transfer facilities (CALM buoy, transfer hose and associated appurtenances). This may include activities such as cycling of valves, pressure and leak testing, lubrication of rotating equipment, and cleaning and painting activities for corrosion protection.

Maintenance is managed using the Bassnet Computerised Maintenance Management System (CMMS) and enables:

- The ability to analyse equipment for better maintenance regimes, design changes or replacement;
- The ability to schedule and plan timely removal of infrastructure in a safe and environmentally responsible manner;
- Timely preventative maintenance schedules;
- Improved control over maintenance expenditures;
- Automatic parts ordering and inventory control;
- Reduction of inventory costs and improved stores accountability; and
- Improved utilisation of labour.

Preventative maintenance is incorporated into the CMMS and includes:

- All routine inspections;
- All statutory inspections; and
- All maintenance carried out on a usage basis such as machine running hours.

Inspection of subsea infrastructure is the process of physical verification and assessment of components detect changes to its as-built state. Inspections are planned to occur every three years (Table 3-2) and techniques may include general visual inspections, cathodic protection surveys using ROV, side-scan sonar (SSS) using the vessel's transducer or autonomous underwater vehicle (AUV), and wall thickness measurements using ROV-deployable tools.

Table 3-3: Nominal Inspection Cycle

Item	Year 1	Year 2	Year 3	Year 1
Rigid pipelines and risers	ROV, SSS or AUV	General visual cathodic protection	None scheduled	Recommence cycle
Fixed steel platforms and conductors	Drop cell cathodic protection survey	General visual cathodic protection	Drop cell cathodic protection survey	Recommence cycle
Subsea systems and structures	None scheduled	General visual cathodic protection	None scheduled	Recommence cycle
Static flexible flowlines	None scheduled	General visual cathodic protection	None scheduled	Recommence cycle
Dynamic risers, dynamic umbilicals, mid-water buoyancy systems	Rolling 2 yearly subsea integrity inspection			

Maintenance and repair activities may include corrective (e.g. repair of equipment) and non-routine maintenance, which may occur during shutdown periods. These activities are largely unplanned and interrupt production and so are not expected/ wanted more than once every few years. The only liquid discharges that may occur during maintenance and repair activities are cooling water that will discharge directly to the sea (refer **Section 7.5**) and freshwater associated with cooling circuits on the generators that will be discharged to the drainage system (refer **Section 7.5**).

Platform and diving frequencies are set 'as required' as per Subsea Inspection Strategy (JS-16-PR-U-00001) and are based on findings during ROV Surveys and planned maintenance requirements. Diving operations will be supported by a suitable Diving Support Vessel (DSV) operating in DP mode or anchored in the field.

The underbuoy hose change out is conducted in accordance with the Underbuoy Hose Removal and Replacement Procedure (GF-19-PR-G-00001). The process of change out includes clearing the line of oil followed by a flush with seawater to the third-party tanker where the water is processed through the slops system. Discharges are thus as per slops discharge (refer **Section 7.4**).

Subsea integrity and maintenance activities carried out by Jadestone include the CPF, subsea export pipeline, CALM buoy (and mooring chains) and underbuoy hoses. The activities are undertaken and managed in accordance with CALM buoy – Operation and Maintenance Manual (TKA-G-800-MA-0010/Rev1), Jadestone's Subsea Inspection Strategy (JS-16-PR-U-00001) (summarised in Appendix D Stag Performance Standards Report (GA-70-REP-F-00007) and Subsea Flexible Hose Maintenance Procedure (GF-16-PR-L-00187). Other than discharges as per the underbuoy hose change out, there are no other discharges to the marine environment.

Wetblasting or grit blasting may be used to prepare structures or equipment prior to painting/ coating. Before commencing wetblasting or grit blasting, the work area is walled-in using sheeting that is taped down to create a fully contained work environment. Wastewater and particulate material (e.g. garnet if grit blasting, paint flakes and rust off old surface coatings) generated during the activity is managed within the work environment and is not discarded to the marine environment.

3.2.6 Integrity and Corrosion Control

Integrity and corrosion control work involves anode replacements on the various subsea pipelines and offshore facilities, cathodic protection monitoring, weld inspections, ultrasonic wall thickness testing, flooded member detection surveys, free span inspection of pipelines, coating inspection and repairs, , protective leg wrap maintenance and installation, non-destructive testing and general inspections and maintenance of subsea valves, Xmas trees and conductors, conductor guide centralisers and other subsea infrastructure. These activities can involve ROV/ AUV inspections or diver assisted surveys.

A program of ongoing fabric maintenance of the CPF is also undertaken as part of the corrosion control program. Prior to painting, the offshore structures are ultra high-pressure water or grit-blasted with garnet (a natural coastal sand product).

Following an inspection, it may be necessary to modify the seabed in the vicinity of subsea infrastructure such as the pipeline to correct for free spans (by placing grout bags under the free span) or burial (by jetting or airlifting sediments from on top of the pipeline).

As part of the maintenance of these facilities, marine growth on the substructures is monitored using ROV and/ or divers and if determined to be beyond the design imposed acceptable thickness it is periodically removed. This is usually undertaken by either water blasting or manual ROV, divers or bespoke automatic devices.

Inspections are scheduled to occur every three years, and replacement programs are planned on inspection findings. No discharges to the marine environment occur with planned replacement activities or inspections.

3.2.7 Utility Systems

<u>Power generation</u>

Main electrical power is supplied by three generator sets powered by Caterpillar diesel engines. Primary fuel for these engines is treated Stag crude oil however they can also run on diesel if required. Each machine is contained within its own enclosure, which provides weather protection, sound attenuation and fire protection.

Cooling water

Seawater is used as a heat exchange medium for the cooling of the three onboard power generators. The cooling water is drawn through a segregated cooling system and is therefore not contaminated by engine oils or other liquid discharges from the process. Average discharge rates are up to 108 m^3/h for each of the generators. Discharge water is approximately 3°C above ambient marine waters and is discharged at hull level.

An industrial grade saltwater chlorinator is used to produce chlorinated water to dose the respective caisson and pumps utilising sea water to prevent the accumulation of marine growth throughout the system. More information on the discharges and process for cooling water are presented in **Section 7.5**.

Desalination brine discharges

The freshwater system is designed to produce, store and distribute fresh and potable water throughout the CPF. During normal operations, fresh and potable water is produced via a desalination process and results in a discharge of ~850 m^3/d with elevated salinity (approximately 10% higher than the intake seawater), increase in temperature (between 27–39°C) and low concentrations of anti-scale chemicals. The seawater feed is taken from the main generator seawater cooling return line and further heated as required by steam supplied from the boiler.

Potable water may also be delivered by supply vessel during extended maintenance periods. A unique hose connection is provided to prevent cross contamination by inadvertent transfer of diesel from the supply vessel.

Storage is provided in a single Potable Water Tank, T960, of 215 m^3 capacity located within the west side of the hull structure. The tank is fitted high and low level alarms and trips.

Heating Ventilation and Air Conditioning (HVAC) system

The purpose of the HVAC system is to:

- Purge enclosed designated areas of the accommodation and hull to maintain a non-hazardous classification and to prevent the entry of flammable gases;
- Provide conditioned air to manned areas to ensure a comfortable working and living environment;
- Provide controlled temperature in enclosed areas for the safe and efficient running of equipment; and
- Purge contaminated air from areas housing essential equipment before reoccupation (black start purging).

Two major air distribution systems are provided, one for the accommodation module and one for the hull. Each system has its own fans, ducting distribution system and fire dampers where required, but they share a common chilled water plant which supplies the cooling medium to both systems.

Facility lighting

The CPF is provided with lighting throughout the accommodation and process areas. In the event of a power failure, the system changes over to a low voltage emergency system.

Fuel gas

Gas produced from the process separators is used as fuel in the boiler and for process blanketing. The remaining gas is sent to flare.

3.2.8 Well Intervention and Workover Operations

A range of well intervention activities are undertaken at the Stag CPF including:

- Workover to replace ESP, including
    - Well kill operations,

    - Pull out of hole and lay down faulty completions,
    - Rig up and run in hole new completion,
    - Cementing, and
    - Casing integrity tests.
- Wireline interventions;
- Annulus monitoring/ treatment;
- Perforating;
- Water shut-off/ zonal isolation;
- Production logging;
- Sand clean out;
- Casing milling, cutting recovery and patch work; and
- Commissioning of new production wells may occur during Stag CPF operations as required.

Work overs and interventions are undertaken on an as needs basis. Based on previous years' activities, approximately seven work overs/ interventions have been required per year. Based on historical activity, it is assumed that approximately 35 work overs/ interventions will be required over the lifetime of this EP.

During work overs and interventions, a dedicated workover crew, working day and night shifts undertakes the required well intervention activities. A brief description of each well intervention and workover activity as listed above is provided below. For noting, discharges to the environment do not occur during or as a result of these activities as the work is carried out on wells that are accessed on the topside of the platform.

<u>Workover to replace ESP</u>

Workovers and interventions are generally conducted utilising the Stag Hydraulic Workover Unit (HWU). The Stag HWU is operated under the procedures set out in the Stag Hydraulic Workover Unit Operations Manual. This manual describes the operating and maintenance requirements of the HWU and details the policies and procedures specific to the unit.

The normal sequence of operations for a workover is as follows:

- Well kill operations (injection of kill fluid (seawater treated with biocide) into well);
- Pull out of hole and lay down faulty completions;
- Casing integrity tests (if required); and
- Pick up and run in hole new completion.

Current Stag reservoir pressures range from approximately 1,380 kPa (200 psi) – 5,250 kPa (760 psi), equivalent to a 0.776 SG fluid gradient. Given Stag oil density is 0.893 SG, hydrostatic pressure of a full column of reservoir oil is greater than the maximum reservoir pressure, therefore the wellbore cannot hold a full column of fluid and cannot flow liquid to surface unassisted. With reservoir pressures being sub-normal, well kill operations are conducted using treated (biocide) sea water.

Casing integrity tests may be conducted if there is believed to be a well integrity issue with the 244 mm production casing. To test the casing integrity, an inflatable packer is run into the well on pipe to the selected test depth, inflated and the casing is pressure tested with seawater to a pre-determined pressure. The inflatable packer is then retrieved from the well and workover operations continue as programmed.

<u>Wireline Interventions</u>

Wireline interventions may be run as part of a workover program or as a separate, standalone operation.

Wireline operations include the running of electric tools into the well for conducting measurements. Measurements can include casing wall thickness, cement evaluation (behind casing), production logging (tools used to measure production properties of the well, for example fluid density, flowrate), formation logging (tools used to measure properties of the formation, for example rock density, resistivity, sonic properties), determining static fluid levels and setting of plugs to seal off the tubing or casing.

Wireline operations can be conducted with pressure containment equipment on live wells or on killed wells during workover operations.

Annulus Monitoring/ Treatment

Annulus monitoring is the measurement of pressure and fluid characteristics in the annuli of the well. This is a routine activity and completed as part of the well integrity management.

If pressures build up to unacceptable levels in the well annuli, annulus fluid will be bled off to the process so as to reduce the pressure. Samples of fluid will be taken so a determination as to the source of the pressure build-up can be identified.

Perforating

Perforating is an activity that may be undertaken to increase productivity (or injectivity) of the well. Small shaped explosive charges are conveyed into the well to a predetermined depth and detonated. The explosive charges blast a small hole through the casing and cement and into the formation to enable fluids to flow from the formation into the well.

Perforating guns can be deployed into the well as part of a wireline intervention, on coiled tubing or on pipe with the HWU.

Explosive charges to sever pipe of plasma cut pipe are included in this perforating activity. These operations are conducted if a string is stuck and needs to be freed from the well.

While perforating activities cause the release of sound energy, as the energy is released hundreds of metres downhole there is no transmission of sound energy to the marine environment. Therefore, no impact assessment of this planned activity appears in **Section 7** of the EP.

Water shut-off / zonal isolation

Water shut offs or zonal isolations are normally carried out by the HWU.

Depending on the location of the zone required to be shut-off will determine the tools and technique used to achieve the isolation. All shutoffs will be conducted utilising the deployment of mechanical barriers into the well, be it bridge plugs or straddle packers/ liners.

Sand clean out

During production, it is common for sand to be deposited and accumulate inside the horizontal sections of casing.

During workovers or interventions, this sand can impede access to the required section of the well. To gain access to the well, this sand has to be flushed away.

With reservoir pressures being sub-normal and the limited pumping capacity of the Stag HWU, it is impossible to lift the sand to surface. As a result, if sand clean-out is required, fluid is injected at surface and the sand is agitated at the build-up to flush it back into the reservoir.

Casing milling, cutting, recovery

During workover operations, or as part of abandonment preparation work, there may be a requirement to cut and recover casing or mill casing or downhole tools.

Casing cutting is achieved through the running of a casing cutting tool into the well. Metal blades on the casing cutter are activated by pumping through the tool. The tool is then rotated with the blades cutting the casing. After cutting the casing cutter is retrieved and the casing can then be recovered (pulled) back to surface.

Well kill/ suspension

Well kill is the process of pumping fluid with a density greater than the produced fluid into the well to stop the well from flowing. This is done to control the well.

Current Stag reservoir pressures range from approximately 1,380 kPa (200 psi) – 5,250 kPa (760 psi), equivalent to a 0.776 SG fluid gradient. Given Stag oil density is 0.893 SG, hydrostatic pressure of a full column of reservoir oil is greater than the maximum reservoir pressure, therefore the wellbore cannot hold a full column of fluid and cannot flow liquid to surface unassisted. With reservoir pressures being sub-normal, well kill operations are conducted using treated (biocide) sea water.

Disposal of NORMS tubing (onshore).

During workovers, the tubing is recovered from the well. During the production phase, naturally occurring radioactive materials may have been deposited on the walls of the tubing.

As tubing is recovered from the well it is tested for radioactivity. If found to be radioactive, the tubing is quarantined, shipped to shore and disposed of by the waste contractor in accordance with the necessary requirements for the disposal of such waste.

3.2.9 Plant Modification

Plant modification may entail the removal, replacement or installation of new equipment to either surface or subsea equipment. Plant modification may occur in response to operational changes or new technology. Such modifications may include removing pipework and process units or upgrading the various components and equipment on the platform, including the addition of new equipment.

When equipment becomes obsolete, or requires change due to wear, corrosion or age, it will be changed out for new, more modern/efficient replacements. Prior to change out, flushing of the section will be undertaken using water and nitrogen, with discharges managed through the closed drainage network, after which the section will be isolated and changed out.

No discharges to the marine environment are planned during modifications to plant and process equipment.

3.2.10 Waste Management

Jadestone's Waste Management Plan (JS-70-PR-I-00034) applies to activities in the Stag Field, which details the waste management practices during operation. The Waste Management Plan also addresses controlled waste management in accordance with the Environmental Protection (Controlled Waste) Regulations 2004. There are no planned discharges of solid wastes to the marine environment.

Non-Hazardous waste

Non-hazardous solid wastes include scrap metal, packaging, wood, cardboard, paper, empty containers and putrescible waste (food scraps) that will routinely be transferred onshore for recycling or disposal.

Non-hazardous wastes are segregated at source into recyclable and non-recyclable wastes and stored in marked containers for transport onshore to Dampier for recycling disposal.

Non-hazardous wastes produced on the Stag CPF that will be segregated to facilitate recycling include:

- Paper and cardboard;
- Mixed plastics;
- Aluminium cans;
- Wooden pallets; and
- Scrap metal.

All non-hazardous solid wastes will be returned to the mainland for disposal or recycling by back-loading onto a support vessel in closed containers (e.g. skips, wheelie bins, tanks or bulki-bags). Jadestone's waste management contractor will dispose of general wastes to an approved landfill facility or appropriate treatment/ recycling facilities for segregated wastes.

Hazardous waste

Hazardous wastes routinely generated include oil contaminated material (e.g. sorbents, filters and rags), spent chemicals and chemical containers, used engine oil, paint cans, hydraulic fluids, batteries, fluorescent tubes, cooking oils and medical wastes. NORMs in the form of scale and sands may be also be generated. Wetblasting, if performed, will generate a sludge waste comprising blasting medium (if used, i.e. garnet), rust and particles of old surface coatings (e.g. paint and epoxy). Oily waste material may also be generated as a result of oil spill response activities.

Hazardous wastes will be segregated at source and stored in clearly marked containers prior to transfer onshore to Jadestone's waste management contractor for recycling wherever practicable or disposal at a licensed waste disposal facility. Hazardous waste types to be segregated in accordance with the Waste Management Plan are:

- Aerosol cans (recyclable);
- Batteries (recyclable);
- Electronic waste (recyclable);
- Empty plastic / metal drums (recyclable);
- Flammable liquid wastes (non-recyclable);
- Fluorescent tubes (recyclable);
- Gas cylinders (recyclable);
- Glycol (non-recyclable);
- Hydrocarbon sludges (non-recyclable);
- Medical waste (non-recyclable);
- Produced sands (non-recyclable);
- Solid hazardous waste (non-recyclable); and
- Waste Oil (recyclable).

Handling and storage of waste chemicals will be in accordance with the relevant Safety Data Sheet (SDS).

As described in **Section 3.2.1** produced sands are generated on the Stag CPF from the Stag reservoir. The sands settle out in the separators where they are regularly flushed to the Stag sands solids washing and handling process. The dry sands are transported back to the mainland in 'bulki bags', each containing approximately 1.7 t of material.

A third-party assessment of NORMs levels in Stag sands – Radiological Assessment of Washed Sands generated from the Stag Offshore Production Platform (GF-7-0-REP-F-00001) – indicated that the levels of NORM within Stag sands do not put them into the category of radioactive waste and that no special procedures/ guidelines are required for handling, transportation or disposal on the basis of their NORMs activity.

Table 3-4: ^{226}Ra and ^{228}Ra Activity Within Stag CPF Produced Sands between 2007 and 2016

Sample Year	^{226}Ra (Bq/kg)	^{228}Ra (Bq/kg)
2007	276	298
2009	1,292	1,363
2010	209	227
2011	265	309

Sample Year	^{226}Ra (Bq/kg)	^{228}Ra (Bq/kg)
2012	275	273
2013	188	189
2014	111, 107	117, 114
2015	127	155
2016	217	251

Third-party tanker and Support Vessels

For the third-party tanker and support vessels against which MARPOL Annex V and/or Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (Part IIIC)/ AMSA Marine Order 95 apply, wastes are contained, segregated, stored, labelled, processed and disposed of in accordance with a Garbage Management Plan, as specified in MARPOL Annex V or AMSA Marine Order 95. Waste may be incinerated onboard the third-party tanker.

3.2.11 Lifting Operations

The Stag Platform is equipped with a single Amclyde Model 20000 diesel-hydraulic pedestal crane, installed on the west side of the CPF. The crane pedestal is integral with the structure of the process module. The crane has a main hook, which was designed to be reeved with four or six lines, and an auxiliary hook with a single line, however, the main hook has been de-rated to four lines only due to the capacity of the crane pedestal. The maximum load of the crane is 26,309 kg.

The crane has an additional brake on the whipline to facilitate personnel riding. The CPF also has monorails and pad eyes installed for use in lifting operations.

Lifting equipment and loose lifting gear are managed in Bassnet CMMS. All personnel involved in lifting operations are suitably competent and hold the relevant qualifications. The lifting operations are managed using the permit to work (PTW) system and follow the Lifting Operations Procedure (JS-90-PR-F-00036).

3.2.12 Export and Offtake Operations

Transfer of Stag crude oil from the CPF to the third-party offtake tanker passes through several pieces of infrastructure and equipment:

- A rigid 8” riser;
- Subsea export pipeline;
- Pipeline end manifold (PLEM);
- Flexible riser at the PLEM;
- The underbuoy hose up to the CALM buoy;
- From the CALM buoy the oil passes through a 200 mm (8”), up to approximately 220 m long, double carcass type floatation hose (the offtake hose). Within the offtake hose a marine breakaway coupling (MBC) is positioned between hose sections 5 and 6; and
- At the end of the offtake hose the oil passes through a manifold connection at the third-party offtake tanker.

The equipment described above is indicated in Figure 1-1.

Transfer of crude oil through the export and offtake infrastructure and equipment is usually gravity fed. This means that the height difference between the Stag CPF where the transfer of cargo commences, and the height at the tanker manifold are different (i.e. the CPF is higher than the tanker manifold) and allow the cargo to flow across the field from the CPF to the tanker. The gravity feed process does not involve a pump.

In the circumstance that transfer is impeded from the CPF to the tanker (e.g. in cooler months when the cargo is more viscous, or when the tanker is empty and the manifold is higher), an export pump is used. The export pump is fitted with a minimum flow valve which automatically recirculates the oil around the pump to maintain the level in the production process on the CPF. The maximum discharge of the pump can therefore only be the maximum production rate from the facility at the time (i.e. a maximum pumped rate of up to 5,000 bbl/d).

Periodically, once cargo loading is complete (approximately every three to four months) or during cyclone response (between the months of November to April inclusive each year), the third-party tanker will depart the field. During this period, either a replacement tanker will arrive, or the field will be shut in until a tanker arrives. In the event a third-party tanker is not in field, the offtake hose will remain shut in and connected to the CALM buoy.

Approximately 3 to 4 planned production shut ins will occur each year in relation to change out of third-party offtake tankers. Shut ins are required for cyclone departure and reconnect of the tanker, as well as for planned maintenance programs of the CPF and subsea infrastructure. The field planning process manages the competing demands of the drivers for shut ins to maintain a consistent frequency of shut ins so operations remain consistent for the facility. The primary risk associated with shut ins due to any of the drivers listed is damage to electrical submersible pumps used downhole in production wells which can be materially affected during production shut in periods.

Following reconnection of the third-party tanker, the underbuoy hose, offtake hose and CALM buoy connections will be leak tested to ensure integrity prior to recommencement of production and cargo transfer to the third-party tanker. in the event integrity defects are identified during pre-cargo transfer testing, an appropriate repair plan is implemented.

Inspection and maintenance activities, as well as operation of the offtake equipment, is the responsibility of Jadestone. The offtake equipment described here is also described in the Facility Description of the Stag Development Safety Case (GA-70-REP-F-00003.02). As such, Jadestone is also the Operator registered with NOPSEMA and is responsible for the operation and maintenance of the equipment, as required by an Operator of a Facility under the OPGGS Act.

Planned inspection and maintenance activities undertaken as a minimum for the offtake equipment includes the following:

- A monthly visual inspection of the offtake hose;
- An annual pressure test of the offtake hose; and
- A five year replacement of the offtake hose (including the MBC situated within the hose).

3.2.13 Support Vessels

Supply/ support vessels provide support activities to the facility during operations, including transport materials, fuel and chemicals, for offloading and backload of equipment, waste and materials.

Support vessels may be used for maintenance, static tow, and connect/ disconnect activities, as required.

These vessels may also be used to provide oil spill response services in the case of an incident.

3.2.14 Helicopter Operations

Helicopter operations contracted for Stag Facility operations encompasses routine crew change and access to 24-hour medivac coverage. The helicopter hanger and passenger processing facilities are currently conducted out of the Karratha airport; however, the aircraft contract arrangements are reviewed on a regular basis and the contractor and heliport arrangements may be changed from time to time.

Helicopter contracting and technical and operational specification are referenced in accordance with OGP Aircraft Management Guidelines.

Aircraft operations and aviation passenger safety are administered by the CAA of Australia which issues guidelines for aircraft take-off and landing facilities.

The helideck on the facility is designed, illuminated, marked out and operated/audited in accordance with these guidelines:

- CAP 437: UK C.A.A. 8th Edition Jan 2018: Standards for Offshore Helicopter Landing Areas; and
- CAAP 92-4(0): Australian CASA – Guideline for the development and operation of off-shore Helicopter Landing Sites.

Selected core personnel on the facility are trained in helicopter operations and helideck procedures, enabling each of them to perform the duties of the helicopter landing officer (HLO) if required.

Wind speed and weather limitations for flights are defined by the aircraft operator and all aircraft operations are at the ultimate discretion of the pilot.

There are no helicopter refuelling facilities on Stag, and no planned helicopter operations on the third-party tanker.

3.2.15 Diving and ROV Operations

Diving operations (air diving or saturation diving) may be required at the Stag CPF and Stag CALM Buoy to conduct inspection and survey, maintenance and repair or intervention. A diving contractor with a NOPSEMA accepted Diving Safety Management System (DSMS) will be contracted to perform diving activities from a diving support vessel (DSV). No diving operations will be carried out from the Stag CPF.

Typical diving activities are summarised in Table 3-4. These activities may be initiated to maintain the safety and operation of the facility and are carried out using detailed planning and maintenance procedures.

Table 3-4: Typical Diving and ROV Activities Undertaken at the Stag Facility

Diving/ ROV tasks	Specifications
Inspection and survey	Inspection of pipelines, pipeline risers and subsea infrastructure (including the CALM buoy and mooring inspection); non-destructive testing inspection; photography and video; condition monitoring.
Maintenance and repair	Cathodic protection measurements and anode replacement; cleaning and marine growth removal; pipeline/ riser coating removal and repair; free span correction; air lifting and dredging; general maintenance of structures, pipelines and risers; underbuoy hose removal and replacement; mooring chain maintenance and replacement.
Intervention activities/ valve operations	Installation and recovery of subsea temporary pig receivers/ launchers; installation of pipeline and riser repair clamps; replacement of flexible risers/ pipelines; installation of protection frame and subsea structures; subsea manifold valve operation.

3.3 Hazardous Substances and Chemical Selection Process

Production chemicals are required to be added to the production process to ensure the process is operating efficiently. The primary means of reducing the risk of environmental impacts from the composition of chemicals used is achieved through Jadestone's Chemical Selection Evaluation and Approval Procedure (JS-70-PR-I-00033). The procedure prioritises the use of environmentally low risk chemicals by undertaking a risk assessment of the product.

The risk assessment process assesses chemicals based on toxicity, biodegradation and bioaccumulation to select an appropriate product. Selection is based on the United Kingdom's Offshore Chemical Notification Scheme (OCNS):

- Chemicals that are Gold, Silver, group E and D under the OCNS Definitive Ranked Lists and have no substitution warning do not require further assessment, as they do not represent a significant impact on the environment in standard discharge scenarios;
- Chemicals not meeting the criteria above (i.e. OCNS white, blue, orange, purple, A, B, C or have product/ substitution warning) require additional assessment to understand the environmental implications for an expected portion to be discharged into the marine environment; or
- Chemicals that are not OCNS registered require further assessment to determine the environmental implications if the chemical is discharged into the marine environment.

Appendix N contains the template for the Environmental Risk Assessment of Chemicals for Operational Activities, extracted from the chemical selection evaluation and approval procedure (JS-GF-70-PLN-I-00002).

The selection of chemicals that fall into the last two assessment types require the additional development of an ALARP justification using a standard template and are subject to periodic review as part of the continuous improvement of chemical selection and usage.

The quantity of chemicals used, and therefore the residual concentration discharged to the environment, is reduced to as low as practicable through routine sampling and assessment from various points in the production process. Concentrations and dosages of chemicals need to be maintained at certain levels to meet the production requirements, but excessive levels are not desirable due to increased operational costs as well as the potential for environmental impacts (Chemical Dosing - Process Chemicals, GA-19-PR-P-00015).

3.4 Maintenance and removal of property

3.4.1 Maintenance of property

Section 572(2) of the OPGGS Act requires that a titleholder must maintain in good condition and repair all structures that are, and all equipment and other property that is:

(a) in the title area; and

(b) used in connection with the operations authorised by the permit, lease, licence or authority

Through ongoing monitoring and maintenance (as described in **Section 3.2.5**), Jadestone will ensure that property is monitored, maintained and repaired as required throughout operations. This includes

- Routine inspections on operational and suspended infrastructure
- Assurance activities
- Maintenance activities

3.4.2 Asset Lifecyle and removal of property

Jadestone is committed to managing the lifecycle of its assets through the implementation of Jadestone's Management of Aging Assets Philosophy (JS-00-PHL-G-00001) which applies to all Jadestone's operating assets. The objectives of this philosophy are to:

- Describe the systematic approach taken to implement, verify and assure the management of ageing assets;
- Identify how the organisation supports delivery on a sustainable basis;
- Describe how planning and implementation is effected; and
- Identify how validation and assurance activities influence the overall program.

The current expected field life for Stag is estimated at 2035. **Table** 3-5 below summarises the infrastructure within the field and its year of commission. Design life in the context of facilities is used in procurement to avoid any obsolescence issues arising during the nominated period, whereas facility integrity is indefinite subject to ongoing integrity management.

Structural components of the Stag facility were designed for a fatigue life of 50 years. Life extension beyond original design life is an ongoing independently certified process. Much of the structural components (Jacket, CALM buoy etc) have currently been extended out to 2023 subject to an agreed ongoing integrity management program), and the current strategy for decommissioning the Stag field is to undertake removal of property at the end of field life which is currently estimated as 2035. Property may also be decommissioned and removed, if that property is determined at any time to have no future utility.

Table 3-5: Year of commission and design life of infrastructure within Stag field

Infrastructure/Equipment	Year of Commission	Design Life
CPF comprising Jacket & Topsides	1998	Structure 50 years[1] Facilities 15 years[2]
Subsea export Pipeline & PLEM	1998	25 years[2]
CALM Buoy	1998	25 years[2]
Flexible Transfer Hoses - Underbuoy Hose & Offtake Hose	Various	10 years plus, dependent upon tested performance[3]
Wells		
12H	1997	Not Applicable[4]
14H	1998	Not Applicable[4]
15H	2000	Not Applicable[4]
17H	1999	Not Applicable[4]
18H	1999	Not Applicable[4]
21H	2000	Not Applicable[4]
25H	2003	Not Applicable[4]
27H	2008	Not Applicable[4]
29H	2006	Not Applicable[4]
32H	2008	Not Applicable[4]
36H	2011	Not Applicable[4]
37H	2010	Not Applicable[4]
38H	2011	Not Applicable[4]
40H	2011	Not Applicable[4]
43H	2012	Not Applicable[4]
44H	2012	Not Applicable[4]
45H	2012	Not Applicable[4]
48H	2013	Not Applicable[4]
49H	2018	Not Applicable[4]

Notes

1. Design life associated with Structural components is 50 years nominal with integrity management assured by an ongoing fitness for service certification programme

2. Design life associated with facilities (15 years) refers to the initial period in which procured items needed to be supported by suppliers and manufacturers. Integrity management of facilities is an ongoing process where fitness for service is maintained and reliability and obsolescence issues are managed
3. Flexible transfer hoses have a design life that is informed by periodic condition assessments (visual and pressure testing. Typical expected design life is > 10 years.
4. Wells, like facilities, are subjected to an ongoing integrity management programme to demonstrate fitness for service (**Section 3.2.5**).

Section 572 (3) of the OPGGS Act requires that a titleholder remove from the title area all structures that are, and all equipment and other property that is, neither used nor to be used in connection with the operations:

(a) in which the titleholder is or will be engaged; and

(b) that are authorised by the permit, lease, licence or authority.

Unless other arrangements are made to the satisfaction of NOPSEMA decommissioning activities are not covered as part of this EP (including the plug and abandonment of wells) and will be subject to separate approval. Prior to the end of field life (currently estimated as 2035) whilst the title is still in force, a decommissioning plan will be in place that sets out the strategy for removal of property from the permit area.

4. EVALUATION OF ENVIRONMENTAL IMPACTS AND RISKS

As required by Regulation 13(5) of the Environment Regulations, this section of the EP provides an outline of Jadestone's methodological approach to evaluate impacts and risks due to an activity (**Section 4.1**), and the outcomes of the impact and risk assessment undertaken for the Stag Facility operational activities (**Section 4.2**).

4.1 Impact and Risk Assessment Methodology

The environmental impacts and risks associated with operational activities of the Stag Facility have been assessed using the Jadestone Risk Management Framework and methods consistent with HB 203:2012 and AS/NZS ISO 31000:2018.

Impact is evaluated in terms of the extent, duration, severity and certainty pertaining to the effect that will or may occur in the environment due to a planned or accidental event associated with the activity.

Risk is evaluated in terms of likelihood and consequence, where likelihood is defined as the probability or frequency of the event occurring, while consequence, like impact, is defined as the extent, duration, severity and certainty pertaining to the effect that will or may occur in the environment due to a planned or accidental event associated with the activity.

The assessment methodology provides a framework to demonstrate:

- That the identified impacts and risks are reduced to as low as reasonably practicable (ALARP) (Regulation 10A(b)); and
- The impacts and risks are acceptable (Regulation 10A(c)).

The impact and risk management process is shown in **Figure 4-1.**

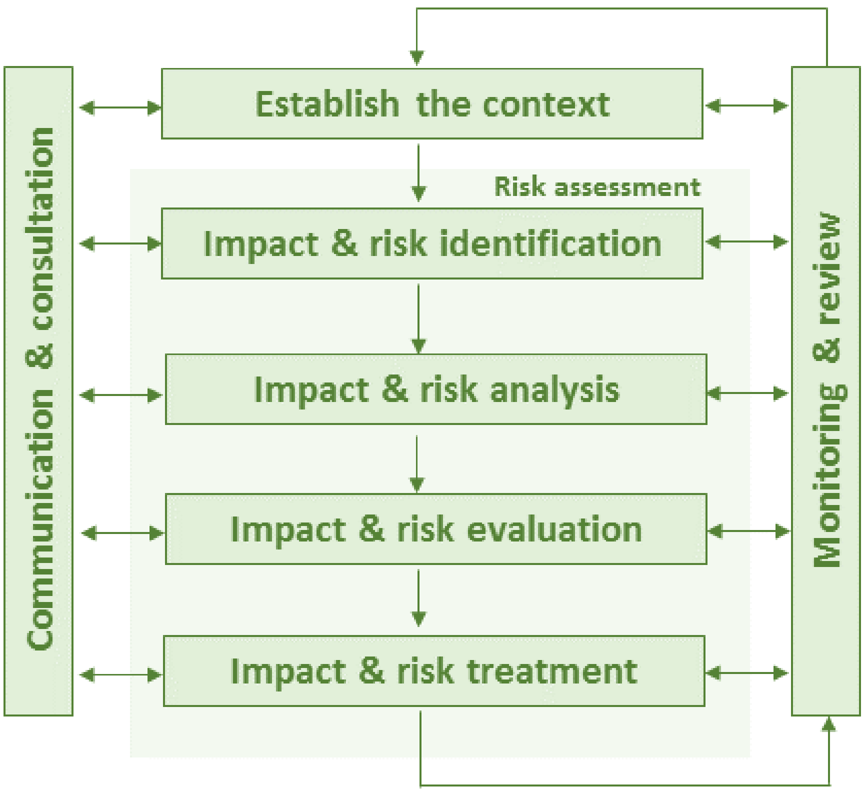


Image source: NOPSEMA (GN0165 Risk Assessment Rev 5 2017)

Figure 4-1: Impact and Risk Evaluation Process

Further detail on the steps involved in the impact and risk evaluation process is provided below.

4.1.1 Impact and Risk Identification

The assessment process evaluates impacts and risks associated with planned and accidental events that will or have the potential to impact the environment. Impacts and risks are identified through a number of activities:

- Workshopping process attended by team that includes relevant technical knowledge and experience in the activities being assessed;
- Information relating to previous operational performance relevant to the activity being assessed such as findings of audits and inspections, incident investigations, performance reports;
- Stakeholder feedback; and
- Industry related information of exploration and production activities relevant to the activity being assessed.

4.1.2 Impact and Risk Analysis

Analysis of the impacts and risks identified for the activity includes a number of steps intended to treat the impacts and risks to levels that are acceptable and as low as reasonably practicable for the business. The steps are:

- Identification of appropriate control measures (preventative and mitigative) to treat likelihood and consequence/ impact (below); and
- Determination of the residual risk rankings (Section 4.2).

Identification of control measures

The following framework tools are applied, as appropriate, to assist with identifying control measures:

- 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 (GIP) – identifies further engineering control standards and guidelines which may be applied over and 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. When formulating control measures for each environmental impact or risk, the 'Hierarchy of Controls' philosophy (see below), which is a system used in the industry to minimise or eliminate exposure to impacts or risks, is applied;
- 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 referenced in Jadestone's Environment Policy; and
- Societal Values (SV) – identifies the views, concerns and perceptions of relevant stakeholders and addresses relevant stakeholder concerns as gathered through consultation.

In addition, Jadestone applies a hierarchy of control measures to help evaluate potential management controls to ensure reasonable and practicable solutions have not been overlooked:

- Elimination - it is preferable to remove the impact or risk altogether;
- Substitution - substitute the impact or risk for a lower one;
- Engineering control measures – use engineering solutions to prevent or detect the hazard or control the severity of consequences/impacts;
- Administrative control measures – use of procedures, JHA etc to assess and minimise the environmental impacts or risks of an activity; and
- Protective – use of protective equipment (e.g. the use of appropriate containers).

Risk ranking process

Impacts and risks are ranked using the Jadestone Qualitative Risk Matrix (Table 4-1 Environmental ranking of a measure between **Low** to **Extreme** is determined by combining the expected severity of the impact (consequence level) with the likelihood of the impact occurring after implementation of control measures. In the case of planned events or impacts, the likelihood level is not considered as the event is intended to occur, and so a consequence level is assigned to determine the nature and scale of the impact.

Table 4-1: Jadestone Qualitative Risk Matrix

Rating		Consequence				
		Negligible	Minor	Moderate	Major	Critical
Likelihood	Expected	Medium	Medium	High	Extreme	Extreme
	Probable	Medium	Medium	Medium	High	Extreme
	Likely	Low	Medium	Medium	Medium	High
	Unlikely	Low	Low	Medium	Medium	Medium
	Rare	Low	Low	Low	Medium	Medium

Consequence levels for events are assigned on the basis of the expected extent of area that will or may be affected, the duration of effect and the severity of the effect. A consequence level of **Negligible** to **Critical** may be assigned (Table 4-2).

Table 4-2: Definition of Consequence Levels

Consequence	
5. Critical	Massive effect; recovery in decades; ecosystem collapse
4. Major	Major effect; recovery in 1 to 2 years; impact to population
3. Moderate	Local effect; recovery in months to a year; impact to localised community
2. Minor	Minor effect; recovery in weeks to months; death of individuals
1. Negligible	Slight effect; recovery in days to weeks; injury to organism

Likelihood levels for accidental or unplanned events are assigned on the basis of preceding performance in relation to the activity at the Facility, in the region or in the industry. A likelihood level of **Rare** to **Expected** maybe be assigned to accidental or unplanned events (Table 4-3). A likelihood level is not assigned to planned events.

Table 4-3: Definition of Likelihood Levels

Likelihood	
5. Expected	Happens several times a month in similar exploration and production operations
4. Probable	Happens several times a year in similar exploration and production operations
3. Likely	Event has occurred in similar exploration and production operations
2. Unlikely	Heard of in the exploration and production industry
1. Rare	Never heard of in the exploration and production industry

4.1.3 Risk Evaluation

Once assessed and treated, an assessment as to whether the impacts and risks recorded can be demonstrated as being ALARP and acceptable. The processes for determining if risks and impacts have been reduced to ALARP and acceptable levels are described below.

Demonstration of ALARP

Regulation 10A(b) of the Environment Regulations requires a demonstration that environmental impacts and risks are reduced to ALARP.

The ALARP principle states that it must be possible to demonstrate that the cost involved in reducing the impact or risk further would be grossly disproportionate to the benefit gained. The ALARP principal arises from the fact that infinite time, effort and money could be spent attempting to reduce a risk or impact to zero. An iterative evaluation process is employed until such time as any further reduction in the residual ranking is not reasonably practicable to implement. Following identification of the residual ranking, the ALARP principle is applied impacts and risks are reduced to ALARP:

- Where the residual rank is LOW as:
  - Good industry practice or comparable standards have been applied to control the impact or risk, because any further effort towards reduction is not reasonably practicable without sacrifices grossly disproportionate to the benefit gained.
- Where the residual rank is MEDIUM or HIGH:
  - Good industry practice is applied for the situation/ impact/ risk; and
  - Alternatives have been identified and the control measures selected to reduce the impacts and risks to ALARP. This may require assessment of Company and industry benchmarking, review of local and international codes and standards, consultation with stakeholders, etc. to demonstrate that alternatives have been considered, and reasons for rejection provided.
- Where the residual rank is EXTREME the risk is not considered to be ALARP as the impact/ risk is unacceptable and the activity cannot continue as described. Further control measures must be applied such that acceptable impact/ risk is demonstrated and the residual risk is reduced to 'High' or lower as described above. The activity should not be carried out if the residual risk remains 'Extreme'.

The process of evaluating the reduction of impacts and risks to ALARP is illustrated in Figure 4-2.

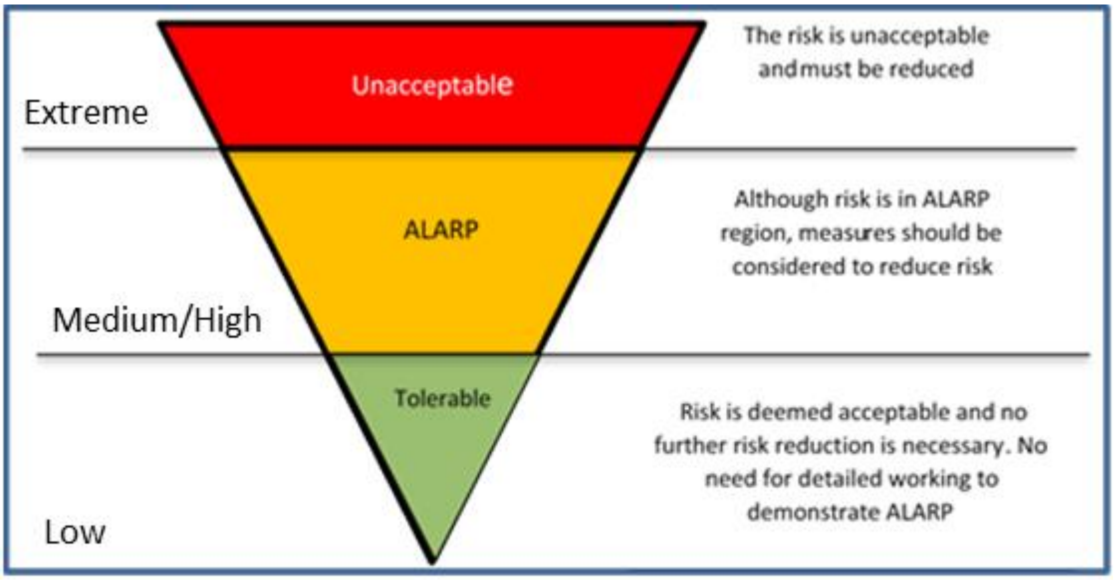


Figure 4-2: ALARP Triangle

Demonstration of Acceptability

Regulation 10A(c) of the Environment Regulations require a demonstration that environmental impacts and risks are of an acceptable level.

Environmental impacts and risks cover a wider range of issues, multiple species, persistence, reversibility, resilience, cumulative effects and variability in severity. The degree of environmental impact/ risk and the corresponding threshold for acceptability has been adapted to include:

- Consideration of the potential impact pathways;
- Preservation of critical habitats;
- Assessment of key threats as described in species and Area Management /Recovery plans;
- Consideration of North-West Bioregional Plan; and
- Principles of ecologically sustainable development ESD (given as an objective in the Environment Regulations and defined in Section 3A the EPBC Act).

The Principles of ESD guide the acceptability criteria which are outlined in Table 4-4.

Table 4-4: ESD Principles and Acceptability Criteria

ESD Principle	Acceptability criteria
a) Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations;	The Jadestone risk assessment process and the Jadestone BMS both consider long-term and short-term economic, environmental, social and equitable considerations.
(b) If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;	No threats of serious or irreversible environmental damage. Scientific knowledge is available and supports this.
(c) The principle of inter-generational equity--that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;	The health, diversity and productivity of the environment is maintained and not impacted.
(d) The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making;	Biological diversity and ecological integrity are not compromised by Stag Facility.
(e) Improved valuation, pricing and incentive mechanisms should be promoted.	N/A

The following process has been applied to demonstrate acceptability in the reduction of impacts and risks:

- LOW residual impacts and risks are Tolerable, if they meet legislative requirements, industry codes and standards, regulator expectations, the Jadestone Environmental Policy and industry guidelines;
- MEDIUM/ HIGH residual impacts and risks are Broadly Acceptable if ALARP can be demonstrated using good industry practice, risk-based analysis, if societal concerns are accounted for and the alternative control measures are disproportionate to the benefit gained; and
- EXTREME residual impacts and risks are Intolerable and therefore Unacceptable. Impacts and risks will require further investigation and mitigation to reduce them to a lower and more acceptable level. If after further investigation the impact or risk remains in the severe category, the risk requires appropriate business sign-off to accept the impact or risk.

The process for evaluating the reduction of impacts and risks to an acceptable level is detailed in Table 4-5

Table 4-5: Acceptability Assessment Criteria

Criteria	Question	Acceptability demonstrated
Policy compliance	Is the proposed management of the impact or risk aligned with the Jadestone Environmental Policy?	The impact or risk must be compliant with the objectives of the company policies.
Management System compliance	Is the proposed management of the impact or risk aligned with the Jadestone Management System?	Where specific Jadestone procedures and work instructions are in place for management of the impact or risk in question, acceptability is demonstrated.
Social acceptability	Have stakeholders raised any concerns about activity impacts or risks, and if so, are measures in place to manage those concerns?	Stakeholder concerns must have been adequately addressed and closed out.
Laws and standards	Is the impact or risk being managed in accordance with existing Australian or international laws or standards, such as EPBC Policy Statements, MARPOL, AMSA Marine Orders, Marine Notices etc.?	Compliance with specific laws or standards is demonstrated.
Industry best practice	Is the impact or risk being managed in line with industry best practice, such as APPEA Code of Environmental Practice, IAGC guidelines etc.?	Management of the impact or risk complies with relevant industry best practice.
Environmental context	Is the impact or risk being managed pursuant to the nature of the receiving environment (e.g. sensitive or unique environmental features generally require more management measures to protect them than environments widely represented in a region)?	The proposed impact or risk controls, EPO and EPS must be consistent with the nature of the receiving environment.
ALARP	Are there any further reasonable and practicable controls that can be implemented to further reduce the impact or risk?	There is a consensus that residual risk has been demonstrated to be ALARP.

4.2 Risk Evaluation Summary

An impact and risk assessment workshop was originally conducted by Jadestone in November 2016 to revise the existing hazard register and develop an updated register to reflect the Jadestone Risk Matrix, and in the interest of continually improving processes and practices. The assessment was undertaken by a multidisciplinary team with sufficient breadth of knowledge, training and experience to reasonably assure that risks and impacts were identified and assessed. The team included management, engineering, operations, maintenance and environmental personnel.

An additional risk workshop was undertaken on the 15th June 2020 to review the risk rankings and management controls in light of the change in operational activity. No revision to the residual risk rankings within the EP was required as a result of this review, although, where relevant, controls were amended to reflect the use of a third-party tanker in place of the FSO.

The assessment process undertaken by Jadestone for operational activities at the Stag Facility identified nine planned hazards and seven unplanned hazards and their associated environmental impacts and risks that will or may occur during operation of the Stag Facility.

The output of the assessment process is documented in the Stag Facility Impact and Risk Register, this EP Appendix B and is summarised in Table 4-6 further detail underpinning the risk record is provided in **Sections 7** and **8**.

For noting, where appropriate, hazards as listed in the assessment record have been grouped according to impact and/ or risk assessment to avoid repetition of assessment information.

Table 4-6: Summary of the environmental impact and risk assessment rankings for hazards associated with planned and unplanned events during operation of the Stag Facility

Hazard	Pre-treatment Ranking	Residual Ranking
Planned events		
1. Light	1	1
2. Noise	1	1
3. Atmospheric emissions	1	1
4. Discharge of produced water	2	1
5. Discharge of liquid wastes	2	1
6. Interaction with other users	1	1
7. Interaction with fauna	2	1
8. Physical footprint	1	1
9. Spill response activities	5	3
Unplanned events		
1. IMS introduction	M	L
2. Non-hazardous and hazardous solid waste	M	M
3. Non-hydrocarbon liquid hazardous materials	M	L
4. Unplanned release of hydrocarbons (Stag crude oil, diesel)	M	L
5. Dropped Objects	L	L

4.3 Impact and Risk Assessment Approach for Worst-case Hydrocarbon Spill Response

The impact and risk assessment approach for the worst-case hydrocarbon spill response follows the process as described above, with additional steps and considerations to determine an environmentally acceptable oil spill response strategy and an ALARP level of response preparedness:

1. Determine threshold concentrations to be used in oil spill modelling
2. Determine the EMBA
3. Identify sensitive receptors
4. Determine Protection Priorities, and
5. ALARP and Acceptability evaluation for spill response.

4.3.1 Determine Oil Spill Modelling Thresholds

Threshold concentrations for each of the hydrocarbon component types are specified as inputs for the model to determine what contact is recorded for each hydrocarbon type and where, to ensure that recorded contacts are for environmentally meaningful concentrations. Meaningful concentrations are those concentrations at which environmental (or biological) impacts may occur, and at which social values (e.g. visual aesthetics) may be impacted, these may have resultant economic impacts.

The determination of environmentally meaningful impact thresholds is complex since the degree of impact will depend on the sensitivity of the biota and habitats contacted, the duration of the contact (exposure) and the toxicity of the hydrocarbon mixture making the contact. The chemical and physical properties of a hydrocarbon change over time due to weathering processes altering the composition of the hydrocarbon. To ensure conservatism in defining the EMBA and the subsequent impact assessment, the threshold concentrations applied to the model are based on the most sensitive environmental resources that may be exposed, the longest likely exposure times and on toxicity information for the hydrocarbon impact pathways and impact threshold concentrations are detailed in **Appendix H**, **Sections 8.4.2.1** and **8.6** for surface oil, entrained oil and dissolved aromatic hydrocarbons (DAHs).

4.3.2 Determine the EMBA

The EMBAs for surface (10 g/m^3), entrained (100 ppb) and dissolved aromatic (70 ppb) hydrocarbon concentration thresholds for the worst-case spill scenario for this EP is shown in Error! Reference source not found.. These contact concentrations are used to inform spill response preparedness and planning as they are the most conservative environmentally meaningful impact thresholds for oil. Error! Reference source not found. also shows a surface oil concentration threshold EMBA at 1 g/m^3, which is used to inform potential risk to social and economic values. The EMBA is shown as a simplified version of the spill modelling results to reduce the number of co-ordinates and allow a search of the protected matters database to be conducted. However, the spill modelling contours are within the simplified EMBAs shown.

A detailed description of the EMBA is provided in **Section 5**.

4.3.3 Sensitive Receptor Identification

Jadestone has generated spatial layers of known environmental values within the marine and coastal environment in WA State, Commonwealth and adjacent international jurisdictions, to identify sensitive receptors (locations with highest environmental values relative to others). The EMBA is overlaid as a boundary to identify the sensitive receptors within the EMBA.

Sensitive receptor assessment considers:

- Protected Area Status: used as an indicator of the biodiversity values contained within that area (e.g. World Heritage Area, Ramsar site and Marine Protected Area);
- Biologically Important Areas (BIA) of Listed Threatened Species: these are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour such as breeding, feeding, resting or migratory;
- Social values: socio-economic and heritage features (e.g. commercial fishing, recreational fishing, amenities, aquaculture);
- Listed species status and predominant habitat (surface versus subsurface): critically endangered/ endangered species, listed species, surface species (e.g. reptiles and birds) and subsurface species (e.g. mammals, sharks and fish); and
- Recovery Plans, Conservation Advice for threatened species.

Once the sensitive receptors within the EMBA have been identified, the potential oil pollution risks are described and evaluated (refer Sections 8.5 and 8.6 general impacts and risks sections) and, in addition, the environmental risks from implementing spill response control measures are described and evaluated (refer Section 7.9).

Sensitive receptors are further evaluated by considering what values are contained within them when determining appropriate spill response strategies (refer Section 7.9 and Table 7-11). This informs the OPEP and guides spill response preparedness and planning.

The next step is to determine those sensitive receptors within the EMBA that are considered to be at the highest risk from the worst-case credible oil spill scenario and are common across ALL modelled scenarios and seasons i.e. the Protection Priorities.

4.3.4 Protection Priorities

It is important to note that in the event of a single worst-case hydrocarbon spill, not all sensitive receptors and areas within the EMBA will be contacted at the same time or at all. Instead, the EMBA is a collation of numerous possible scenarios (generally 100) to develop the areas for focus in response preparedness and strategic planning. As such, only a portion would be contacted during a single spill.

It is best practice to develop spill response strategies for those areas most likely to be contacted in a single maximum credible worst-case spill. To be able to develop these strategies, the sensitive receptors in the EMBA and their vulnerability to a hydrocarbon event (considering nature and scale of spill) need to be understood. A critical first step is to identify these areas – a concept termed here as 'Protection Priorities'. The selection of Protection Priorities is based on stochastic modelling of multiple hydrocarbon spills.

Defining Protection Priorities determines the scale and needs of the oil spill response strategy. Thus, Protection Priorities (as a subset of all the sensitive receptors present within the full extent of the EMBA) specific to a particular spill are selected using the following criteria:

- Sensitive receptor within EMBA; and
- >5% probability of shoreline contact based on modelling results; OR
- Has the maximum accumulated volume on shorelines; OR
- Has the shortest timeframe to floating oil shoreline contact; OR
- Vulnerability to impact from hydrocarbons – e.g. mangroves are more vulnerable than intertidal rock pavement; known turtle nesting beaches are vulnerable during nesting periods. *IPIECA, the global oil and gas industry association for environmental and social issues, the International Maritime Organisation (IMO) and International Association of Oil and Gas Producers (OGP) developed a guidance document for 'Sensitivity mapping for oil spill response' IPIECA/IMO/OPG (2016). This document was used as a reference and basis for the sensitivity of habitats vulnerability;* AND
- Any other area of interest within the EMBA including areas that have a high social value or are a concern raised through stakeholder consultation (Section 6).

It is logical and best practice to focus spill response planning and strategies on those locations most likely to be contacted in the credible worst-case oil spill scenario; that is, the scenario that represents the highest risk across all modelled scenarios covering any season, rather than attempt to cover the full spatial extent of the EMBA. This allows for flexibility in response planning as plans are developed for environmental resources at greatest risk of being contacted by an oil spill, and can be adapted for any scenario that occurs (refer OSRA Section 6, Figure 6-1)

The evaluation of Protection Priorities is based upon stochastic modelling of multiple hydrocarbon spills. The focus for spill response planning and preparedness is based upon the level of risk (probability of contact, vulnerability to hydrocarbons, time to contact and volume/ concentration of loading). Response Plans are based on the nature and scale of the worst-case modelled hydrocarbon event for each Protection Priority (refer Sections 8.4.2.1 and 8.6) which includes estimation of shoreline loading volume and time to contact, which are provided in the OPEP.

For purposes of spill response preparedness strategies, it is not necessary for all Protection Priorities to have specific operational response plans in place. For example, wholly submerged Protection Priorities may only be contacted by entrained oil, and the response will largely be the implementation of scientific monitoring to assess impact and recovery. Protection Priorities with emergent features can have response actions prepared.

4.3.5 ALARP and Acceptability Evaluation for Spill Response

Jadestone applies a robust and systematic process to ensure that credible spill scenarios are adequately evaluated, to promote a clear link between the nature and scale and the Protection Priorities, and, to ensure that effective control measures exist to mitigate environmental risks and impacts to a level that is ALARP. This process is depicted in **Figure 4-1**.

The process promotes a clear link between the nature and scale of the maximum credible worst-case spill scenario and the identified Protection Priorities to ensure that selected response strategies are appropriate and demonstrated to be effective and adequate.

As part of the risk assessment process, the spill response strategies selected are evaluated for their environmental impact (**Figure 4-2**).

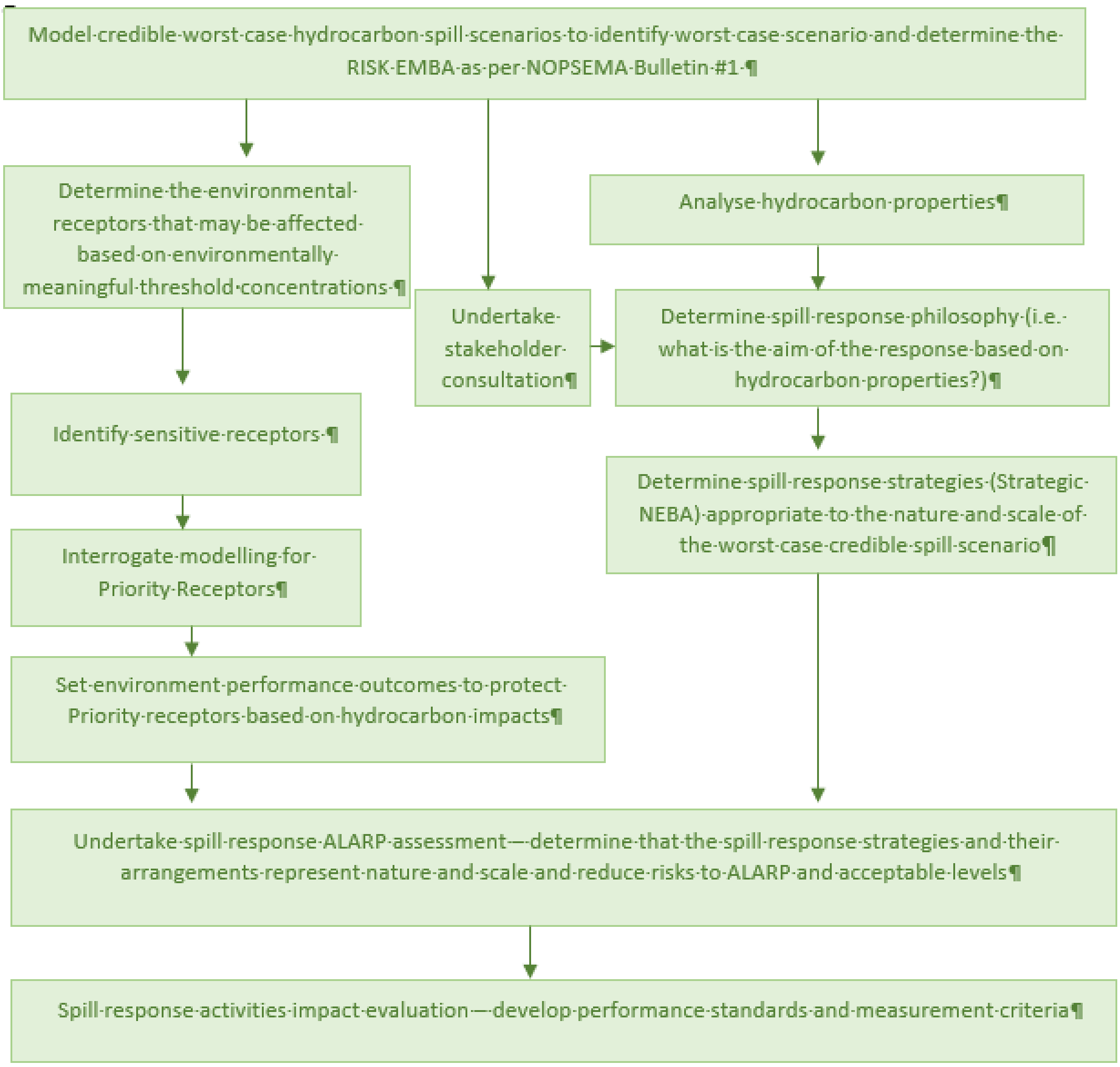


Figure 4-1: Spill Scenario Evaluation and ALARP Determination Process

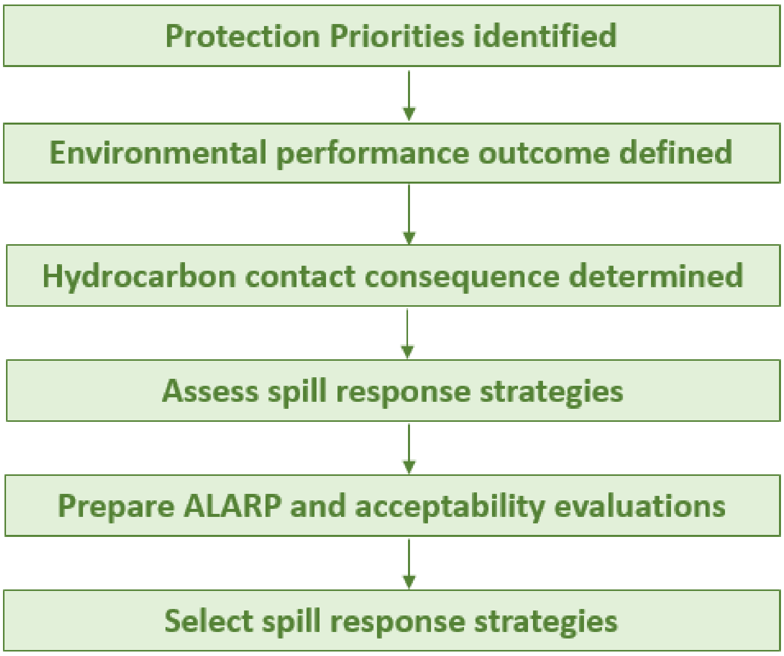


Figure 4-2: Spill Control Analysis and ALARP Determination Process

5. DESCRIPTION OF THE ENVIRONMENT THAT MAY BE AFFECTED

Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 Regulation 13(2) requires the proponent to '(a) describe the existing environment that may be affected by the activity; and (b) include details of the particular relevant values and sensitivities (if any) of that environment.'

To address this requirement, Jadestone has evaluated the values and sensitivities within two types of areas related to the activity:

- The Operational Area – the geographical area encompassing the environment that may be affected by the planned activities (Section 2.4); and
- The Environment that May Be Affected (EMBA) – the geographical area encompassing the environment that has the potential to be affected by the unplanned events associated with the activities described (Section 2) depending upon the level of exposure.

The spatial extent of the EMBA and location of the Operational Area is presented in Figure 3-1. The EMBA is based on the low-level exposure of hydrocarbons on and in, the water and represents the largest extent of an oil spill due to the worst-case scenario as per NOPSEMA Bulletin #1. This is further described Appendix H Section 1.1. and below:

1. Surface hydrocarbons EMBA– hydrocarbons that are 'on' the water surface (>1 g/m_2)
2. Entrained hydrocarbons EMBA– hydrocarbon that is entrained 'in' the water (>10 ppb)
3. Dissolved hydrocarbons EMBA– the dissolved component of hydrocarbon in' the water (>10 ppb), and
4. Shoreline loading EMBA – hydrocarbons greater than 10 g/m_2.

Details of the environmental values and sensitivities in the Operational Area are described here in Section 3. The environmental values and sensitivities in the EMBA have been used to inform the assessment of the unplanned events in particular, LOWC, diesel spills, oil spill response planning and oil spill risk assessment (Section 8.6 and Section 8.7). Full details of the environmental values and sensitivities in the EMBA is contained in Appendix C. A number of spill scenarios have been modelled and the EMBA represents the worst case for all of the spills rather than the worst case of a single spill. Within the EMBA is a smaller RISK EMBA which is represented by higher thresholds (termed as 'moderate' in NOPSEMA bulletin #1), this represents the environment within which receptors could be affected (rather than just contacted) and is based on scientific knowledge to determine the potential for impact. This is further described in **Section 8.4.2.1**. All of the receptors within the RISK EMBA are contained within the EMBA and therefore fully described within this chapter.

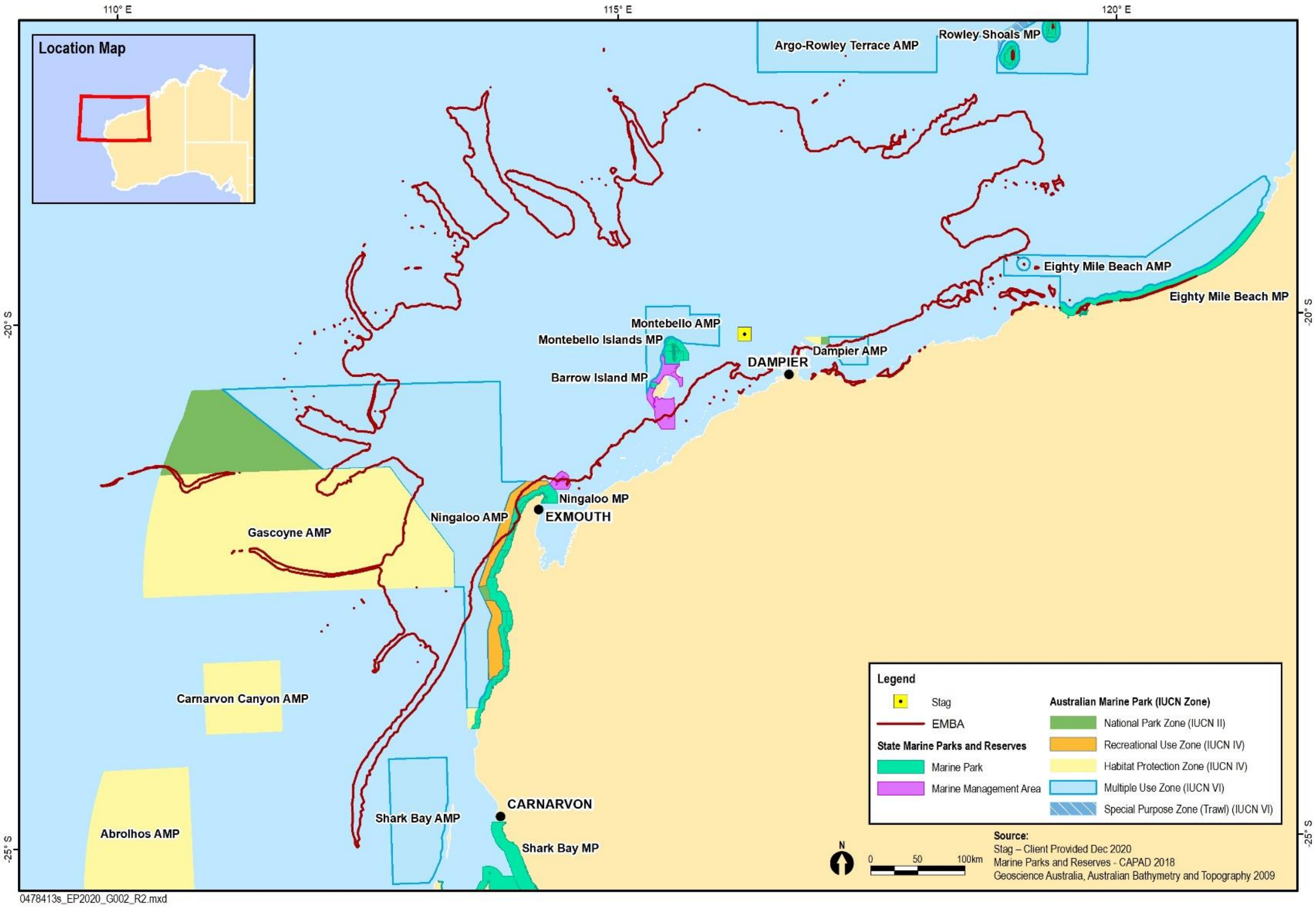


Figure 5-1: Annualised EMBA for Worst Case Scenarios Hydrocarbon Spill

5.1 Regional Setting

The Operational Area and EMBA lie entirely within the Commonwealth waters of the North-west Marine Region (the region) and adjacent state waters between Ningaloo and Eighty Mile Beach. The region is distinguished by its predominantly wide continental shelf, very high tidal regimes (especially in the north), high cyclone incidence, unique current systems and warm, low-nutrient surface waters.

The region supports high species-richness of tropical Indo-west Pacific biota, but low levels of endemism (DSEWPaC 2012d). The offshore islands, coastline and waters within the region provide vital habitat to an extensive range of marine species including turtles, cetaceans, whale sharks and seabirds and has high fish biodiversity and consequently, is of value to commercial fish, prawn and crab fisheries.

5.2 Physical Environment

5.2.1 Climate

The region lies in the arid tropics experiencing high summer temperatures and periodic cyclones. Rainfall in the region is low with evaporation generally exceeding rainfall throughout the year although intense rainfall may occur during the passage of summer tropical cyclones and thunderstorms (Condie et al. 2006). Mean air temperatures over the neighbouring ocean area range from a minimum of 11°C in winter to a maximum of 37°C in summer. Due to the arid climate, daytime visibility in the area is generally greater than 5 nm (SSE 1991).

The summer and winter seasons fall into the periods September–March and May–July, respectively. Winters are characterised by clear skies, fine weather, predominantly strong east to south-east winds and infrequent rain. Summer winds are more variable, with strong south-westerlies dominating. Three to four cyclones per year are typical, with the official cyclone season being November through to April (BoM 2013).

5.2.2 Seawater Temperature and Salinity

Salinity is relatively uniform at 34–35 ppt throughout the water column and across the North-West Shelf. Due to the low rainfall, there is little freshwater run-off from the adjacent mainland (Blaber et al. 1985). North-West Shelf waters are usually thermally stratified, with a marked change in water density at approximately 20 m (SSE 1993). Surface temperatures vary annually, being warmest in March (32°C) and coolest in August (19°C). Vertical gradients are correlated to sea surface temperatures and are greatest during the warm-water season (SSE 1991). Near bottom water temperature is approximately 23°C with no discernible seasonal variation.

Changes in water temperature and salinity characteristics can result from changes in local heating and evaporation following the southward movement of warmer water due to southward-moving cyclones and can have flow-on effects to primary and secondary productivity (McKinnon et al. 2003).

5.2.3 Wind

Non-cyclonic wind conditions are predicted for the Stag Field based on four years of continuous wind measurements at a nearby site (Wandoo platform; WNI 1995). Wind patterns are monsoonal with a marked seasonal pattern; wind shear on surface waters generates local-scale drift currents that can persist for extended periods (hours to days). During October–March, the prevailing non-storm winds are from the south-west, west and north-west at an average speed of less than 10 knots, peak average speeds of 15– 25 knots, and maximum speeds of 30 knots. Winds from the south-east to north-east quadrant are experienced at a frequency of less than 10% over these seasons. In June–August, winds are generally lighter and more variable in direction than in spring and summer. Non-storm winds prevail from north-east through to south-east at average speeds of 5–6 knots, peak average speeds of 10–15 knots, and maximum speeds of 20 knots. Transitional wind periods, during which either seasonal wind pattern may predominate, can be experienced in April–May and September of each year.

Extreme wind conditions in the area may be generated by tropical cyclones, strong easterly pressure gradients, squalls, tornados and waterspouts. Tropical cyclones generate the most significant storm conditions on the North-West Shelf (SSE 1993). These clockwise-spiralling storms have generated wind speeds 50–120 knots within the region (SSE 1991). Tropical cyclones develop in the eastern Indian Ocean, and the Timor and Arafura Seas during the summer months of November to April. Since recordings began in 1960/61, tropical cyclones have approached from the northwest through to east, with the most frequent directions being from the north (34%) and east (36%). Due to the circular wind patterns involved however, winds can approach from any direction during the passage of the storm.

5.2.4 Waves

The wave climate is composed of locally generated wind waves (seas) and swells that are propagated from distant areas (WNI 1995). Sea directions run roughly parallel to prevailing wind directions. Hence, in summer, seas typically approach from the west and south-west, while in winter, seas typically approach from the south and east. Mean sea wave heights of less than 1 m with peak heights of less than 2 m are experienced in all months of the year (WNI 1995). Mean swell heights are low at around 0.4–0.6 m in all months. Due to the proximity of the mainland, the greatest exposure to swells is from the west (SSE 1993). Tropical cyclones have generated significant swell heights of up to 5 m in this area, although the predicted frequency of swells exceeding 2 m is less than 5% (WNI 1996). In the open ocean, sustained winds result in wind-forced currents of approximately 3% of the wind speed (Holloway and Nye 1985).

5.2.5 Tides and Currents

Sea surface currents over the North-West Shelf are generated by several components such as tidal forcing, local wind forcing and residual drift. Of these, tidal and wind forcing are the dominant contributions to local sea surface currents. The orientation and degree of drop-off of the continental shelf slope also influences the oceanography of the area. The tides of the North-West Shelf have a strong semi-diurnal signal with four tide changes per day (Holloway and Nye 1985; CMAR 2007). Peak tidal flows are from the north-northwest on the ebb, and to the south-southeast on the flood (Holloway and Nye 1985; SSE 1993; King 1994). Mid-shelf tidal currents are predicted to have average speeds of approximately 0.25 knots during neap tides and up to 0.5 knots during spring tides (NSR 1995; WNI 1995).

The dominant offshore sea surface current (typically seaward of the 200m isobath) is the Leeuwin Current (**Figure 5-2**), which carries warm tropical water south along the edge of WA's continental shelf, reaching its peak strength in winter and becoming weaker and more variable in summer (CMAR 2007; Condie et al. 2006). The current is described as a surface current, extending in depth to 150 m (BHPB 2005; Woodside 2005). From September to mid-April the nearshore Ningaloo Current flows northwards, opposite to the Leeuwin Current, along the outside of the Ningaloo Reef and across the inner shelf (BHPB 2005; Woodside 2005). The Indonesian Throughflow is the other important current influencing the upper 200 m of the outer North-West Shelf (Woodside 2005; CMAR 2007). This current brings warm and relatively fresh water to the region from the western Pacific via the Indonesian Archipelago. Modelling undertaken by Woodside and CMAR indicates that significant east-west flows occur across the North-West Shelf to the north of the North-West Cape, possibly linking water masses in the area (Woodside 2005; Condie et al. 2006).

Offshore drift currents are represented as a series of interconnected eddies and connecting flows that can generate relatively fast (1–2 knots) and complex water movement. These offshore drift currents also tend to persist longer (days to weeks) than tidal current flows (hours between reversals). Therefore, in the event of an accidental oil spill, offshore drift currents have a greater influence than tidal currents on oil dispersion over timescales exceeding a few hours (APASA 2012a).

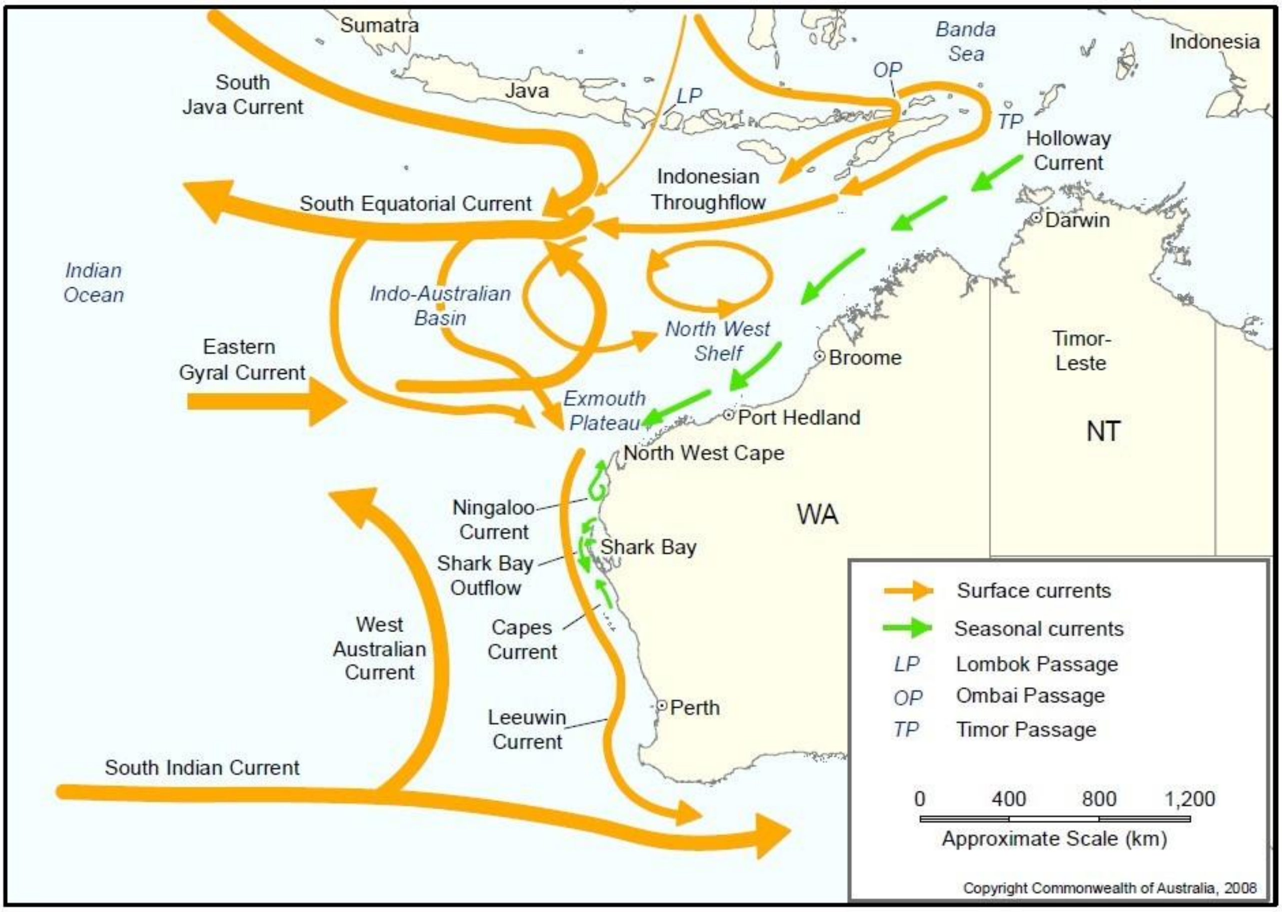


Figure 5-2: Surface Currents of the North-West Marine Region

5.2.6 Sedimentology

The Operational Area is characterised by a thick sequence of carbonate rock that is overlain by thin layers of unconsolidated fine to medium grained, carbonate sediments with occasional shell or gravel patches (Racal, 1994; Dames and Moore, 1995). Surveys conducted over the NWS indicate that a similar seafloor occurs extensively over this geographic region, but with spatial variation in the grain size and origin of the surface sediments (McLoughlin and Young, 1985; Woodside, 1990). Surface seabed sediments in the area are predominantly composed of skeletal remains of marine fauna, with lenses of weathered sands (McLoughlin and Young, 1985).

A debris seabed survey around the Stag Platform was undertaken as part of the Stag Apache Site Survey Campaign 2011 (Neptune Geomatics, 2011b). The survey confirmed that the surrounding seabed is free from debris. Two seabed types have been classified throughout the Stag Operations area:

- Type A: Low relief unconsolidated calcareous fine to medium sand; and
- Type B: Low relief unconsolidated calcareous gravelly medium to coarse sand.

5.3 Subtidal Benthic Habitats

Benthic habitats are defined as those subtidal habitats lying below the lowest astronomical tide (LAT). The benthic habitats within the EMBA range from those at LAT to more than 6,000 m at the canyons linking the Cuvier Abyssal Plain and Cape Range Peninsula (DEWHA 2012).

Benthic habitats are partially driven by light availability. Primary producers (photosynthetic corals, seagrass and macroalgae) are limited to the photic zone, whereas benthic invertebrates including filter feeding communities may be found in deeper waters. The depth of the photic zone varies spatially and temporally is predominantly dependent on the volumes of the suspended material in the water column. The photic zone in the offshore Pilbara approximately 70 m whereas in oceanic waters, the photic zone may extend to 120 m (DEWHA 2008).

5.3.1 Operational Area

The sediments within the Operational Area of the Stag Facility are dominated by sand sized particles, with medium sand comprising the largest fraction. There were no clear trends in particle size distribution (PSD) with increasing distance from the CPF in sediment samples collected by Oceanica (2015). Most sediment was grey in colour and contains shells and other biota present.

The majority of samples taken by Oceanica (2015) had no vegetation present and no obvious odour. This is consistent with results from a survey by CSIRO in 2001 (IRC 2001) who reported unconsolidated fine-medium and medium-coarse sands with patches of coral rubble (CSIRO 2001).

Apache Energy Ltd conducted sampling of the infauna within the Operational Area prior to development drilling as a baseline for comparison to the post-development (Kinhill 1997; 1998). This study confirmed that the benthic biota within the vicinity of Stag is comparable to that found over similar substratum and at similar depths over the wider region (Ward and Rainer 1988; Woodside 1988; Rainer 1991). The unconsolidated sediments in this habitat were found to support a diverse infauna, consisting predominantly of mobile burrowing species, which include molluscs; crustaceans (crabs, shrimps and smaller related species); polychaete, sipunculid and platyhelminth worms; asteroids (sea stars); echinoids (sea urchins), and other small infaunal animals. Similar results were obtained in a more contemporary study by Oceanica (2015), who reported prawns, polychaetes, tube polychaetes, amphipods and bryozoans in sediment samples collected.

There is small spatial variability in the infaunal assemblages (e.g. crustaceans, molluscs, ostracods, bivalves, polychaete worms and amphipods) surrounding the Stag Facility and this is typical of soft sediments in the surrounding areas (IRCE 2001, Oceanica 2015).

While there are no significant benthic primary producers (benthic photosynthetic organisms) associated with the soft sediment habitat within the Operational Area, some small patches of algae were found by Oceanica (2015). The subsea infrastructure such as the CPF platform, CALM buoy mooring and third-party tanker hull, are likely to provide attachment points with sufficient light availability for algae as well as other filter feeding organisms (e.g. hydroids, bryozoans and molluscs). Pipelines have been shown to have a high abundance of commercially important fish, including snapper and grouper, as well as the presence of thousands of larval fish and juveniles suggesting the pipelines may actually enhance fish stocks (McLean et al., 2017). Although little is known about the habitat preference of syngnathids and pipefish, it is unlikely that they would occur in the operational area, with research showing a preference for coral reefs in tropical areas (Foster & Vincent 2004; Scales 2010).

Sediment and water quality data within the Operational Area was collected and analysed initially as a baseline study by Kinhill in 1997. The following characteristics were described:

- Water quality: temperature 29.6–30.7oC at surface and 29.3–29.6oC seabed;
- Salinity 33.3–33.9 ppt;
- Oxygen 4.49 – 6.2 mg/L;
- Organic content 40% sediment;
- Sediment particle size was spatially (and temporally) variable;
- No hydrocarbons in marine sediments;
- Metals (barium, cadmium, chromium, copper, lead and zinc were low (below detection limits);
- Infauna 67.8 individuals/kg; and
- There was a higher number of polychaete worms, crustaceans, echinoderms and molluscs in baseline than subsequent surveys (attributed to drilling and change in PSD).

5.3.2 EMBA

A wide range of benthic habitats occur within the EMBA including benthic primary producer habitats (i.e. photosynthetic organisms) such as macroalgal beds, seagrass meadows and hard corals which are distributed in shallow subtidal and intertidal waters, as well as intertidal water/ shoreline distributed habitats such as mangroves and salt marshes. Benthic primary producers are important components of ecosystems as they provide the source of energy driving food webs and provide shelter for a diverse array of organisms.

Other subtidal habitats within the EMBA include unconsolidated sediment, which is the most common subtidal habitat on the North-West Shelf, and rocky substrate (e.g. outcropping limestone pavement). Subtidal rocky substrate typically supports a mosaic benthic community which may comprise benthic primary producers such as macroalgae and hard corals in the photic zone. In deeper waters and/or where light is limited, hard substrate may have a community dominated by habitat-forming filter feeding organisms such as various soft corals, sponges and hydroids.

Other intertidal and shoreline habitats in the EMBA include intertidal sand/mud flats, intertidal rocky reefs, rocky shorelines and sandy beaches. Intertidal mud/sand flats are particularly extensive along the more northerly mainland shorelines of the EMBA, where the tidal range is greatest, and comprise large areas of exposed mud and sand at low tide. These are important foraging habitats for shorebirds, including important migratory species, which consume benthic organisms living in and on these flats. Protected sand/mud flat habitats within the EMBA include the Eighty-Mile Beach Ramsar site (also a proposed Marine Park; refer Section 5.7.4). There are numerous sandy beaches within the EMBA, on both offshore islands and the mainland, that are important nesting sites for a number of protected marine turtle species (refer **Section 5.6.3**).

Habitat diversity is highest in shallower waters where light availability promotes the occurrence of benthic primary producers, and in areas where hard substrate provides attachment points for a greater diversity of habitat forming organisms. Within the EMBA benthic habitat diversity is therefore highest within waters along the Ningaloo coastline, coastal waters between the Dampier Archipelago and Eighty Mile Beach, shallow waters around offshore islands extending from North-West Cape to Eighty Mile Beach (including Muiron, Thevenard, Montebello/ Barrow/ Lowendal, Dampier Archipelago and Turtle islands) and offshore shoals (e.g. Rowley shoals).

A more detailed description of benthic primary producers within the EMBA is provided in the sections below.

5.3.3 Coral Reefs and Communities

Across the North-West Shelf, corals tend to occur in relatively shallow areas with strong currents where water movement provides a constant supply of nutrients and particulate food. Corals occur as extensive reefs, patch reefs, isolated bomboras or in scattered colonies across the limestone pavement that dominates the shallow water areas of the region. They contain photosynthetic unicellular algae called zooxanthellae and are therefore reliant on sunlight for their survival

Corals can be grouped into the following categories:

- Sceleractinian corals (hard corals) – reef-building corals;
- Non-sceleractinian corals (sometimes referred to as calcified soft corals) – generally not considered to be reef-building; and
- Soft corals belonging to the order Alcyonacea – non reef-building.

Coral spawning usually occurs during the months of March and April in two concentrated events each of three to four days' duration, occurring on nocturnal, neap and ebb tides 7 to 10 nights following the full moon. In addition to this main spawning period in autumn, coral recruitment occurs throughout the year, with brooding species implicated. There have also been recent observations inferring broadcast spawning of corals along the North-West Shelf in October to November, although this appears to be a minor event relative to the March/April spawning.

Regionally, cyclone damage to corals may be significant (WAM 1993; LDM 1996) through physical disturbance and sedimentation (Heinsohn and Spain 1974; Van Woesik et al. 1991; Stejskal 1992). Bleaching of corals surrounding coastal islands was part of a worldwide phenomenon that has been linked to global warming (Hoegh-Guldberg 1999). Other natural events, such as sedimentation and predation may also contribute to temporal variability of live coral cover. Coral predators such as the crown-of-thorns seastars, Acanthaster planci, and the corallivorous gastropods, Drupella cornus and D. rugosa, have been recorded in the NWS region.

Communities subject to frequent natural perturbation are likely to be either resilient or transient and highly dynamic in terms of cover and distribution (WAM 1993). The ability of such species to recolonise after large-scale natural or human disturbance is also likely to be high, although there is interspecific variation in rate of recovery. Fast-growing Acropora species, for example, can recover from severe damage in a few years whereas slow-growing massive species may take up to 30 years to recover from major damage (WAM 1993).

Dampier Archipelago

The closest coral reefs to the Stag facility are those around the Dampier Archipelago, 32 km southeast of the location (**Figure 5-3**). Coral communities occur throughout the proposed reserves and together, the shallow intertidal and subtidal reef communities comprise 8% (approximately 18,300 ha) of the major marine habitats. The most diverse coral areas in the proposed reserves are found on the seaward slopes of Delambre Island, Hamersley Shoal, Sailfish Reef, Kendrew Island and north-west Enderby Island. Live coral cover can vary greatly from reef to reef, as indicated by contrasting covers of 10 to 60% on Sailfish Reef and Hamersley Shoal, respectively. The proposed reserves have a high diversity of hard corals, with at least 229 species recorded from Western Australian Museum (WAM) surveys (CALM 2005b).

Montebello/Barrow/Lowendal Islands

Coral reefs surround the Barrow/Lowendal/Montebello Island complex (**Figure 5-4**), 75–96 km southwest of the Stag Facility. Approximately 6% of the Montebello/Barrow Islands Marine Parks are comprised of shallow intertidal and subtidal reef communities. The best developed of these communities are in the relatively clear water and high energy conditions of the fringing reefs to the west and south-west of the Montebello Islands, at Biggada Reef on the west side of Barrow Island. Coral 'bommies' and patch reefs occur in the more turbid and lower energy waters along the eastern edge of the Montebello Islands and the south-eastern edge of Barrow Island (CALM 2004).

Corals occur on submerged limestone reefs and submarine slopes as fringing reefs and patch reefs in the shallow waters (5–10 m) to the south, east and north of the Lowendal Islands. Corals are also present in slightly deeper waters (up to 20 m) on exposed limestone pavement running north towards the Montebello Islands (LeProvost Semeniuk Chalmers 1986; LDM 1994). This habitat extends south along the eastern edge of the Barrow Island Shoals.

Corals are abundant around Barrow Island, growing as high profile reefs and on pavement on the west and east coasts. The most significant coral reefs around Barrow Island are Biggada Reef on the west coast, Dugong Reef and Batman Reef off the south-east coast, and those along the edge of the Lowendal Shelf on the east side of Barrow Island (Chevron 2008).

Quantitative sampling of seven sites around the Lowendal Islands showed a range of 34 to 63 species or taxa per site, with massive forms such as Favites and Porites, and tubular and digitate species of Acropora dominating the assemblages (LDM 1994). No corals were present in the channel between the Lowendal Islands and the northern tip of Barrow Island. A small submerged fringing reef lies in shallow water on the northeast side of Barrow Island. A total of 235 species comprising 60 coral genera have been recorded from the Montebello Islands during surveys carried out by the WA Museum (WAM 1993).

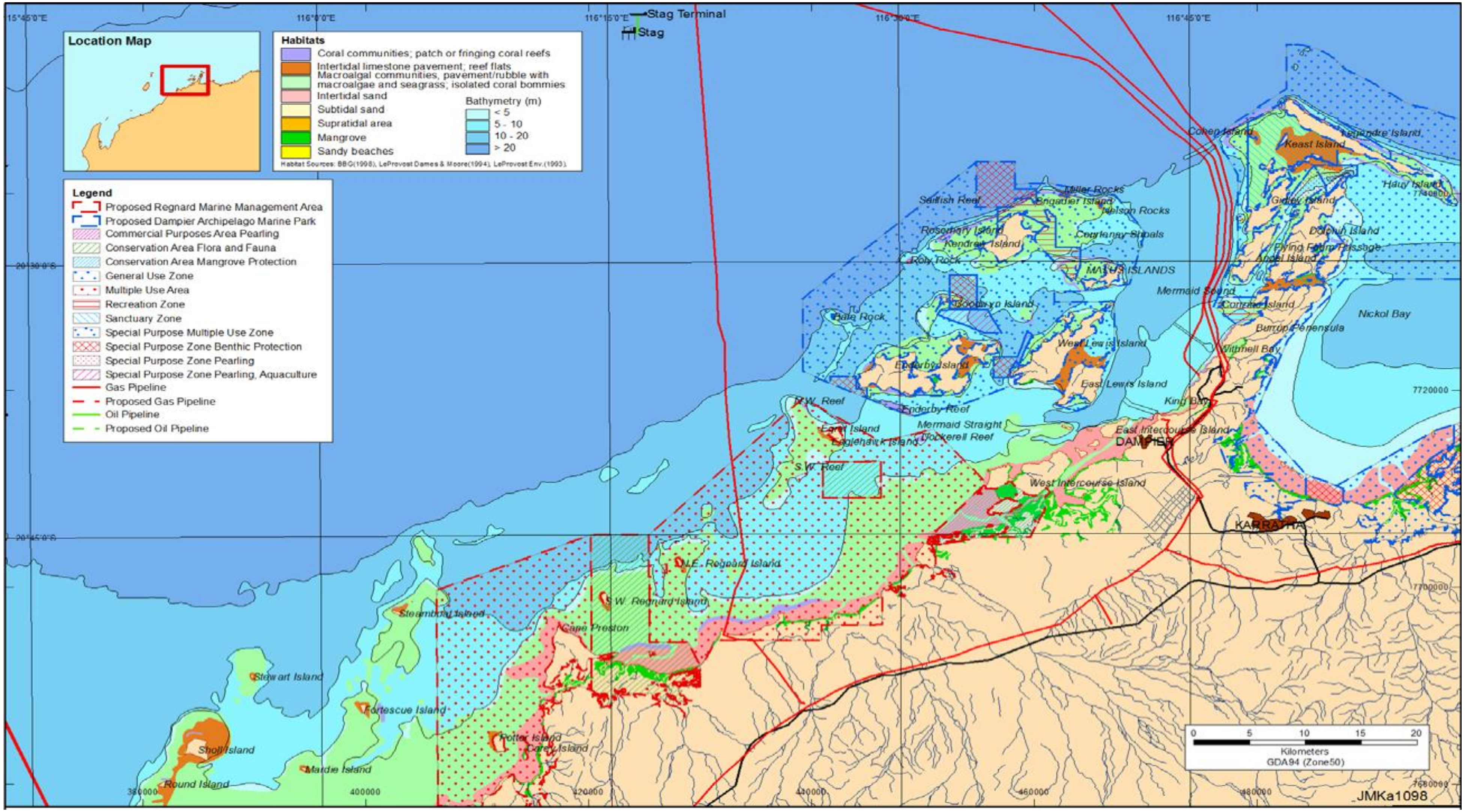


Figure 5-3: Marine Habitats Surrounding the Dampier Archipelago

Offshore Islands between North-West Cape and Dampier Archipelago

Hard corals occur as components of shallow intertidal and subtidal habitats around numerous small offshore islands within this region (including Muiron, Thevenard, Airlie and Serrurier islands) associated with limestone pavement create fringing intertidal reefs, patch reefs or represent isolated coral bomboras. Corals around Muiron Islands are contained within the State managed Muiron Island Marine Management Area.

Ningaloo Reef

Ningaloo Reef is the largest fringing barrier coral reef, and the second largest coral reef system in Australia. The most diverse coral communities along this coastline are in the relatively clear water, high energy environment of the fringing barrier reef and low energy lagoonal areas to the west of North-West Cape. The diversity of hard corals along this coastline is high with at least 217 species representing 54 genera of hermatypic (reef building) corals recorded to date (Veron and Marsh 1988). All 15 families of hermatypic corals are represented, however species diversity and community structure vary with environmental conditions such as exposure to wave action, currents, depth and water clarity. **Figure 5-5** provides an overview of habitats, including coral communities. The Ningaloo Reef is protected within the Ningaloo Coast World Heritage Area (**Section 5.7.1**) and Ningaloo Marine Park (Commonwealth and State waters (**Sections 5.7.6.4** and **5.8.2**).

Rowley Shoals

The Rowley Shoals are a collection of three atoll reefs, Clerke, Imperieuse and Mermaid, which are located about 300 km northwest of Broome. The shoals contain 214 coral species and ~ 530 species of fish (Done et al. 1994; Gilmour et al. 2007). The reefs provide a distinctive biophysical environment in the region as there are few offshore reefs in the northwest. They have steep and distinct reef slopes and associated fish communities. In evolutionary terms, the reefs may play a role in supplying coral and fish larvae to reefs further south via the southward flowing Indonesian Throughflow. Both coral communities and fish assemblages differ from similar habitats in eastern Australia (Done et al. 1994). Mermaid Reef is a submerged reef protected by the Commonwealth and managed under the Mermaid Reef Australian Marine Park (see **Section 5.7.6.9**). Clerke Reef and Imperieuse Reef include permanent sandy cays above the high water mark and are managed by the Western Australian Government as the Rowley Shoals Marine Park (**Section 5.8.5**).

Coastline between Dampier Archipelago and Eighty Mile Beach

The coastline in this region is subject to high tidal currents and infrequent cyclonic events, and shallow coastal waters are typically very turbid due to suspension of fine sediments driven by these currents. Coral communities along this stretch of coastline typically have lower diversity and density than shorelines further south (e.g. Dampier Archipelago and Ningaloo Reef) and are associated with outcropping limestone subtidal pavement or intertidal rocky shorelines. Corals further offshore typically exhibit greater diversity and density where sediments are coarser and water conditions are less turbid. A total of 51 species of coral from 19 genera have been identified from areas offshore from Port Hedland which is lower than the 120 coral species from 43 genera recorded in Dampier Port and inner Mermaid Sound (Blakeway and Radford 2005). Along this stretch of coastline, corals are less likely to form biogenic reefs and more likely to be present as components of mosaic communities with other benthic organisms.

Rankin Bank and Glomar Shoals

Rankin Bank (19° 46' 44.184" S, 115° 36' 59.220" E) and Glomar Shoals (19° 36' 41.846" S, 116° 44' 4.472" E) are shoals located, over 35nm each way from the Montebellos and approximately 150 km north of Dampier. Glomar Shoal and Rankin Bank are the only large, complex, bathymetrical features on the outer western shelf of the West Pilbara (AIMS 2014). Species of major recreational interest found on these shoals include saddletail snapper, red emperor, cods, coral and coronation trout, sharks, trevally, tuskfish, tunas, mackerels and billfish (Fletcher and Santoro 2012).

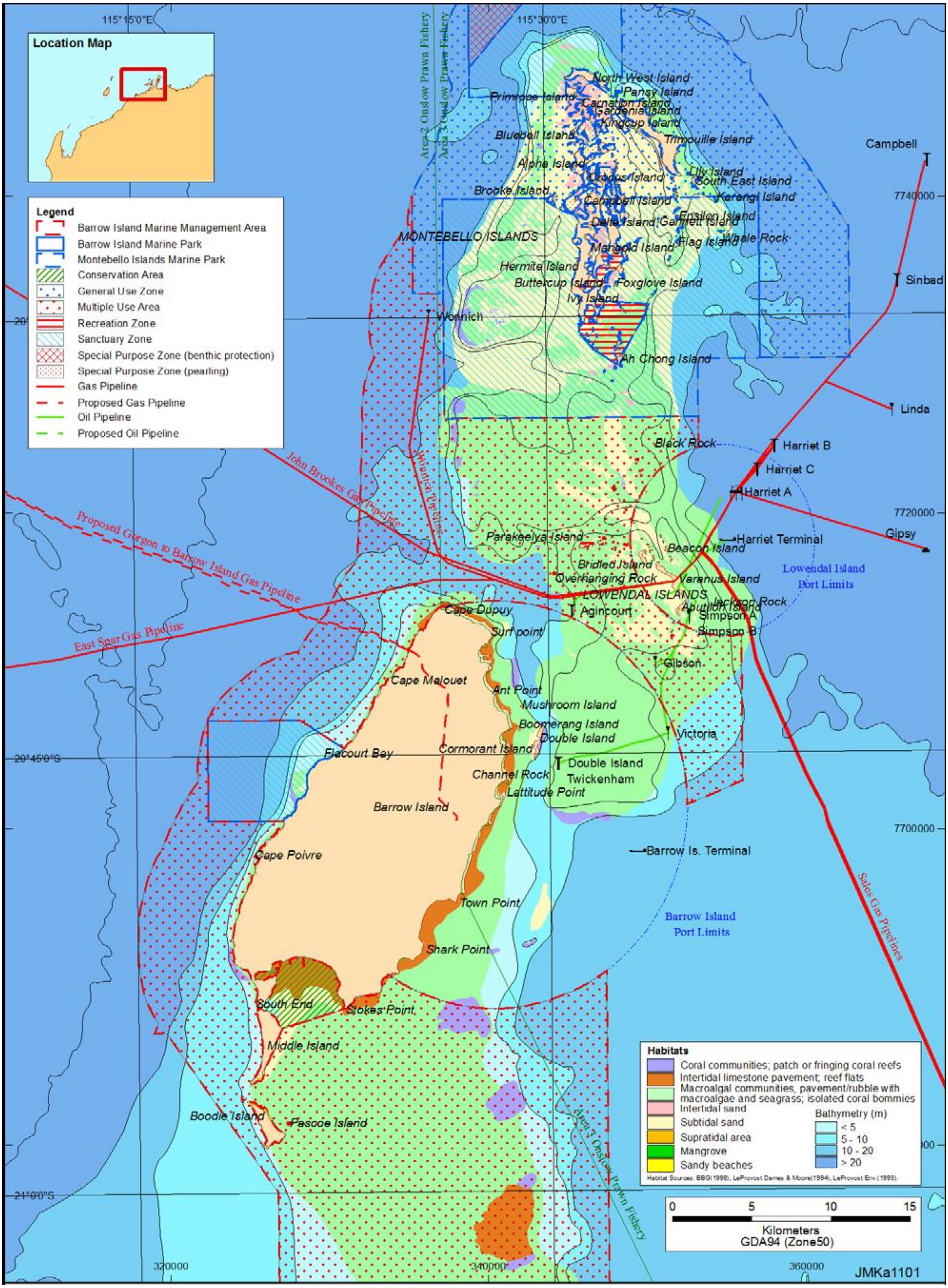


Figure 5-4: Marine Habitats Surrounding the Montebello, Lowendal and Barrow Islands

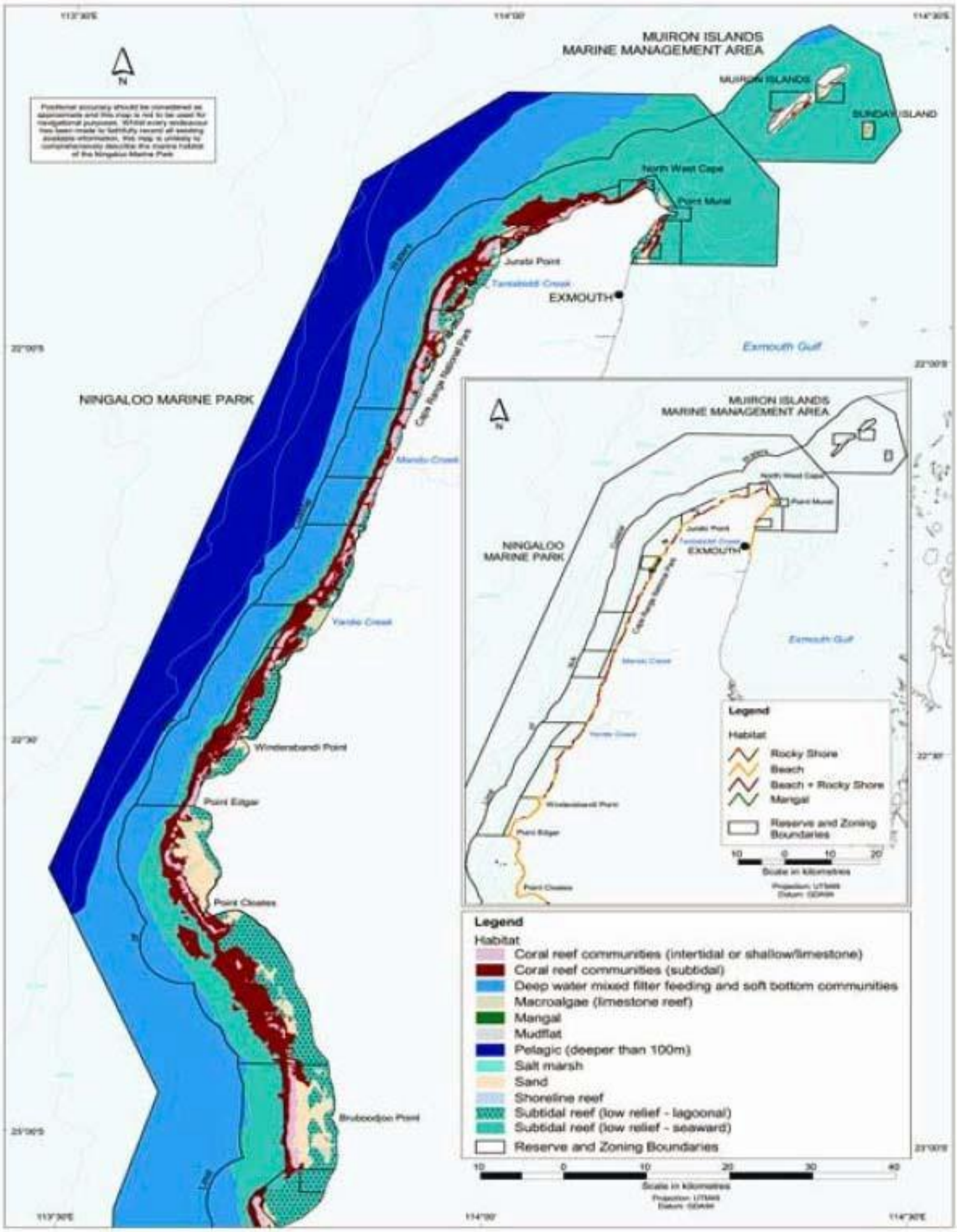


Figure 5-5: Marine Habitats Surrounding the Ningaloo Marine Park North of Point Cloates

The Glomar Shoals have been identified as a Key Ecological Feature (KEF) of the North-west Marine Bioregion (Falkner et al. 2009). The area is known to be an important for many commercial and recreational fish species such as Rankin cod, brown striped snapper, red emperor, crimson snapper, bream and yellow-spotted triggerfish (Falkner et al. 2009; Fletcher and Santoro 2012). Catch rates at the Glomar Shoals are high, indicating that it is an area of high productivity.

5.3.4 Macroalgae and Seagrasses

Macroalgae are most prolific over the shallow pavement limestone reefs adjacent to the offshore islands in the region, including those of the Dampier Archipelago 32 km southeast of the Stag Facility location. Seagrasses form extensive meadows over some of the shallow water sandflats (down to approximately 15 m water depth). In deeper waters, macroalgae and seagrasses are less abundant due to lower light levels reaching the benthos.

Macroalgae and seagrasses are important primary producers in tropical inshore waters. Seagrasses are directly grazed by dugongs (Prince 1986) and both seagrasses and macroalgae are grazed by green turtles. Few fish species graze directly on seagrass or macroalgae but both vegetation types support a diverse and abundant invertebrate fauna that are the principal food source for many inshore fish species (Blaber and Blaber 1980). Small crustaceans, such as amphipods, copepods and isopods, emerge from macroalgae and seagrasses at night and are fed upon by planktivorous fish such as herring, sardine and anchovy (Robertson and Watson 1978). Dense schools of these fish are in turn fed upon by both predatory fish, such as tuna and mackerel, and diving birds, such as shearwater and terns. Beds of seagrasses and macroalgae may support the juvenile stages of prawn species that are commercially important in the region (Loneragan et al. 2003).

Dampier Archipelago

Macroalgae dominate submerged limestone reefs and also grow on stable rubble and boulder surfaces in the Dampier Archipelago/Cape Preston region (**Figure 5-3**). These communities are most commonly found on shallow limestone pavement in depths less than 10 m. Low relief limestone reefs, which are dominated by macroalgae, account for 17% (~ 35,460 ha) of the major marine habitats within the Dampier Australian Marine Park. Brown algae are the most abundant group of algae in the region, with Sargassum sp., Dictyopteris sp. and Padina sp. being the dominant species. The most common green algae are the articulate coralline Halimeda sp, while prominent red algal species include crustose corallines, non-corallines and algal turf. Seagrass occurs in the larger bays and sheltered flats of the region. Six species of seagrass are present on the subtidal soft sediment habitats, these being Cymodocea angustata, Halophila ovalis, Halophila spinulosa, Halodule uninervis, Thalassia hemprichii and Syringodium isoetifolium. Seagrasses do not form extensive meadows within the proposed reserves, but rather form interspersed seagrass/macroalgae beds. The most significant areas of seagrass are found between Keast and Legendre islands and between West Intercourse Island and Cape Preston (CALM 2005b). Macroalgae and seagrasses are important primary producers, trapping light energy from the sun and making it available to the ecosystem. They also provide important habitats for molluscs, sea urchins, sea stars, sea cucumbers, crabs and fishes. Marine turtles feed on algae and seagrass, and the ephemeral seagrass typically found in the area is likely to be the preferred food source for the resident dugong population

Montebello/Barrow/Lowendal Islands

Macroalgae are the dominant macrophyte in the Montebello/Lowendal/Barrow Island region, occupying approximately 40% of the benthic habitat area of the region (CALM 2004) (**Figure 5-4**). At least 132 macroalgal taxa occur in marine habitats around Barrow Island with most thought to be widely distributed in the tropical Indo-Pacific region (Dr J. Huisman, pers. comm. in Chevron 2005). Macroalgae generally attach to hard substrates such as rock, although species such Caulerpa, Halimeda, Udotea and Penicillus can anchor in soft sediments or attach to shell fragments or rubble.

The most numerically abundant macroalgae are of the Sargassum genus, which cover the shallow subtidal rock platforms around the islands. Seasonally, Sargassum grows large foliose fronds bearing reproductive structures and then senesce each winter. Consequently, the biomass of the macroalgal beds varies greatly with this seasonal cycle of growth and senescence. Other abundant taxa in the Montebello/Lowendal/Barrow Island region include Halimeda, Caulerpa, Dictyopteris, Dictyota, Cystoseira, Padina, Codium and Laurencia (Chevron 2008).

On the east coast of Barrow Island, macroalgal diversity is highest in the rock pools and toward the deeper edge of the intertidal zone (Chevron 2008). The dominant macroalgae on the east coast platforms are Cystoseira trinodis, Sargassum spp., Caulerpa spp. and Halimeda spp. Macroalgal turfs are widespread on the intertidal pavement reef and comprise red algae such as Laurencia, Chondria, Ceramium, Centroceras clavulatum, Gelidiopsis and Hypnea (Chevron 2005; 2008).

Seagrasses in the Montebello/Lowendal/Barrow Island region are sparsely interspersed between macroalgae and do not form extensive meadows. Six species have been recorded to date: Cymodocea angustata, Halophila ovalis, Halophila spinulosa, Halodule uninervis, Thalassia hemprichii and Syringodium isoetifolium (CALM 2004). Most of these are small, ephemeral species that grow on subtidal sands and in intertidal pools and have a seed bank in the surficial sediments that allows them to recolonise quickly following disturbance. The most common species are Halophila ovalis on the deeper subtidal sand and Syringodium isoetifolium and Halodule uninervis in the rock pools (Chevron 2005, 2008).

Offshore Islands between North-West Cape and Dampier Archipelago

Macroalgae and seagrass occur around the numerous small offshore islands within this region (including Muiron Islands, Thevenard Island, Airlie Island and Serrurier Island) associated with limestone pavement and protected areas of soft sediments. Dominant species are consistent with those described for the Dampier Archipelago and the Ningaloo Coastline.

Ningaloo Coastline

Macroalgal meadows along the Ningaloo coastline are generally found on the shallow limestone lagoonal platforms and occupy about 2,200 ha of the Ningaloo Marine Park and Muiron Islands Marine Management Area (CALM 2005a) (**Figure 5-5**). Macroalgal communities within the Park have been broadly described (Bancroft and Davidson 2001). The dominant genera are Sargassum, Padina, Dictyota and Hydroclathrus (McCook et al. 1995). Seagrass species are generally patchily distributed and are not a major component or a major primary producer on the reef (CALM 2005a). The biogeography of several species such as Cymodocea angustrata, Cymodocea serrulate, Halodule uninervis, Haliphola ovalis, Haliphola spinulosa, Syringodium isoetifolium, and Thalassodendron ciliatum suggest that these species are likely to occur in the reserves. It is also highly likely that some temperate species have their northernmost limit in the reserves.

Exmouth gulf

Exmouth Gulf is a rich marine environment. It is a resting ground for humpback whales (**Figure** 5-7), and important area for dugong and turtles. The mangrove systems on the eastern margins are areas of high primary productivity feeding and are a nursery for fish both within the Gulf and the nearby Ningaloo Reef (**Section 5.8.2**)

The mangroves along the eastern side of the gulf stretch for nearly 50 km. They have been identified by BirdLife International as a 420 km^2 Important Bird Area (IBA) because they support over 1% of the world populations of pied oystercatchers and grey-tailed tattlers, as well as being an important site for the restricted-range dusky gerygone. Another IBA is 11 ha Sunday Island, lying in the north of the Gulf near the Muiron Islands, which is an important nesting site for roseate terns.

Coastline between Dampier Archipelago and Eighty Mile Beach

Tropical macroalgae and seagrass species occur in the shallow waters along this stretch of coastline and are typically associated with areas of outcropping hard substrate and protected soft sediments, respectively. Abundance and biomass typically exhibit strong seasonal trends. Common algae species in the Port Hedland region include tropical genera such as Sargassum, Caulerpa and Halimeda with seagrass including ephemeral Halophila spp (BHPB 2011).

5.4 Intertidal Shoreline Habitats

5.4.1 Mangroves

Mangroves are recognised as significant as they are productive coastal forest systems, providing habitat and shelter for infauna, epifauna, gastropods, crustaceans, fish and other marine species. Mangroves are important nursery areas for fish, lobster and prawn species, some of which are targeted by recreational and commercial fishers. Mangroves may also provide shelter for other species such as juvenile turtles. Ospreys (Pandion haliaetus) and white-bellied sea eagles (Haliaeetus leucogaster) roost in mangroves, while a range of smaller birds' nest in them (DEC 2007a). Mangroves are also recognised for their capacity to protect coastal areas from erosion due to storms and storm surge. In WA, mangroves are generally of high conservation significance and are protected throughout under the Wildlife Conservation Act 1950.

The regional mangroves of mainland and islands from Exmouth to Eighty Mile Beach represent Australia's only 'tropical-arid' mangroves. Within the NWS region, mangroves are present on the Montebello and Lowendal Islands, along the south eastern and southern shores of Barrow Island, in sheltered pockets on the offshore islands of the Dampier Archipelago, along the western side of the Cape Range Peninsula, on the eastern shore of Exmouth Gulf, and in extensive stretches along many creeks and watercourses on the mainland coast. Western Australia does not support any unusual endemic or restricted mangrove species. All mangrove species within Western Australia are common and widespread elsewhere, either in northern Australia, or in the Indo-pacific region proximal to northern Australia.

<u>Dampier Archipelago</u>

Six species of mangrove are found within the Dampier Archipelago/Cape Preston region, these being the white mangrove (Avicennia marina), red mangrove (Rhizophora stylosa), club mangrove (Aegialitis annulata), ribbed fruit orange mangrove (Brugiera exaristrata), yellow leaf spurred mangrove (Ceriops tagal) and river mangrove (Aegiceras cornculatum). Mangrove communities (mangals) account for 3% (~5,950 ha) of the proposed Dampier Archipelago Marine Park and Cape Preston Marine Management Area (**Figure 5-3**). Most of these communities are along the mainland coast on the tidal flats at Regnard Bay, the Maitland River mouth, King Bay and Nickol Bay. Well-developed communities also occur in some of the sheltered bays on the islands, for example at West Intercourse Island, in Searipple Passage and the southern shores of West Lewis and East Lewis islands (CALM 2005b). The mangrove communities at the Fortescue River delta, Cape Preston area, West Intercourse Island, Enderby Island, Searipple Passage/Conzinc Bay and Dixon Island have been assessed by Semeniuk (1997) as having international significance from a biodiversity and ecological basis.

<u>Montebello/Barrow/Lowendal Islands</u>

The mangroves of the Montebello Islands (**Figure 5-4**) are globally significant because they are the world's only mangroves growing in lagoons of offshore islands (Semeniuk 1997). Six species of mangrove are found on the islands: Avicennia marina, Bruguiera exaristata, Ceriops tagal, Rhizophora stylosa, Aegialitis annulata and Aegiceras corniculatum. Mangroves on the Montebello islands occur as isolated trees through to patches of continuous forest, the largest being a 15 ha stand in Stephenson Channel (DEC 2007a).

Within the Lowendal Island group, three species of mangroves are found on Varanus, Abutilon and Bridled Islands. Mangrove distribution within the Lowendals is very restricted, being largely determined by local geomorphology, substrate type, and soil water and groundwater salinity (VCSRG 1988).

On Barrow Island, mangroves are restricted to a few small areas on the east and southern coast at Mattress Point, south of Chevron camp, near the airstrip, at Stokes Point and near Pelican Island on the western side of Bandicoot Bay (Chevron 2008). Avicennia marina is the most common species, although Rhizophora stylosa is also present. These mangroves are generally poorly developed in comparison to their mainland counterparts and generally occur as a narrow band of stunted trees. Nevertheless, mangroves on Barrow Island are important habitat for many avifauna species, including ospreys and white-bellied sea eagles, and for red fiddler crabs (Uca sp.) at Square Bay (RPS BBG 2005).

Ningaloo Coastline

Three species of mangroves have been identified within Ningaloo Marine Park. The dominant species is the white mangrove (Avicennia marina), with the red mangrove (Rhizophora stylosa) and the ribbed-orange fruit mangrove (Bruguiera exaristata) existing in limited numbers (May et al. 1983). The largest mangrove community (~31 ha), found within Mangrove Bay, is characterised by established trees to 5 m in height. Established mangrove stands can also be found associated with tidal creek systems including a well-developed mangal within Yardie Creek.

Coastline between Dampier Archipelago and Eighty Mile Beach

Mangroves are a common habitat within sheltered areas such as estuaries, tidal creeks and sheltered bays, along the mainland between Dampier Archipelago and Eighty Mile Beach. Seven species of mangrove have been recorded within the Port Hedland Industrial Area, with Avicennia marina and Rhizophora stylosa being the most abundant (BHPB 2011). Avicennia marina is the dominant mangrove within mangrove stands at Eighty Mile Beach.

5.4.2 Coastal Salt Marsh

Coastal salt marsh is a transitional habitat between land and salty or brackish water (e.g. in bays and estuaries). It is dominated by halophytic (salt tolerant) herbaceous plants (e.g. samphires). In the Port Hedland Industrial Management Unit and surrounding areas, salt marsh habitat commonly replaces mangrove stands with increasing distance from the water line where sediments are drier and more saline (BHPB 2011). Salt marshes are also a feature of the landscape further north, at Eighty Mile Beach. Salt marshes may be inundated by spring high tides and therefore may be exposed to oil spills on spring high tides.

5.4.3 Sandy Beaches

Sandy beaches are those areas within the intertidal zone in which unconsolidated sediment has been deposited by wave and tidal action. Sandy beaches can vary from low to high energy zones which will influence their profile through varying rates of erosion and accretion. Sandy shorelines are generally interspersed among areas of hard substrate (e.g. sandstone) that form intertidal platforms and rocky outcrops. Sandy beaches provide habitat to a variety of burrowing invertebrates and subsequently provide foraging grounds for shorebirds (DNP 2013), as well as important habitat for nesting turtles.

Sandy beaches are found throughout the bioregion on both the mainland at Eighty Mile beach, Dampier and Onslow, as well as on many of the numerous islands throughout including Barrow Island, Murion Islands, Thevenard, Serrurier, Dampier Archipelago, Bedout Island, North Turtle Island, and the chain of nearshore islands covered under the Great Sandy Island Nature Reserves. Eighty Mile Beach Marine Park is one of the Australia's largest uninterrupted sandy beaches (stretching 220 km) and is an important feeding ground for small wading birds that migrate to the area each summer, travelling from countries thousands of kilometres away (DEC 2011). It is also a listed Ramsar wetland (see **Section 5.7.13**).

5.4.4 Mud Flats

Intertidal mudflats form when fine sediment carried by rivers and the ocean is deposited in a low energy environment. Tidal mudflats are highly productive components of shelf ecosystems responsible for recycling organic matter and nutrients through microbial activity. This microbial activity helps stabilise organic fluxes by reducing seasonal variation in primary productivity which ensures a more constant food supply (Robertson 1988). Intertidal sand and mudflats support a wide range of benthic infauna and epifauna which graze on microscopic algae and microbenthos, such as bivalves, molluscs, polychaete worms and crustaceans (Zell 2007).

The high abundance of invertebrates found in intertidal sand and mudflats provides an important food source for finfish and shellfish which swim over the area at high tide. Mudflats have also been shown to be significant nursery areas for flatfish. During low tide, these intertidal areas are also important foraging areas for indigenous and migratory shorebirds. Mudflats also play a vital role in protecting shorelines from erosion (Wade and Hickey 2008).

Eighty Mile beach has significant intertidal mudflats that are used by birds in spring and summer including species listed as threatened under the EPBC Act or listed on the IUCN Red List of Threatened Species (2017). The sediments that dominate these flats are generally of terrigenous origin (Wilson 2013).

5.4.5 Rocky Shorelines

Intertidal platforms are areas of hard bedrock and/or limestone with or without a sediment veneer of varying thickness. These platforms can vary from low to high relief and provide a habitat for a diverse range of intertidal organisms (Morton and Britton in Jones 2004, SKM 2009, 2011, and Hanley and Morrison 2012) and some species of shore birds (Garnet and Crowley 2000). They are common within each of the coastal bioregions within the area of interest.

Intertidal rock pavement and rocky shores are typically associated with high stress environments, with periods of desiccation, predation and sometimes strong wave energies. The higher tidal ranges and less severe wave action in the north mean that smooth intertidal slopes are not common. Intertidal rock pavement is a significant part of the marine landscape, due to the high biological productivity, and their sediments on the coast through erosion and biological production of material such as shell fragments. Some platforms protect nearshore waters, such as Ningaloo and North-West Cape, which is separated from the coast by shallow water lagoons.

Rocky coasts occur where there is a lack of sandy sediment or where erosion has exposed the underlying rock. Rocky shores can include pebble/cobble, boulders, and rocky limestone cliffs (often at the landward edge of reef platforms). Rocky shorelines are an important foraging area for seabirds and habitat for invertebrates found in the intertidal splash zone (Morton and Britton in Jones 2004). For example, oyster catchers and ruddy turnstones feed along beaches and rocky shorelines.

Rocky shores dominate on most of the Barrow and Montebello islands and provide habitat for a variety of intertidal organisms. CALM (2004) estimated the linear extent of rocky shore habitat in the zone as approximately 63% of the coastline, and a further 11% was categorised as beach interspersed with rocky shore. Rocky shores provide food for shorebirds (Chevron 2010) and are also common within the Dampier Archipelago, notably King and Conzinc Bays, and Angel, Gidley, Enderby and the Lewis Islands.

5.4.6 Summary of Habitats within the Operational Area and EMBA

Table 5-1 summarises the habitats that may be affected by routine events at the Stag Facility within the Operational Area as well as unplanned events that may arise within a larger EMBA.

Table 5-1: Environmental Values and Sensitivities for Habitats within the Operational Area

Habitats	Environmental value	Sensitivities within the Operational Area	Sensitivities within the EMBA
Subtidal Benthic Habitats			
Soft sediments and benthic fauna	Support a diverse infauna consisting predominantly of mobile burrowing species that include molluscs, crustaceans (crabs, Shrimps and smaller related species), polychaetes, sipunculid and platyhelminth worms, asteroids (sea stars), echinoids (sea urchins) and other small animals. Biological activity occurs throughout the year.	**Yes –** Soft sediment is the dominant habitat.	**Yes –** Soft sediment is the Dominant subtidal habitat throughout the EMBA.
Hard Coral habitat	Food source for some fish species;	**No**	**Yes –** Important coral localities:

Habitats	Environmental value	Sensitivities within the Operational Area	Sensitivities within the EMBA
	Integral source of carbonate sediments; large component of primary productivity and habitat to regional marine ecology Peak coral spawning occurs March–April Coral spawning also occurs October–November.		Dampier Archipelago, Ningaloo Reef, Muiron Islands Barrow/ Montebello/Lowendal Island group and Rowley Shoals.
Macroalgae beds	Primary producers; dugong and turtle feeding habitat; support a diverse and abundant fauna of small invertebrates that are the principal food source for many inshore tropical fish species Produce reproductive structures and then senesce each winter (May–September).	**No**	**Yes –** Macroalgal habitat prevalent within shallow waters (photic zone) associated with primarily rocky substrate along the mainland coast and associated with offshore islands.
Seagrasses meadows	Primary producer; dugong feeding habitat Throughout the year they are growing or shedding fronds.	**No**	**Yes –** Seagrasses occur within the photic zone along the Dampier Archipelago, Ningaloo Reef, Muiron Islands Barrow/ Montebello/ Lowendal Island group.
Hard substrates and epiflora/ fauna	Support higher diversity of Epifauna than soft sediment habitats and provide surfaces for attachment of fauna (e.g. hard coral, soft corals, sponges) and macroalgae.	**No**	**Yes –** Hard substrates occur throughout the EMBA. Filter feeding epifauna can occur across a range of depths. Benthic primary production associated with hard substrate restricted to shallow photic zone.
Intertidal Shoreline Habitats			
Mangroves	An important primary producer habitat along shorelines of the Pilbara mainland and islands. Important habitat for birds, molluscs, crustaceans, juvenile fish; bird watching hide. Important for shoreline stabilisation and nutrient recycling.	**No**	**Yes –** Along mainland coastline between Ningaloo coast to Broome; Montebello and Lowendal Islands south eastern and southern shores of Barrow Island and in sheltered pockets on the offshore islands of the Dampier Archipelago and Exmouth Gulf.
Salt marsh	Primary producer habitat commonly occurring landward of mangrove stands. Salt marshes stabilise sediments, recycle nutrients and provide habitat for coastal fauna.	**No.**	**Yes –** Can be distributed landward of mangrove habitat in brackish environment. Known occurrence between Port Hedland and Eighty Mile Beach.
Sandy beaches	Shorebird foraging/ breeding habitat; turtle nesting habitat. Crested tern nesting post-wet season; turtle nesting October to February; hatchling emergence November to April.	**No**	**Yes –** Sandy beaches occur throughout the region. Important sites occur on Eighty Mile beach, Dampier and Onslow, as well as on many of the numerous islands including Barrow Island, Murion Islands, Thevenard, Serrurier, Dampier Archipelago, Bedout

Habitats	Environmental value	Sensitivities within the Operational Area	Sensitivities within the EMBA
			Island, North Turtle Island.
Mud/sand flats	Support a diverse assemblage of vertebrates and invertebrates, macroalgae and seagrass. Biological activity occurs throughout the year.	**No**	**Yes** – Found throughout the EMBA. Important site is Eighty-Mile Beach which is a Ramsar site important for migratory shorebirds.
Rocky shorelines	Foraging area for shorebirds. Invertebrates found in the vertical splash zone; roosting areas for seabirds. Biological activity occurs throughout the year.	**No**	**Yes** – Found throughout the EMBA including Ningaloo Coast, Muiron Islands, Montebello/ Barrow/ Lowendal Islands and Dampier Archipelago.

5.5 Marine Fauna

Fauna that may be present within the EMBA for the activity include plankton, invertebrates, fish, marine mammals, marine reptiles and seabirds.

5.5.1 Plankton

Plankton is divided into two categories: phytoplankton and zooplankton. Phytoplanktonic algae are important primary producers and range in size from 0.2 to 200 mm. Zooplankton are small, mostly microscopic animals that drift with the ocean currents, and it has been estimated that 80% of the zooplankton in waters off Australian continental shelf and shelf margin are the larval stages of fauna that normally live on the seabed (Raymont, 1983). A common feature of plankton populations is the high degree of temporal and spatial variability. Phytoplankton in tropical regions have marked seasonal cycles with higher concentrations occurring during the winter months (June–August) and low in summer months (December–March) (Hayes et al., 2005; Schroeder et al., 2009). Zooplankton rely on phytoplankton as food and are subject to similar seasonality.

5.5.2 Invertebrates

Pelagic invertebrates other than zooplankton include mobile cnidarians (jellyfish), salps and squid. Larger marine fauna such as leatherback turtles may consume jellyfish, whereas fish and large mammals such as dolphins and whales generally consume squid.

The mostly sandy substrates within the North-west Marine Bioregion are thought to support low densities of benthic communities, such as bryozoans, molluscs and echinoids (DEWHA, 2008a). In areas of harder substrates, sponge communities are sparsely distributed.

Apache sampled the biota surrounding the location of the Stag Facility and loadout location (the FSO at the time) prior to development drilling of this Facility, to provide a baseline for comparison to the post-development and post-commissioning situation (Kinhill, 1997, 1998). Sampling confirmed that the benthic biota within the vicinity of Stag Field was comparable to that found over similar substratum and at similar depths over the wider region (Ward and Rainer, 1988; Woodside, 1988; Rainer, 1991). The unconsolidated sediments in this habitat support a diverse infauna, consisting predominantly of mobile burrowing species such as crustaceans (crabs, shrimps and smaller related species), polychaete, sipunculid and platyhelminth worms, asteroids (sea stars), echinoids (sea urchins), and other small infaunal animals.

The abundance and composition of this infauna is variable over both space and time (Ward and Rainer, 1988; Rainer, 1991; Kinhill, 1997). Differences between locations are related to such factors as depth and seafloor texture while changes over time within a location may be related to changes in the physical environment, such as water temperature or wave-induced currents. Ward and Rainer (1988) reported a seasonal pattern in the abundance of small species of decapod crustaceans in this region. However, because they only sampled at two times, it is not clear if this pattern was related to season or to other factors, such as storm events, which operate at much shorter time scales. By comparison to the infauna, the diversity and abundance of large encrusting animal species (epibenthic fauna) in this region is relatively low (Ward and Rainer, 1988; Woodside, 1988; Kinhill, 1997). This is probably due to instability of the sediment and the lack of exposed and colonisable reef.

5.5.3 Fish

The NWMR supports large populations of cartilaginous fishes (such as sharks and rays), that are typically higher-order predators and perform an important ecological role through the regulation of prey species. The NWMR contains 157 chondrichthyan species (sharks, skates and rays), 18 of which are endemic. This includes 94 shark species, many of which are found in other parts of Australia, and which represent approximately 19% of the world's shark species (Heupel and McAuley, 2007). Sharks, skates and rays occupy a broad range of habitats, from shallow to deep-water, with some species being pelagic.

Large pelagic fish such as tuna, mackerel, swordfish, sailfish and marlin are another important component of the ecosystem and are found mainly in oceanic waters and occasionally on the continental shelf (Brewer et al., 2007). Both juvenile and adult phases of the large pelagic species are highly mobile and have wide geographic distributions, although the juveniles more frequently inhabit warmer or coastal waters (DEWHA 2008a).

The demersal habitat of the NWS hosts a diverse assemblage of fish of tropical Indo-west Pacific affinity, with up to 1,400 species known to occur – many in shallow coastal waters (Allen et al., 1988). Last et al. (2005) described the North-west Shelf Province as being characterised by a high level of endemism and species diversity. Many of these fish species are commercially exploited by trawl and trap fisheries, for example the genera Lethrinus (emperor) and Lutjanus (snapper) (Sainsbury et al., 1985).

Within the southern portion of the North-west Shelf Province, small pelagic fish (e.g. lantern fishes) comprise a third of the total fish biomass (Bulman, 2006), and play an important ecological role, not only for this particular area but for the entire NWMR. They inhabit a range of marine environments, including inshore and continental shelf waters and form a vital link within and between many of the region's trophic systems, feeding on pelagic phytoplankton and zooplankton and providing a food source for a wide variety of predators including large pelagic fish, sharks, seabirds and marine mammals (Mackie et al., 2007).

The shallow waters (<30 m) of the Dampier Archipelago support a characteristic and rich fish fauna of 650 species from a variety of habitats including coral and rocky reefs, mangroves, sand and silty bottoms and sponge gardens (Hutchins, 2004). The majority of these species were found over hard substrate, but significant numbers were also found from soft bottom and mangrove areas. The outer islands of the Archipelago are inhabited predominantly by coral reef fishes whereas inner areas close to the mainland are occupied by mangrove and silty-bottom dwellers. The inter-island passages have a relatively rich soft bottom fauna. The fish fauna of the archipelago is less diverse that the islands of the West Pilbara to the south but are closely related to the fauna at the offshore Montebello Islands (Hutchins, 2004). EPBC Act protected fish species within the Dampier Archipelago include the dwarf sawfish (Pristis clavata).

The Glomar Shoals, approximately 70 km north-east of the Stag Facility (**Section 5.7.7**), have been identified as a Key Ecological Feature (KEF) of the North-west Marine Bioregion (Falkner et al., 2009). The area is known to be an important for a number of commercial and recreational fish species such as rankin cod, brown striped snapper, red emperor, crimson snapper, bream and yellow-spotted triggerfish (Brewer et al., 2007; Falkner et al., 2009; Fletcher and Santoro, 2012). Catch rates at the Glomar Shoals are high, indicating that it is an area of high productivity.

Continental Slope Demersal Fish Communities have also been identified as a KEF within the Stag Facility EMBA (**Section 5.7.7**) which are located 110 km NW of the Stag Facility. This KEF represents the continental slope between North-West Cape and the Montebello Trough, which supports more than 500 fish species, 76 of which are endemic, making it the most diverse slope bioregion in Australia. The slope of the Timor Province and the Northwest Transition also contains more than 500 species of demersal fish, of which 64 are considered to be endemic, and is the second richest area for demersal fish species across the entire Australian continental slope.

Similar to that of the Stag Facility and surrounds, the fish fauna of Barrow/Lowendal/Montebello Islands are widespread throughout the Indo-west Pacific region, but also include species protected by legislation. Protected species within the Barrow/Lowendal/Montebello Islands include the whale shark (Rhincodon typus), great white shark (Carcharodon carcharias) and grey nurse shark (Carcharias taurus).

The warm waters of the north-west shelf are thought to be the location of spawning for some fish species. Some fish species are likely to be more susceptible than others to impact due to their physical characteristics (e.g. size, ability to move quickly) and behaviours (e.g. schooling, spawning aggregations). The life stage (i.e. egg, larvae, juvenile, adult) of a fish is also likely to influence its susceptibility to impacts. A summary of key species likely to spawn in the EMBA (DoF 2013) can be found in **Table** 5-2**.**

Table 5-2: Spawning Dates for Key Fish Species

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Blacktip shark (*Carcharhinus tilstoni and C. limbatus*)											■	■
Goldband snapper (*Pristipomoides multidens*)	■	■	■	■								
Rankin cod (*Epinephelus multiinotatus*)								■	■	■		
Red Emperor (*Lutjanus sebae*)	■		■							■		
Sandbar shark (*Carcharhinus plumbeus*)	■									■	■	■
Spanish mackerel (*Scomberomorus commerson*)								■	■	■	■	
Pink snapper (*Pagrus auratus*)					■	■	■	■				
Baldchin groper (*Choerodon rubescens*)	■	■							■	■	■	■
Crystal (snow) crab (*Chaceon* spp.) Gascoyne	■	■	■	■	■	■	■	■	■	■	■	■
Champagne (spiny) crab (Hypothalassia acerba)			■	■	■							

5.5.4 Crustaceans

The NWMR is thought to contain a high diversity of crustaceans across a range of habitats, from intertidal sites to the deeper waters of the slope and the abyss. Dominant species groups include copepods, prawns, scampi and crabs. These groups display a strong biogeographic affinity with the Indo-west Pacific, with few endemic species present. As well as being preyed upon by large pelagic fish, crustaceans are also a significant food for cephalopods (squid and octopus species; DEWHA 2008a). The North-West Slope Trawl Fishery

(NWSTF) targets scampi in the NWMR. Data from the fishery suggests that muddy sediments support significant populations of crustaceans (DoF 2012).

5.5.5 Cephalopods

Approximately 81 different species of cephalopod are believed to occur in the NWMR, five of which may be endemic as they have only been recorded from one location or are thought to have a very restricted distribution (DEWHA 2008a). The area between Kalbarri and the Dampier Archipelago appears to be particularly significant for octopus, dumpling squids and several species of cuttlefish (DEWHA 2008a). Squid are an important food item for a number of species in the NWMR. Sperm whales, for example, feed exclusively on the Japanese flying squid (Todarodes pacificus) and sharpear enope squid (Ancistrocheirus lesueurii), while seabirds (such as black noddies and red-footed boobies) feed on the purple back flying squid (Sthenoteuthis oualaniensis; DEWHA 2008a).

Information on species listed under the EPBC Act such as sharks, turtles, cetaceans and avifauna are covered in **Section 5.6**.

Table 5-7 summarises the fauna that may be affected by routine events at the Stag Facility within the Operational Area as well as unplanned events that may arise within a larger EMBA.

5.6 Threatened and Migratory Species

The EPBC Act lists both threatened and migratory species that are protected under Commonwealth legislation and various international conventions and treaties.

A search of the EPBC Act Protected Matters Database in December 2020 (**Appendix C**) identified 52 threatened species (endangered, vulnerable, and critically endangered) as occurring or having habitat within the EMBA (**Table 5-2**). Fourteen of these threatened species are terrestrial and have been excluded as it is unlikely that they would be impacted from an oil spill associated with the Stag Facility.

No listed threatened ecological communities were identified within the EMBA. Further detail on species identified as threatened or migratory is presented in the following sections. **Appendix C** contains the full PMST search and includes additional listed species that are not classified as threatened or migratory under the EPBC Act but are considered ‘Other matters protected by the EPBC Act’. This list comprises additional cetaceans, birds, fish (pipefish, pipehorses and seahorses) and reptiles (sea snakes).

Table 5-3: Marine Fauna and Management Considerations in the Operational Area and EMBA

Class	Common Name	Scientific Name	EPBC Act Status	WC Act	Cons Advice	Recovery Plan	Threat Abatement Plan	BIA	Identified /relevant risks	Section in EP
Threat abatement plan for the impacts of marine debris on vertebrate wildlife of Australia's coasts and oceans (DoEE 2018)										
Sharks and Fish	Whale shark	*Rhincodon typus*	V; M	OPF (S7)	Yes	No		EMBA 9km from PW	Vessel interaction Habitat disturbance	**7.7**
	White shark	*Carcharodon carcharias*	V; M	V (S3)	No	Yes	No			
	Green sawfish	*Pristis zijsron*	V; M		Yes	Yes		EMBA		
	Grey nurse shark (west coast population)	*Carcharias taurus*	V	V (S3)	No	Yes	Marine debris			
	Dwarf sawfish	*Pristis clavata*	V	P1	No			EMBA		
	Narrow sawfish	*Anoxypristis cuspidata*	M		No					
	Freshwater/ Largetooth sawfish	*Pristis pristis*	VM		Yes	Yes		EMBA		
	Shortfin mako	*Isurus oxyrinchus*	M		No	No				
	Longfin mako	*Isurus paucus*	M		No	No				
	Porbeagle mackerel shark	*Lamna nasus*	M		No	No				
	Reef Manta Ray	*Manta alfredi*	M		No	No				
	Giant Manta Ray	*Manta birostris*	M		No	No				
The Action Plan for Australian Mammals 2012 (Woinarski et al. 2014) Threat abatement plan for the impacts of marine debris on vertebrate wildlife of Australia's coasts and oceans (DoEE 2018)										

Class	Common Name	Scientific Name	EPBC Act Status	WC Act	Cons Advice	Recovery Plan	Threat Abatement Plan	BIA	Identified /relevant risks	Section in EP
Marine mammals	Sei whale	*Balaenoptera borealis*	VM	E (S2)	Yes	No	Marine debris		Noise Habitat degradation/ pollution vessels	**7.2, 8.2, 7.7**
	Fin whale	*Balaenoptera physalus*	VM	E (S2)	Yes	No	Marine debris			
	Humpback whale	*Megaptera novaeangliae*	VM		Yes	No	Marine debris	PW EMBA	Noise Vessels Pollution	**7.2, 8.2, 7.7**
	Blue whale	*Balaenoptera musculus*	EM	E (S2)	No	Yes	Marine debris	PW EMBA	Noise Vessels	
	Southern right whale	*Eubalaena australis*	EM	V (S3)	No	Yes	Marine debris		Noise Habitat disturbance vessels	
	Antarctic minke whale	*Balaenoptera bonaerensis*	M				Marine debris			
	Bryde's whale	*Balaenoptera edeni*	M			No	Marine debris			
	Sperm whale	*Physeter macrocephalus*	M	V		No				
	Killer whale	*Orcinus orca*	M			No	Marine debris			
	Spotted bottlenose dolphin (Arafura/Timor Sea populations)	*Tursiops aduncus*	M			No	Marine debris			

Class	Common Name	Scientific Name	EPBC Act Status	WC Act	Cons Advice	Recovery Plan	Threat Abatement Plan	BIA	Identified /relevant risks	Section in EP
	Indo-Pacific humpback dolphin	*Sousa chinensis*	M			No				
	Dugong	*Dugong dugon*	M	OPF (S7)		No	Marine debris			
Marine reptiles	Recovery Plan for Marine Turtles in Australia (DoEE, 2017) Threat abatement plan for the impacts of marine debris on vertebrate wildlife of Australia's coasts and oceans (DoEE 2018)									
	Hawksbill turtle	*Eretmochelys imbricata*	VM	V S3		Yes	Marine debris	EMBA	Marine debris vessel interaction	**7.7, 7.2, 7.1**
	Flatback turtle	*Natator depressus*	VM	V S3		Yes	Marine debris	PW EMBA	Light Vessel interaction	**7.7, 7.2, 7.1**
	Green turtle	*Chelonia mydas*	VM	V S3		Yes	Marine debris	EMBA	Marine debris vessel interaction	**7.7, 7.2, 7.1**
	Loggerhead turtle	*Caretta caretta*	EM	E S2		Yes	Marine debris	EMBA	Marine debris vessel interaction	**7.7, 7.2, 7.1**
	Leatherback turtle	*Dermochelys coriacea*	EM	V S3		Yes	Marine debris		Marine debris vessel interaction	**7.7, 7.2, 7.1**
	Short-nosed seasnake	*Aipysurus apraefrontalis*	CE	CE (S1)	Yes	No	Marine debris			
	Salt-water crocodile	*Crocodylus porosus*	M	OPF (S7)		No				
Birds	Threat Abatement Plan for the incidental catch (or bycatch) of seabirds during oceanic longline fishing operations (DoEE 2018) Threat abatement plan for the impacts of marine debris on vertebrate wildlife of Australia's coasts and oceans (DoEE 2018)									
	Curlew Sandpiper	*Calidris ferruginea*	CE Mw	V S3		No			Loss wetlands human disturbance	

Class	Common Name	Scientific Name	EPBC Act Status	WC Act	Cons Advice	Recovery Plan	Threat Abatement Plan	BIA	Identified /relevant risks	Section in EP
									habitat loss pollution	
	Great Knot	*Calidris tenuirostris*	CE Mw	V S3		No			Pollution	**8.5**
	Bar-tailed Godwit (menzbieri)	*Limosa lapponica menzbieri*	CE Mw	V S3		No				
	Bar-tailed Godwit (baueri)	*Limosa lapponica baueri*	V Mw	V S3						
	Eastern Curlew	*Numenius madagascariensis*	CE Mw	V S3	Yes	No			Loss wetlands human disturbance habitat loss pollution	
	Lesser Sand Plover	*Charadrius mongolus*	E Mw	E S2		No			Habitat loss Disturbance	
	Greater Sand Plover	*Charadrius leschenaultii*	V Mw	V S3	Yes				Pollution Habitat loss	8.5
	Red Knot	*Calidris canutus*	E Mw	V S3		No			Habitat loss Disturbance	
	Southern giant-petrel	*Macronectes giganteus*	E Mw	P4		Yes	Marine Debris Bycatch			
	Northern giant-petrel	*Macronectes halli*	V Mw	P4		Yes	Marine Debris Bycatch			

Class	Common Name	Scientific Name	EPBC Act Status	WC Act	Cons Advice	Recovery Plan	Threat Abatement Plan	BIA	Identified /relevant risks	Section in EP
	Australian painted snipe	*Rostratula australis*	E Mw	E S2	Yes	No			Habitat loss/disturbance	
	Soft-plumaged petrel	*Pterodroma mollis*	V		Yes	No			Feral cats habitat destruction (erosion)	
	Australian fairy tern	*Sternula nereis nereis*	V	V	Yes	No		EMBA	Habitat disturbance	**8.5**
	Campbell Albatross	*Thalassarche impavida*	V M	V S3		Yes	Bycatch		N/A commercial fishing	N/A
	Abbott's Booby	*Papasula abbotti*	E	E S2	Yes	No				
	Indian Yellow-nosed Albatross	*Thalassarche carteri*	V M			Yes	Bycatch Marine Debris			
	Shy Albatross	*Thalassarche cauta*	E M		Yes	Yes	Bycatch Marine Debris			
	Black-browed Albatross	*Thalassarche melanophris*	V M			Yes	Bycatch Marine Debris			
	White-capped Albatross	*Thalassarche steadi*	V M			Yes	Bycatch Marine Debris			
	Common noddy	*Anous stolidus*	M	LC		No				
	Fork-tailed swift	*Apus pacificus*	M	LC		No				

Class	Common Name	Scientific Name	EPBC Act Status	WC Act	Cons Advice	Recovery Plan	Threat Abatement Plan	BIA	Identified /relevant risks	Section in EP
	Streaked shearwater	*Calonectris leucomelas*	M	LC		No				
	Lesser frigatebird	*Fregata ariel*	M	LC		No		EMBA		
	Great frigatebird	*Fregata minor*	M	LC		No				
	White-tailed tropicbird	*Phaethon lepturus*	M	LC		No		EMBA		
	Red-tailed tropicbird	*Phaethon rubricauda*	M	LC		No				
	Flesh-footed Shearwater	*Puffinus carneipes*	M	LC		No	Marine debris Bycatch			
	Wedge-tailed shearwater	*Puffinus pacificus*	M	LC		No	Marine debris Bycatch	EMBA PW		
	Little tern	*Sterna albifrons*	M	LC		No		EMBA		
	Bridled tern	*Sterna anaethetus*	M	LC		No				
	Lesser crested tern	*Sterna bengalensis*	M	LC		No				
	Caspian tern	*Sterna caspia*	M	LC		No				
	Roseate tern	*Sterna dougallii*	M	LC		No		EMBA		
	Masked booby	*Sula dactylatra*	M	LC		No				
	Brown booby	*Sula leucogaster*	M	LC		No	Marine debris	EMBA		
	Common sandpiper	*Actitis hypoleucos*	Mw	LC		No				
	Ruddy turnstone	*Arenaria interpres*	Mw	LC		No				
	Sharp-tailed sandpiper	*Calidris acuminata*	Mw	LC		No				

Class	Common Name	Scientific Name	EPBC Act Status	WC Act	Cons Advice	Recovery Plan	Threat Abatement Plan	BIA	Identified /relevant risks	Section in EP
	Sanderling	*Calidris alba*	Mw	LC		No				
	Pectroral Sandpiper	*Calidris melanotos*	Mw	LC		No				
	Red-necked Stint	*Calidris ruficollis*	Mw	LC		No				
	Oriental Plover	*Charadrius veredus*	Mw	LC		No				
	Swinhoe's snipe	*Gallinago megala*	Mw	LC						
	Pin-tailed snipe	*Gallinago stenura*	Mw	LC						
	Oriental Pratincole	*Glareola maldivarum*	Mw	LC		No				
	Grey-tailed Tattler	*Heteroscelus brevipes*	Mw	LC		No				
	Broad-billed Sandpiper	*Limicola falcinellus*	Mw	LC		No				
	Asian Dowitcher	*Limnodromus semipalmatus*	Mw	LC		No				
	Black-tailed godwit	*Limosa limosa*	Mw	LC						
	Little Curlew	*Numenius minutus*	Mw	LC		No				
	Whimbrel	*Numenius phaeopus*	Mw	LC		No				
	Osprey	*Pandion haliaetus*	Mw	LC		No				
	Ruff	*Philomachus pugnax*	Mw	LC						
	Pacific Golden Plover	*Pluvialis fulva*	Mw	LC						
	Grey Plover	*Pluvialis squatarola*	Mw	LC						
	Crested Tern	*Thalasseus bergii*	Mw	LC						
	Common Greenshank	*Tringa nebularia*	Mw	LC						

Class	Common Name	Scientific Name	EPBC Act Status	WC Act	Cons Advice	Recovery Plan	Threat Abatement Plan	BIA	Identified /relevant risks	Section in EP
	Marsh Sandpiper	*Tringa stagnatilis*	Mw	LC						
	Common Redshank	*Tringa tetanus*	Mw	LC						
	Terek Sandpiper	*Xenus cinereus*	Mw	LC						

Key EPBC: WC Act; V = vulnerable; OPF = Other Protected Fauna; CE = Critically Endangered; P1 = Priority Flora and Fauna List; M = Migratory marine; Mw = Migratory wetland; S = Schedule; LC = Least concern

Table 5-4: Threatened and Migratory Species in the EMBAs

Class	Common Name	Scientific Name	EPBC Act – Status
Fish	Whale shark	*Rhincodon typus*	Vulnerable; Migratory – marine
	White shark	*Carcharodon carcharias*	Vulnerable; Migratory – marine
	Green sawfish	*Pristis zijsron*	Vulnerable; Migratory – marine
	Grey nurse shark (west coast population)	*Carcharias taurus*	Vulnerable
	Freshwater/ Large tooth sawfish	*Pristis pristis*	Vulnerable; Migratory
	Dwarf sawfish	*Pristis clavata*	Vulnerable
	Narrow sawfish	*Anoxypristis cuspidata*	Migratory – marine
	Shortfin mako	*Isurus oxyrinchus*	Migratory – marine
	Longfin mako	*Isurus paucus*	Migratory – marine
	Porbeagle mackerel shark	*Lamna nasus*	Migratory – marine
	Reef Manta Ray	*Manta alfredi*	Migratory – marine
	Giant Manta Ray	*Manta birostris*	Migratory – marine
Marine mammals	Sei whale	*Balaenoptera borealis*	Vulnerable; Migratory – marine
	Fin whale	*Balaenoptera physalus*	Vulnerable; Migratory – marine
	Humpback whale	*Megaptera novaeangliae*	Vulnerable; Migratory – marine
	Blue whale	*Balaenoptera musculus*	Endangered; Migratory – marine
	Southern right whale	*Eubalaena australis*	Endangered; Migratory – marine
	Antarctic minke whale	*Balaenoptera bonaerensis*	Migratory – marine
	Bryde's whale	*Balaenoptera edeni*	Migratory – marine
	Sperm whale	*Physeter macrocephalus*	Migratory – marine
	Killer whale	*Orcinus orca*	Migratory – marine
	Spotted bottlenose dolphin (Arafura/ Timor	*Tursiops aduncus*	Migratory – marine
	Indo-Pacific humpack dolphin	*Sousa chinensis*	Migratory – marine
	Dugong	*Dugong dugon*	Migratory – marine
Marine reptiles	Hawksbill turtle	*Eretmochelys imbricata*	Vulnerable; Migratory – marine
	Flatback turtle	*Natator depressus*	Vulnerable; Migratory – marine
	Green turtle	*Chelonia mydas*	Vulnerable; Migratory – marine
	Loggerhead turtle	*Caretta caretta*	Endangered; Migratory – marine
	Leatherback turtle	*Dermochelys coriacea*	Endangered; Migratory – marine
	Short-nosed sea-snake	*Aipysurus apraefrontalis*	Critically Endangered
	Salt-water crocodile	*Crocodylus porosus*	Migratory – marine
Birds	Curlew Sandpiper	*Calidris ferruginea*	Critically Endangered; Migratory – wetland

Class	Common Name	Scientific Name	EPBC Act – Status
	Great Knot	*Calidris tenuirostris*	Critically Endangered; Migratory – wetland
	Bar-tailed Godwit (menzbieri)	*Limosa lapponica menzbieri*	Critically Endangered; Migratory – wetland
	Eastern Curlew	*Numenius madagascariensis*	Critically Endangered; Migratory – wetland
	Lesser Sand Plover	*Charadrius mongolus*	Endangered; Migratory – wetland
	Red Knot	*Calidris canutus*	Endangered; Migratory – wetland
	Southern giant-petrel	*Macronectes giganteus*	Endangered; Migratory – marine
	Australian painted snipe	*Rostratula australis*	Endangered; Migratory – wetland
	Soft-plumaged petrel	*Pterodroma mollis*	Vulnerable
	Australian fairy tern	*Sternula nereis nereis*	Vulnerable
	Bar-tailed Godwit (baueri)	*Limosa lapponica baueri*	Vulnerable; Migratory – wetland
	Greater Sand Plover	*Charadrius leschenaultii*	Vulnerable; Migratory – wetland
	Campbell Albatross	*Thalassarche impavida*	Vulnerable; Migratory – marine
	Abbott's Booby	*Papasula abbotti*	Endangered
	Common noddy	*Anous stolidus*	Migratory – marine
	Fork-tailed swift	*Apus pacificus*	Migratory – marine
	Streaked shearwater	*Calonectris leucomelas*	Migratory – marine
	Lesser frigatebird	*Fregata ariel*	Migratory – marine
	Great frigatebird	*Fregata minor*	Migratory – marine
	White-tailed tropicbird	*Phaethon lepturus*	Migratory – marine
	Red-tailed tropicbird	*Phaethon rubricauda*	Migratory – marine
	Flesh-footed Shearwater	*Puffinus carneipes*	Migratory – marine
	Wedge-tailed shearwater	*Puffinus pacificus*	Migratory – marine
	Little tern	*Sterna albifrons*	Migratory – marine
	Bridled tern	*Sterna anaethetus*	Migratory – marine
	Lesser crested tern	*Sterna bengalensis*	Migratory – marine
	Caspian tern	*Sterna caspia*	Migratory – marine
	Roseate tern	*Sterna dougallii*	Migratory – marine
	Masked booby	*Sula dactylatra*	Migratory – marine
	Brown booby	*Sula leucogaster*	Migratory – marine
	Common sandpiper	*Actitis hypoleucos*	Migratory – wetland
	Ruddy turnstone	*Arenaria interpres*	Migratory – wetland
	Sharp-tailed sandpiper	*Calidris acuminata*	Migratory – wetland
	Sanderling	*Calidris alba*	Migratory – wetland
	Pectroral Sandpiper	*Calidris melanotos*	Migratory – wetland

Class	Common Name	Scientific Name	EPBC Act – Status
	Red-necked Stint	*Calidris ruficollis*	Migratory – wetland
	Oriental Plover	*Charadrius veredus*	Migratory – wetland
	Swinhoe's snipe	*Gallinago megala*	Migratory – wetland
	Pin-tailed snipe	*Gallinago stenura*	Migratory – wetland
	Oriental Pratincole	*Glareola maldivarum*	Migratory – wetland
	Grey-tailed Tattler	*Heteroscelus brevipes*	Migratory – wetland
	Broad-billed Sandpiper	*Limicola falcinellus*	Migratory – wetland
	Asian Dowitcher	*Limnodromus semipalmatus*	Migratory – wetland
	Little Curlew	*Numenius minutus*	Migratory – wetland
	Whimbrel	*Numenius phaeopus*	Migratory – wetland
	Osprey	*Pandion haliaetus*	Migratory – wetland
	Ruff	*Philomachus pugnax*	Migratory – wetland
	Pacific Golden Plover	*Pluvialis fulva*	Migratory – wetland
	Grey Plover	*Pluvialis squatarola*	Migratory – wetland
	Crested Tern	*Thalasseus bergii*	Migratory – wetland
	Common Greenshank	*Tringa nebularia*	Migratory – wetland
	Marsh Sandpiper	*Tringa stagnatilis*	Migratory – wetland
	Common Redshank	*Tringa totanus*	Migratory – wetland
	Terek Sandpiper	*Xenus cinereus*	Migratory – wetland

5.6.1 Fish

Twelve species of EPBC listed fish and rays have been identified as potentially occurring within the EMBA for the Stag Facility. Of these, four species BIAs' also overlap with the EMBA including the; whale shark, green, dwarf and freshwater sawfishes (**Figure 5-6**).

Whale Shark

The whale shark (*Rhincodon typus*) is an oceanic and coastal, pelagic fish, generally found in tropical areas where the surface temperature is 21–25°C. It is a filter feeder and, commonly ranges in size from 4–10 m (Colman, 1997). This species was listed as Vulnerable under the EPBC Act in 2001 and is also classified as Vulnerable on the World Conservation Union's Red List of Threatened Species (IUCN, 2012). In WA, whale sharks are protected under the Wildlife Conservation Act 1950, the Conservation and Land Management Act 1984 and the Fish Resources Management Act 1994.

There is a general lack of knowledge on many aspects of whale shark biology, including definitive migration patterns. They are normally oceanic and cosmopolitan in their distribution and are known to aggregate in the reef front waters adjacent to the Ningaloo Reef between March to June (Colman, 1997; Wilson et al., 2006) with the highest frequency of sightings occurring in April (Wilson et al., 2001). However, the season is variable and individual whale sharks have been recorded at other times of the year. This location has been identified as a foraging BIA (**Figure 5-6**), While the species spends the majority of its time in deeper water, it is also encountered close to or at the surface.

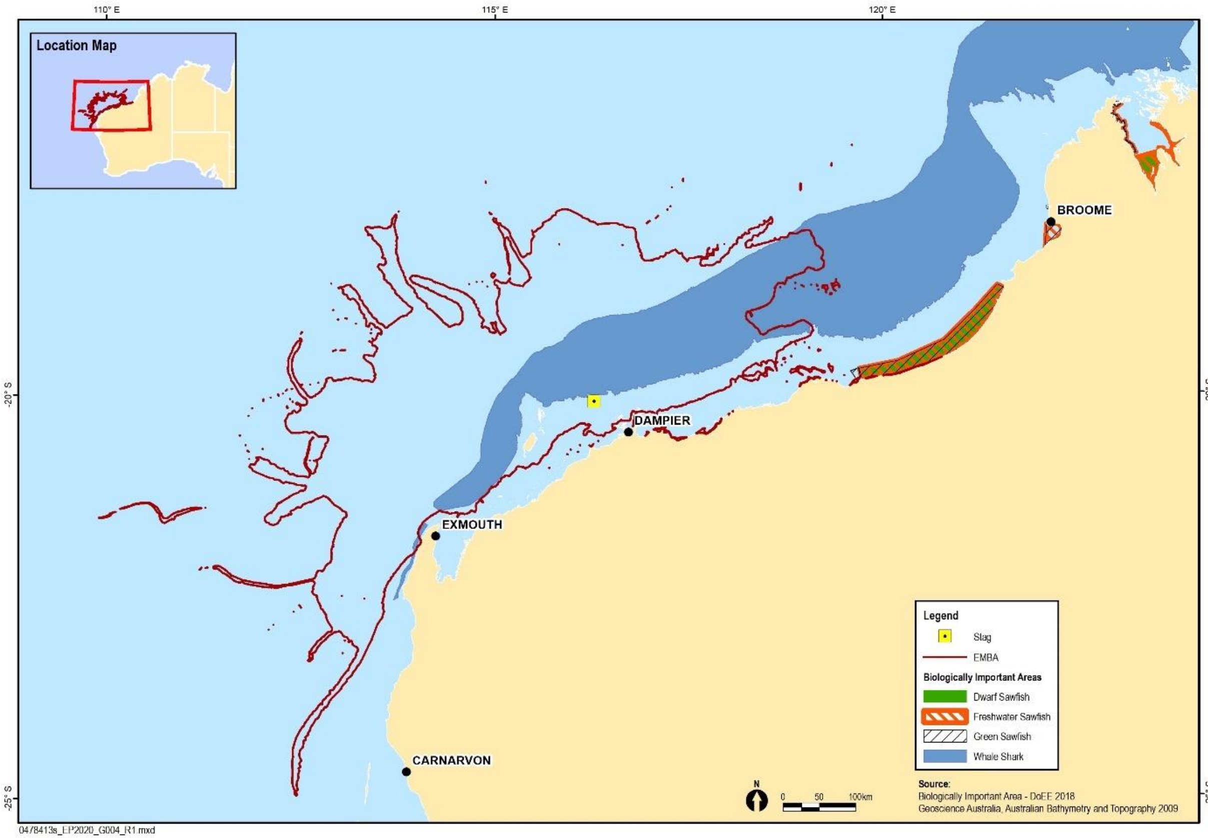


Figure 5-6: Biologically Important Areas for Shark and Fish

Whale shark presence 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 the reef. Estimates of the size of the population participating in the Ningaloo aggregation are between 300 and 500 individuals (Meekan et al., 2006).

Preliminary research on the migration patterns of whale sharks in the western Indian Ocean, and isolated and infrequent observations of individuals, indicate that a small number of the WA population migrate through the NWMR. Wilson et al. (2006) tagged 19 whale sharks in 2003 and 2004, with long-term movements patterns successfully recorded from six individuals. All travelled north-east into the Indian Ocean after departing Ningaloo Reef, with one tracked to Ashmore Reef and another to Scott Reef.

The most significant threat to whale sharks is intentional and unintentional mortality from fishing outside of Australian waters. In Australian waters, threats to the recovery of the species include boat strike from large vessels and habitat disruption from mineral exploration, production and transportation. Other lesser threats include disturbance from domestic tourism operations, marine debris and climate change.

Ongoing threats to whale sharks, together with life history characteristics; including slow growth, late maturation and extended longevity (Colman, 1997); means the whale shark remains susceptible to declines across its international range.

White Shark

The great white shark (*Carcharodon carcharias*) is listed as vulnerable under the EPBC Act and may occur within the spill trajectory area as they are known to prey on humpback whales and have been recorded in NWC waters during humpback migrations. Study into great white shark populations is difficult (Cailliet, 1996) given the uncertainty about their movements, emigration, immigration and difficulty in estimating the rates of natural or fishing mortality. In Australia, great white sharks have been recorded from central Queensland around the south coast to north-west WA but may occur further north on both coasts (Last and Stevens, 2009). They are widely but not evenly distributed in Australian waters and is considered uncommon to rare compared to most other large sharks (CITES, 2004). Great white sharks can be found from close inshore around rocky reefs, surf beaches and shallow coastal bays to outer continental shelf and slope areas (Pogonoski et al., 2002). They also make open ocean excursions and can cross ocean basins (for instance from South Africa to the western coast of Australia and from the eastern coast of Australia to New Zealand). Great white sharks are often found in regions with high prey density, such as pinniped colonies (DEWHA, 2009).

Grey Nurse Shark

In Australia, the grey nurse shark has an inshore coastal distribution primarily in sub-tropical to cool temperate waters on the continental shelf. There are two separate, genetically distinct grey nurse shark populations in Australian waters—one on the east coast and one on the west coast (Stow et al., 2006 as cited in CoA 2014). The range of the west coast population is not well known; however, records indicate that the species is widely distributed from the North-West Shelf (including coastal waters in Exmouth Gulf), south to the Great Australian Bight (CoA 2014).

It is thought that individuals have a high degree of site fidelity, although some studies have suggested that the species exhibits some migratory characteristics moving between different habitats and localities (McAuley, 2004).

Grey Nurse Sharks are often observed aggregating above the seabed (at depths 10–40 m) near deep sandy-bottomed gutters or rocky caves in the vicinity of inshore rocky reefs and islands (CoA 2014). Grey nurse sharks have also been recorded in the surf zone, around coral reefs, and to depths of around 200 m on the continental shelf (Pollard et al. 1996). No key aggregation sites have been identified in WA waters.

As outlined in the Recovery Plan for the Grey Nurse Shark (Carcharias taurus) 2014 (DoEE 2014), the principal current threats to the grey nurse shark in Australia are:

- Mortality related to incidental capture by commercial and recreational fisheries; and
- Mortality related to shark control activities such as beach meshing or drum lining.

Although individuals may be present in the EMBA, based on their distribution it is likely limited to individuals only.

Shortfin and Longfin Mako

The shortfin mako and longfin mako sharks are listed as Migratory under the EPBC Act. The longfin mako is a widely distributed but rarely encountered oceanic shark that ranges from Geraldton around the north coast to at least Port Stephens in New South Wales (DSEWPaC 2012). The shortfin mako is an oceanic and pelagic species, although they are occasionally seen inshore. They are found throughout temperate seas but are rarely found in waters colder than 16°C.

Porbeagle Mackerel Shark

The Porbeagle is wide-ranging and inhabits temperate, subarctic and subantarctic waters of the North Atlantic and Southern Hemisphere (Francis et al. 2002). In Australia, the species occurs in waters from southern Queensland to south-west Australia (Last and Stevens 2009). Animals typically occur in oceanic waters off the continental shelf, although they occasionally enter coastal waters (Francis et al. 2002).

The Porbeagle primarily inhabits oceanic waters and areas around the edge of the continental shelf although they occasionally move into coastal waters, but these movements are temporary (Campana and Joyce 2002; Francis et al. 2002). Individuals are known to undertake seasonal migrations, possibly in search of food, although the timing and details of these migratory movements are not well-understood (Saunders et al. 2011).

Dwarf Sawfish

The dwarf sawfish (*Pristis clavata*) is listed as vulnerable under the EPBC Act. The Australian distribution of the dwarf sawfish is considered to extend across northern Australia and along the Kimberley and Pilbara coasts (Last and Stevens, 2009; Stevens et al., 2005). The majority of records of dwarf sawfish in WA have come from shallow estuarine waters of the Kimberley region which are believed to be nursery areas, with immature juveniles remaining in these areas up until three years of age (Thorburn et al., 2004). Sawfish regularly use the tidal creeks and mangrove areas of Roebuck Bay, within the EMBA, for breeding and refuge (Bennelongia, 2009). The updated sawfish recovery plan (CoA 2015) indicates where pupping is known and likely to occur along the Pilbara coastline, with main areas within the EMBA being along Eighty Mile Beach. Similarly, the Recovery Plan indicates that adults are known to occur along the coast north of Exmouth and within the EMBA and operational area.

Freshwater and Green Sawfish

In Australian waters, green sawfish have historically been recorded in the coastal waters off Broome, Western Australia, around northern Australia and down the east coast as far as Jervis Bay, NSW (Stevens et al., 2005). Important areas for freshwater sawfishes include King Sound, and the Fitzroy, Durack, Robinson and Ord rivers. Both species are wider ranging than the dwarf sawfish.

Sawfishes generally inhabit inshore coastal, estuarine and riverine environments. The freshwater sawfish has been recorded in north-west Australia from rivers (including isolated water holes), estuaries and marine environments (Stevens et al. 2005). Newborns and juveniles primarily occur in the freshwater reaches of rivers and in estuaries, while most adult freshwater sawfish have been recorded in marine and estuarine environments (Peverell 2005, Thorburn et al. 2007). It is believed that mature freshwater sawfish enter less saline waters during the wet season to give birth (Peverell 2005) and freshwater river reaches play an important role as nursery areas (DoE 2014c).

The green sawfish inhabits muddy bottom habitats and enters estuaries (Allen, 1997; Stead, 1963). It has been recorded in inshore marine waters, estuaries, river mouths, embankments and along sandy and muddy beaches (Peverell et al., 2004; Stevens et al., 2005; Thorburn et al., 2004). Stead (1963) reported that this species was frequently found in shallow water. Green sawfish have been recorded in very shallow water (<1 m) to offshore trawl grounds in over 70 m of water (Stevens et al., 2005).

Smaller specimens (<2.5 m in length) are more common in foreshore and offshore coastal waters (Thorburn et al., 2004), as well as estuaries and river mouths at slightly reduced salinities, but do not venture into freshwater. Larger individuals (>2.5 m in length) are found in both inshore and offshore waters.

The updated sawfish recovery plan (CoA 2015) indicates where pupping is known and likely to occur along the Pilbara coastline, with main areas within the EMBA being along Eighty Mile Beach. Similarly, the Recovery Plan indicates that adults are known to occur along the coast north of Exmouth within the EMBA and operational area.

Principal threats to sawfish species are fishing activities (by-catch, traditional or illegal fishing) and habitat degradations or modification.

Narrow sawfish

The narrow sawfish (Anoxypristis cuspidate) is listed as Migratory under the EPBC Act. It is a marine or marginal (brackish water) species found from inshore waters to a depth of 40 m (Compagno et al. 2006). Though details of its ecology are not precisely known, it probably spends most of its time on or near the bottom in shallow coastal waters and estuaries. A study showed the narrow sawfish to be the most abundant amongst the sawfish sampled in the Gulf of Carpentaria (Peverell, 2005) which holds some consistency with the offshore distribution of the species as shown by a study of Northern Prawn Fishery by-catch. Peverell (2005) also used catch data of offshore surface net fisheries to conclude that narrow sawfish also inhabit the mid-water column and can thus be described as a benthopelagic animal. The narrow sawfish is known to form aggregations of mature females during the months of October to November. Its Australian distribution is unclear though it is most common in the Gulf of Carpentaria with southward ranges extending to Broad Sound in Queensland and the Pilbara Coast (circa 116°E), Western Australia (Last & Stevens, 2009).

Manta Rays

The giant and reef manta rays can be found throughout the waters of WA. They are listed as migratory and may be found in locations such as Ningaloo. The giant manta ray appears to be a seasonal visitor to coastal or offshore sites. Giant manta rays are often seen aggregating in large numbers to feed, mate, or clean. Sightings of these giant rays are often seasonal or sporadic but in a few locations their presence is a more common occurrence. This species is not regularly encountered in large numbers and, unlike some other rays do not often appear in large schools (>30 individuals) when feeding. Overall, they are encountered with far less frequency than the smaller manta species, despite having a larger distribution across the globe (IUCN, 2014b).

Pipefish and seahorse (Syngnathidae)

Other EPBC Act protected marine species that may occur within the EMBA include various species of pipefishes and seahorses (Family Syngnathidae). Knowledge about the distribution, abundance and ecology of both syngnathids and solenostomids is limited (DSEWPaC 2012). In tropical areas such as the EMBA, species are primarily found among coral reefs (Foster & Vincent 2004; Scales 2010).

5.6.2 Marine Mammals

Marine mammals occur in the waters of the Stag Facility, some being seasonal visitors while others occur at low densities year- round. Marine mammals that may occur in the region include cetaceans (whales, porpoises and dolphins) and dugongs. A search of the EPBC Act protected matters database (**Appendix C**) revealed 31 cetaceans that may occur within the EMBA. The search identified five threatened marine mammal species that may occur within the Stag Facility EMBA, including three species listed as vulnerable, the sei whale (Balaenoptera borealis), humpback whale (Megaptera novaeangliae) and fin whale (Balaenoptera physalus), and two species listed as endangered, the blue whale (Balaenoptera musculus) and southern right whale (Eubalaena australis). Further information on these species is provided in **Figure** 5-7. In addition, seven marine mammals were identified as migratory.

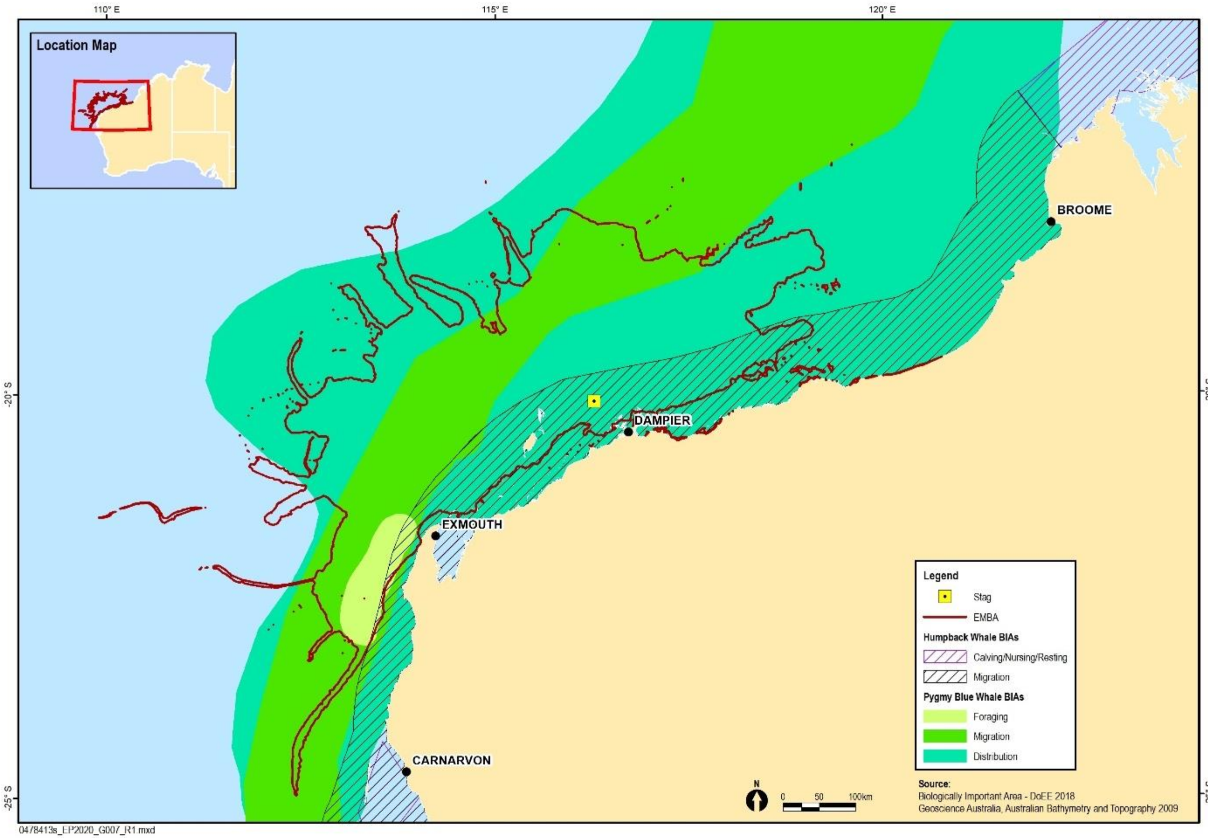


Figure 5-7: Biologically Important Areas for Marine Mammals

Humpback Whale

Humpback whales are moderately large baleen whales that occur throughout Australian waters and are the most commonly sighted whale in the NWMR (DSEWPaC, 2012e).

The WA humpback whale population (known as the Group IV population) is genetically distinct from the eastern Australian population and was severely depleted by whaling activities. The population was estimated at 12,000 to 16,000 individuals in 1934 and continued to decline to an estimated 800 individuals prior to the moratorium on whaling in the southern hemisphere in 1962 (Chittleborough, 1965). More recent population estimates have suggested whale numbers have increased to ~ 28,830 in 2008 (Hedley et al., 2011 as cited in DoE 2015). Numbers have increased further in recent years and the Action Plan for Australian Mammals 2012 by Woinarski et al., 2014, and a recent paper from Bejder et al., 2015 recommend that humpback whales no longer meet any criteria for listing as threatened under the EPBC Act.

Humpback whales migrate annually between summer feeding grounds in Antarctica and breeding aggregation areas in Southern Kimberley between Broome and the northern end of Camden Sound.

The Approved Conservation Advice for Megaptera novaeangliae (humpback whale) (DoE 2015) identifies that the humpback whale migration pathway is within the continental shelf boundary or 200 m bathymetry along the WA coastline. However actual sightings recorded by Jenner et al (2001) and Double et al. (2010 and 2012) indicate that the route is actually much closer to shore, particularly along the Pilbara coast, with migrating whales tending to travel within 50 km of the coast between North-West Cape and Camden Sound.

Humpback whales pass north along the waters west of Barrow Island to the Montebello Islands during their annual winter migration from the Antarctic. Once past the Montebello Islands their migration route heads east towards their breeding grounds in the Kimberley. The northward migration past Montebello and Barrow Islands generally occurs from mid-July with the peak in late July, though this can vary by up to three weeks. Unlike the northern migration, which tends to follow the deeper water of the continental shelf, the southward migration concentrates whales closer to the mainland with a peak Aug–mid-Sep (DoE 2015).

Major calving areas have been identified in the Kimberley region and particularly between Lacepede Islands (16°8S) and Camden Sound (15°38S) (Jenner et al., 2001) which are more than 900 km from the Stag Operational Area.

The Operational Area is within a region identified in the Conservation Advice (DoE 2015) as a 'species core range' (**Figure** 5-7) and whales may travel through this area on a seasonal basis as part of their migratory movements. The Stag Platform is more than 900 km from core calving grounds and more than 250 km from identified resting areas at Exmouth Gulf and southern Kimberley. As such, whales may be present in the area as part of the season migration.

<u>Blue Whale</u>

Blue whales are found in all oceans of the world. They are the largest living animal and can grow to a length of over 30 m and weigh an average of 100–120 t. There are two recognised subspecies in Australia: the 'true' blue whale (Balaenoptera musculus intermedia) and the 'pygmy' blue whale (Balaenoptera musculus brevicauda) (DSEWPaC, 2012d). Both of these species are covered by the Blue Whale Conservation Management Plan 2015 (DoEE 2015). In general, the southern blue whale is found south of 60° S and pygmy blue whales are found north of 55° S (DEWHA, 2008a, b). As southern blue whales feed predominantly in polar waters it has been suggested that all blue whales sighted in Australian waters are pygmy blue whales (DEH, 2005). During summer–autumn true blue whales feed mainly in the Antarctic, mostly on krill, while pygmy blue whales are thought to feed in productive regions in temperate latitudes (Branch *et al*., 2007).

The Perth Canyon is the only area so far identified off the WA coast where pygmy blue whales aggregate with some predictability. The area represents a significant feeding ground for pygmy blue whales between January and April, with aerial surveys between 1999 and 2004 recording an average of 30 individuals at the peak of the season (March–May) (Jenner et al.,2002; McCauley et al., 2004). Acoustic detections suggest that true blue whales also over-winter around the Perth Canyon and head south in mid-October (McCauley et al., 2004).

The blue whale BIA (migratory path) overlaps the operational area (**Figure** 5-7). However Blue whale migration is thought to follow deep oceanic routes, although little is known about their precise migration routes (DSEWPaC, 2012d). The blue whale is rarely present in large numbers outside recognised aggregation areas. Chevron's Wheatstone project cetacean monitoring studies indicated that during their southern migration blue whales were recorded between the 750 m and the 850 m isobaths and between the 300 m and the 350 m isobaths (RPS, 2010). These data also showed a seasonal migration pattern further west from May to August (moving northwards), with a southwards migration occurring between November and December (RPS, 2010). These findings are supported by acoustic detections undertaken off the Montebello Islands which showed a northerly pulse from late March to early August with peak migration in June and July, and a pulse of southerly transiting whales from early October to late November, with a peak migration period occurring from early November to early December (McCauley and Jenner, 2010).

Tagging surveys have shown pygmy blue whales migrating northward relatively near to the Australian coastline (100 km) until reaching North-West Cape after which they travelled offshore (240 km) to Indonesia. Passive acoustic data documented pygmy blue whales migrating along the Western Australian shelf break (Woodside 2012). The National Conservation Values Atlas has identified the pygmy whale migration pathway on the continental shelf edge at depth of 500 to 1,000 m (**Figure** 5-7) (McCauley & Jenner 2010).

<u>Sperm Whale</u>

Sperm whales typically occur in deep waters (greater than 200m) off the continental shelf along the southern coastline between Cape Leeuwin and Esperance (Bannister et al. 1996). Although there is a lack of detailed information on migration timings, sperm whales are known to migrate northwards in winter and southwards in summer. Sperm whales have been recorded in deep water off the North-west Cape on the west coast of Western Australia (RPS, 2010b), and appear to occasionally venture into shallower waters in other areas (RPS, 2010b). No BIA are in the waters surrounding the Stag Platform or the EMBA.

Given that major foraging areas occur off Perth and in proximity to the Great Australian Bight, sperm whales are unlikely to be present in high numbers within the operational area or EMBA, and any occurrence would be infrequent and limited to transiting individuals.

Sei Whale

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 locations in Australian waters (Parker, 1978). The species is migratory, moving between Australian waters and Antarctic feeding areas but their movements are unpredictable and not well documented. They have been sighted inshore (in the proximity of the Bonney upwelling, Victoria) as well as in deeper offshore waters and have only been sighted in summer and autumn.

Fin Whale

Fin whales are listed as vulnerable and migratory under the EPBC Act. The fin whale is the second largest species after the blue whale. Fin whale distribution in Australia is known primarily from stranding events and whaling records and the whales are thought to be present along the western coast of Australia to NSW. The Australian Antarctic waters are important feeding grounds for fin whales but there are no known mating or calving locations in Australian waters (Morrice et al., 2004). The migration routes and location of winter breeding grounds are uncertain, but presence has been detected in summer and autumn months.

Southern Right whale

Southern right whales from Australian populations probably forage between about 40°S and 65°S, generally south of Australia. In the region of the Sub-Tropical Front (41–44°S) they mainly consume copepods, while at higher latitudes (south of 50°S) krill is the main prey item. The species feeds in the Southern Ocean in summer, moving close to shore in winter. Right whales feed by surface skimming or shallow dives, trapping plankton on fine baleen fibres. The migratory paths between calving and feeding areas are not well understood (CoA 2012).

The Conservation Management Plan for the Southern Right Whale 2011-2021 (CoA 2013) indicates that the core coastal range for southern right whale is from Perth along the southern coastline to Sydney. Although sightings have been recorded as far north as Exmouth these are rare (Bannister et al. 1996) and no BIA are located in the waters surrounding the Stag Platform or the EMBA.

Given that major calving areas and aggregations occur in proximity to the Great Australian Bight, southern right whales are unlikely to be present in high numbers within the operational area or EMBA, and any occurrence would be infrequent and limited to transiting individuals.

Other whale species

Other cetacean species whose broad distributions overlap with the EMBA include whales that are infrequently observed and usually restricted to cooler or deep waters such as Bryde's whales, Antarctic minke and killer whales. As no BIA for these species are known in the region, and they are generally restricted to deeper waters, it is unlikely they will be encountered in significant numbers.

Spotted Bottlenose dolphin

The Indo-Pacific bottlenose dolphin (Tursiops aduncus) (Arafura / Timor Sea populations) is generally considered to be a warm water subspecies of the spotted bottlenose dolphin, occurring in shallow (often <10m deep) inshore waters (Bannister et al., 1996; Hale et al., 2000). The known distribution of the Indo-Pacific bottlenose dolphin extends from Shark Bay north to the western edge of the Gulf of Carpentaria in Australia (DoEE, 2016b).

No BIA for the spotted bottlenose dolphin is located within the EMBA, although a foraging BIA is located in the shallower waters off Broome.

Indo-Pacific Humpback dolphin

The Indo-pacific humpback dolphin is typically found in water less than 20m deep but has been recorded in water up to 40m deep. This species is generally found in association with river mouths, mangroves, tidal channels and inshore reefs (DoEE 2016a). This species of dolphin is known to have resident groups that forage, feed, breed and calve in the state waters of Roebuck Bay and areas further north (DoEE 2016a).

No BIA for the Indo-pacific humpback dolphin is located within the EMBA, although a foraging and breeding BIA is located in the shallower waters off Broome.

Dugong

Dugongs are listed as a Migratory species under the EPBC Act and protected under Schedule 4 of the WA Wildlife Conservation Act. They are also listed on the Appendix 1 of the Convention of International Trade in Endangered Species (CITES) and on Appendix II of the Convention on the Conservation of Migratory Species of Wild Animals 1979. Dugongs (Dugong dugon) are large herbivorous marine mammals (up to 3 metres) that feed off seagrass and generally inhabit coastal areas in shallow waters (less than 5 m).

Dugong distribution and movement is based on the abundance, size and species of seagrass meadow. Key populations along the WA coast are principally located at: Shark Bay (the largest resident population in Australia), Ningaloo Marine Park, the Pilbara coast and offshore areas including Montebello/Barrow/Lowendal Islands, and further north at Eighty Mile Beach and off the Kimberley Coast, particularly Roebuck Bay and Dampier Peninsula (Marsh et al. 2002; DSEWPaC 2012).

A foraging and migration BIA is in Roebuck Bay (outside the EMBA) while the waters around Ningaloo Reef are a recognised breeding and nursery BIA.

5.6.3 Marine Reptiles

Marine turtles and sea snakes have been identified as potentially occurring within the EMBA for the Stag Facility.

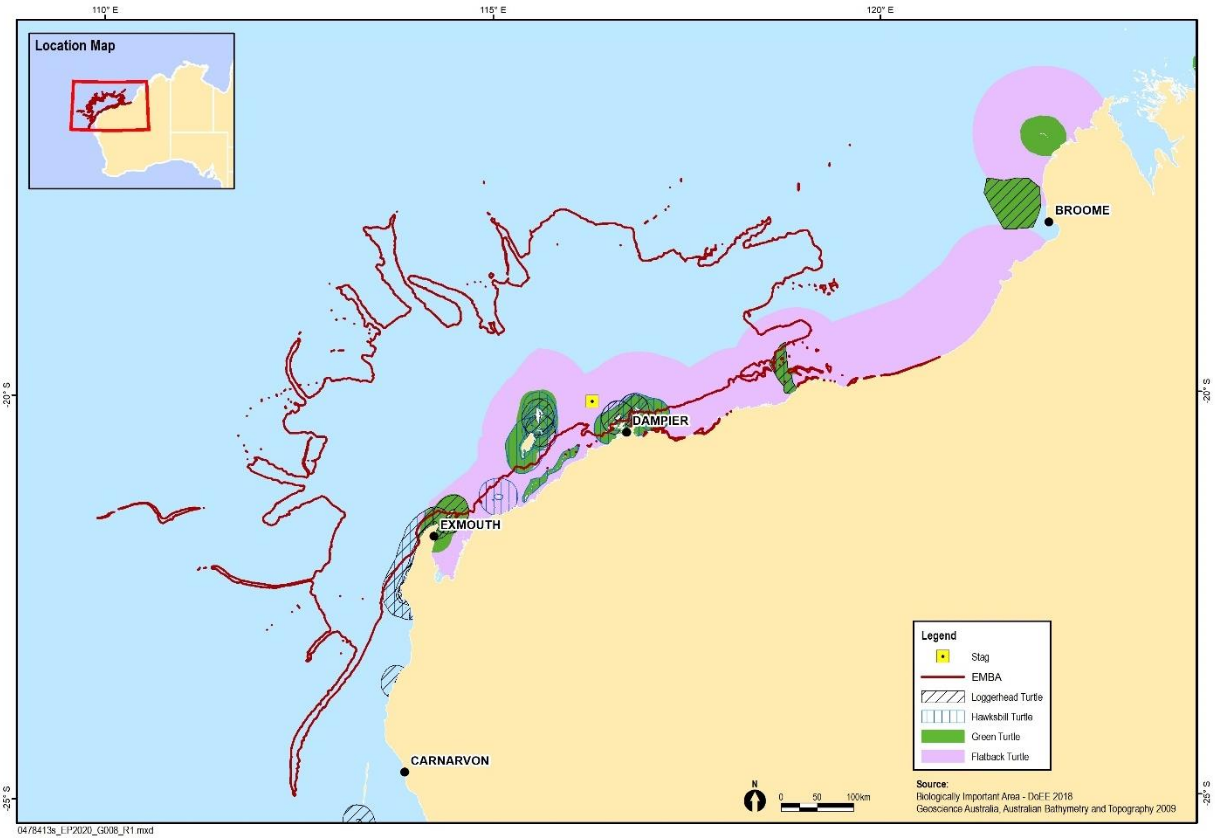


Figure 5-8: Biologically Important Areas for Turtles

Marine Turtles

Five species of threatened marine turtles may occur within the EMBA, three of these species are classed as threatened-vulnerable under the EPBC Act, the hawksbill (Eretmochelys imbricata), flatback (Natator depressus) and green turtles (Chelonia mydas) with two species, the loggerhead (Caretta caretta) and leatherback turtle (Dermochelys coriacia), classed as threatened-endangered. Green, flatback, hawksbill, and loggerhead turtles nest on the sandy beaches of offshore islands and the mainland within the Stag Facility EMBA. The leatherback turtle may also visit the open waters of the region.

These species are all identified within the Recovery Plan for Marine Turtles in Australia (CoA 2017). The Operational Area overlaps with nesting and internesting areas identified as habitat critical to the survival of the Flatback Turtles.

The nearest turtle nesting sites to the operational area are located ~ 35 km to the south-east at Dampier Archipelago and ~ 60 km to the south-west at Barrow, Montebello and Lowendal Islands. **Table** 5-5 outlines turtle activity within the Operational Area and EMBA.

Hawksbill Turtles

WA supports one genetic stock of hawksbill turtles with nesting centred on the Dampier Archipelago. The WA stock is the largest in the Indian Ocean and is one of the largest hawksbill turtle populations remaining in the world (Limpus, 2009a).

Table 5-5: Marine Turtle Activity

Species	Hawksbill turtle	Flatback turtle		Green turtle	Loggerhead turtle	Leatherback turtle
Stock	WA Stock	**Pilbara Stock**	**Southwest Kimberley**	NWS Stock	WA Stock	Australia
Nesting period	Year Round	October -March	Year Round	November -March	November -Mar	December -Jan
Nesting peak	Oct-Feb	Nov-Jan	Dec-Jan	Jan - Feb	January	-
Internesting buffer	20 km	60 km	60 km	20 km	20 km	-
Important rookeries	**Nesting location:** Dampier Archipelago (including Rosemary Island, Delambre Island), Montebello Islands (including Ah Chong Island, South East Island and Trimouille Island), Lowendal Islands (including Varanus Island, Beacon Island, Bridled Island), Sholl Island	**Nesting location:** Montebello Islands, Mundabullangana Beach, Barrow Island, Thevenard Island, Cemetery Beach, Dampier Archipelago (including Delambre Island and Huay Island), coastal islands from Cape Preston to Locker Island	**Nesting location:** Eighty Mile Beach, Eco Beach, Lacepede Islands	**Nesting locations:** Adele Island, Maret Island, Cassini Island, Lacepede Islands, Barrow Island, Montebello Islands (all with sandy beaches), Serrurier Island, Dampier Archipelago, Thevenard Island, Northwest Cape, Ningaloo coast.	**Nesting location:** South Murion Island, North-West Cape, Gnarloo Bay.	There are no Confirmed leatherback turtle nesting sites in Western Australia. Scattered nesting occurs in southern Queensland and Northern Territory such as Coburg Peninsula (outside operational area)
Generalised diet	Omnivorous, feeding on algae, sponges, soft corals and other soft-bodied invertebrates	Primarily carnivorous, feeding on soft-bodied invertebrates. Juveniles eat gastropod molluscs, squid, siphonophores. Limited data indicate that cuttlefish, hydroids, soft corals, crinoids, molluscs and jellyfish are also eaten (SPRAT, DoEE website and DoEE 2016).		Primarily herbivorous, foraging on algae, seagrass and mangroves. In their pelagic juvenile stage, they feed on algae, pelagic crustaceans and molluscs	Carnivorous, feeding predominantly on benthic invertebrates in habitats ranging from near shore to 55 m. During their post-hatchling stage, they feed on algae, pelagic crustaceans and molluscs	Oceanic and Therefore, remain planktivorous throughout their life, feeding on jellyfish and large planktonic ascidians (e.g. sea squirts) in the water column

In WA, their nesting range is relatively small and extends from the Muiron Islands to the Dampier Archipelago, a distance of ~ 400 km. The most significant breeding areas are within the Dampier Archipelago, Montebello Islands, Lowendal Islands and Barrow Island supporting hundreds of nesting females annually (Pendoley, 2005; Limpus, 2009a). Rosemary Island within the Dampier Archipelago may support in the order of 1,000 nesting females annually and may be the largest remaining hawksbill nesting population globally.

Low density nesting is also known from Airlie Island, Muiron Islands and Cape Range (Limpus, 2009a). The closest known breeding/ nesting grounds to the Stag Facility are Rosemary Island (Dampier Archipelago), Montebello and Lowendal Islands.

On Varanus Island, hawksbills tend to nest in greater numbers on the eastern beaches (Pipeline Beach, Harriet Beach, and Andersons Beach). Between 1986 and 1999, approximately 350 individual hawksbills were tagged on Varanus Island (Apache, 1999). Maxwell (2003) used these data to predict that up to 260 hawksbills may visit Varanus Island each year, although a maximum number of nests at 180 per year have been recorded. The most recent turtle tagging program on Varanus Island in the 2010 breeding season reported 70 turtles coming ashore. Of these 70 turtles, 27 were hawksbills and eight were newly tagged. Pipeline Beach was the most frequented beach on Varanus Island (Pendoley Environmental, 2011).

Hawksbill turtles also nest along the North-West Cape/ Ningaloo coast, Muiron Islands, and the Montebello Islands. Rosemary Island is probably the largest hawksbill rookery, with numbers at the other sites comparable to those found on Varanus Island. This suggests a total annual hawksbill turtle stock in WA of approximately 1,000–1,500 animals. With an interbreeding period of 2–4 years, 2,000–4,500 hawksbill turtles probably nest in WA waters (Morris, 2004).

On Barrow Island, nesting occurs at low densities on the beaches of both the west and east coasts, however, Barrow Island is not considered a regionally important nesting site for hawksbill turtles (Chevron, 2008).

Although hawksbills are known to nest year-round, the Draft Turtle Recovery Plan (CoA 2016) indicates that peak nesting periods are October to February. The location of feeding areas and biology of the species within this region is largely undocumented (Limpus, 2009a) but it is thought that individuals may migrate up to 2,400 km between their nesting and foraging grounds (DSEWPaC, 2012f).

<u>Flatback Turtles</u>

The flatback turtle is endemic to the northern Australian continental shelf and all nesting occurs in Australia with approximately one third of the total breeding for the species occurring in WA. WA supports two genetic stocks of flatback turtles: the Pilbara Stock characterised by summer nesting and Southwest Kimberley stock which breeds year-round with a winter peak (Limpus 2007; CoA 2016).

Nesting locations for both stocks are outlined in **Table** 5-5. The closest known breeding/ nesting grounds to the Stag Facility are Dampier Archipelago, Barrow, Montebello, Varanus and Lowendal Islands. The Turtle Recovery Plan (CoA 2017) has proposed a 60 km inter-nesting buffer for the flatback turtle which overlaps the Stag Operational Area.

Pendoley (2005) focussed on documenting the activity of flatback turtles on Barrow Island, Lowendal Islands and Montebello Islands and identified that the east coast of Barrow Island supports an important rookery for flatbacks. A turtle tagging program over three nesting seasons from 2005 to 2008 tagged a total of 2,979 flatbacks at Barrow Island and 1,060 flatbacks at Mundabullangana (Chevron 2008). Tagging shows that flatback turtle nesting on Barrow Island is focused on central east coast beaches, which include Mushroom, Bivalve, Terminal, and Yacht Club North and South beaches. Peak of nesting occurs during the December–January periods (Pendoley, 2005; Chevron, 2008).

Post-nesting females commonly sleep on the intertidal platform off the east coast rookery of Barrow Island at low tide. Satellite tracking of adult (female) flatback turtles shows they use a variety of inshore and offshore marine areas off the east and west coasts of Barrow Island. Females inter-nest close to their nesting beaches, typically in 0–10 m of water (Chevron, 2008). However, flatback turtles also travel approximately 70 km and inter-nest in shallow nearshore water off the adjacent mainland coast, before returning to Barrow

Island to lay another clutch of eggs. The average inter-nesting period is 13–16 days. There have been occasional records of nesting by flatback turtles on the Jurabi Coast and Muiron Islands (CALM, 2005a).

From long-term tagging studies on Varanus Island and Pendoley's observations, the nesting season for flatback turtles peak in December and January with subsequent peak hatchling emergence in February and March. Flatbacks have been observed to nest on Varanus Island between November and February (Pendoley Environmental, 2011).

Green turtles

Green turtles are the most widespread and abundant turtle species in WA waters, nesting from the Ningaloo coast to the Lacepede Islands and out to Scott and Ashmore Reefs (Prince, 1994; Limpus, 2008a; DSEWPaC, 2012f), with three distinct breeding stocks: the NWS stock, the Scott Reef stock and the Ashmore Stock (Dethmers, et al., 2006; Limpus, 2008a). The NWS population is one of the largest in the world and the most significant rookery is the western side of Barrow Island (Prince, 1994; Limpus, 2008a). Other principal rookeries include the Lacepede Islands, Montebello Islands, North-West Cape and Browse Island (Prince, 1994; Limpus, 2008a). Numerous other small rookeries also occur in WA. The green turtle is also known to breed in large numbers in the dunes above the extensive beaches found on Serrurier Island, with counts indicating the island supports the second largest rookery in the Pilbara (Oliver, 1990). Low numbers of green turtles have also been observed nesting on Airlie Island and Varanus Island (Pendoley Environmental, 2011). The closest known breeding/nesting grounds to the Stag Facility are Barrow, Montebello and Varanus Islands.

Green turtle nesting abundance fluctuates significantly from year to year, depending on environmental variables and food availability at feeding sites. In an aerial survey of Pilbara waters in April 2000, Prince (2001) estimated a mixed species population of 57,000 turtles of which most were green turtles.

Chevron (2005, 2008) reported that green turtles nest predominantly on the sandy west coast beaches of Barrow Island. In addition to nesting, green turtles mate and forage close to Barrow Island during the summer breeding season. Aggregations of green turtles have been reported from the shallow areas along the west coast of Barrow Island, with turtles foraging on and around nearshore reefs. Green turtles have also been observed to the south and south-east of Barrow Island, around dugong Reef and over the Barrow Shoals (Chevron, 2005, 2008). The Recovery Plan for Marine Turtles in Australia (Environment Australia, 2003) identifies Barrow Island and all waters within a 20km radius of the island as critical habitat to the survival of the green turtles.

Nesting of green turtles has been recorded from August to March on Serrurier Island (Woodside, 2002), from December to March along coast adjacent to Ningaloo (CALM, 2005a) and from October to February on Varanus Island (Pendoley Environmental, 2011). On Barrow Island, mating aggregations may commence from October with peak nesting from December to January and hatchlings emerging through summer and early autumn, although nesting does occur year-round (Chevron, 2005, 2008; Pendoley, 2005). The Draft Turtle Recovery Plan (CoA 2016) identifies the nesting period the NWS stock as November to March with peaks in January and February.

Loggerhead turtles

WA supports one genetic stock of loggerhead turtles with nesting encompassing Muiron Islands, Ningaloo Coast south to about Carnarvon and islands near Shark Bay, including Dirk Hartog Island (Limpus, 2008b), with occasional nesting recorded from Varanus and Rosemary Islands (DSEWPaC, 2012f). One nesting loggerhead has been tagged on Varanus Island since 1986 (Apache, 1999). Low numbers of loggerheads have also been observed on Barrow Island (Chevron, 2008). The annual nesting population in the region is thought to be in the several thousand (Limpus, 2008b). The closest known breeding/nesting grounds to the Stag Facility are Rosemary Island (Dampier Archipelago) and Barrow and Varanus Islands. Loggerhead Turtles regularly use Roebuck Bay as a seasonal feeding and transit area on migration (Bennelongia, 2009). Interestingly, the Draft Turtle Recovery Plan (CoA 2016) only identified Gnarloo and the Ningaloo coast as nesting locations.

Aerial surveys conducted in 2000 and 2001 in the Exmouth region recorded only 12 sightings in Commonwealth waters and these turtles were most likely loggerheads (BHPB, 2005). Within the Ningaloo Marine Park, loggerhead turtles tend to nest in higher proportions in the southern areas of the reserves (CALM, 2005a).

Leatherback turtles

The leatherback turtle (Dermochelys coriacea) is a pelagic feeder, found in tropical, subtropical and temperate waters, but is uncommon throughout their Australian range (DSEWPaC, 2012f). No major leatherback turtle nesting areas have been recorded in Australia, although scattered isolated nesting (1–3 nests per annum) occurs in southern Queensland and Northern Territory (Limpus and McLachlan, 1994). At least two nesting attempts have been reported in WA (Limpus, 2009b).

Leatherback turtles feed mainly on pelagic, soft-bodied marine organisms such as jellyfish, which occur in greatest concentrations in areas of upwelling or convergence (DSEWPaC, 2012f). The leatherback turtle is a highly pelagic species with adults only going ashore to breed. Individuals may be encountered within the Stag Operational Area but are unlikely to be encountered in significant numbers given that no confirmed breeding occurs in WA and that leatherbacks in WA are most commonly sighted feeding in the southwest region (DSEWPaC, 2011b).

Sea snakes

A search of EPBC Act protected matters revealed 18 listed seasnakes that may occur within the EMBA (**Appendix C**). Of these species, one is considered threatened (critically endangered), the short-nosed sea snake (*Aipysurus apraefrontalis*).

Storr et al. (1986) estimate nine genera and 22 species of sea snakes and kraits occur in WA waters. However, little is known of the distribution of individual species, population sizes or aspects of their ecology. Sea snakes are essentially tropical in distribution, and habitats reflect influences of factors such as water depth, nature of seabed, turbidity and season (Heatwole and Cogger, 1993). Sea snakes and kraits are widespread throughout waters of the NWS in offshore and nearshore habitats. They can be highly mobile and cover large distances or they may be restricted to relatively shallow waters and some species must return to land to eat and rest.

The short-nosed sea snake is listed as critically endangered under the EPBC Act. However, most specimens have been collected from Ashmore and Hibernia Reefs (Minton and Heatwole, 1975) which are not within the EMBA for the Stag Facility. This species is believed to show strong site fidelity to shallow coral reef habitats in <10 m of water.

5.6.4 Birds

Marine waters and coastal habitat in the EMBA contain habitats that are important to birds, including offshore islands, sandy beaches, tidal flats, mangroves and coastal and pelagic waters. These habitats support a variety of birds which utilise the area in different ways and at different times of the year (DSEWPaC 2012a). Birds can be broadly grouped according to their preferred foraging habitat as coastal/ terrestrial birds, seabirds and shorebirds.

Coastal or terrestrial species inhabit the offshore islands and coastal areas of the mainland throughout the year and are either primarily terrestrial or they may forage in coastal waters. Resident coastal and terrestrial species include species such as the osprey (Pandion haliaetus) (DEWHA 2008).

Shorebirds, including waders and wetland birds, inhabit the intertidal zone and adjacent areas. Some shorebird species are resident while others are migratory and include species that utilise the East Asian–Australasian Flyway. Shorebirds that regularly migrate through the area include the Scolopacidae (curlews, sandpipers etc.) and Charadriidae (plovers and lapwings) families.

Seabirds include those species whose primary habitat and food source is derived from pelagic waters and spend the majority of their lives at sea, ranging over large distances to forage over the open ocean. Seabirds present in the area include terns, petrels, shearwaters, tropicbirds, frigatebirds, boobies and albatrosses (DEWHA 2008).

A search of the EPBC protected matters database in December 2020 using the EMBA for the Stag Facility, revealed 75 listed bird species, 19 of which are classified as threatened and may occur within the EMBA. Further information on these species is provided below. The protected matters search also identified numerous migratory marine bird species and migratory wetland bird species that may occur within the EMBA (**Appendix C**).

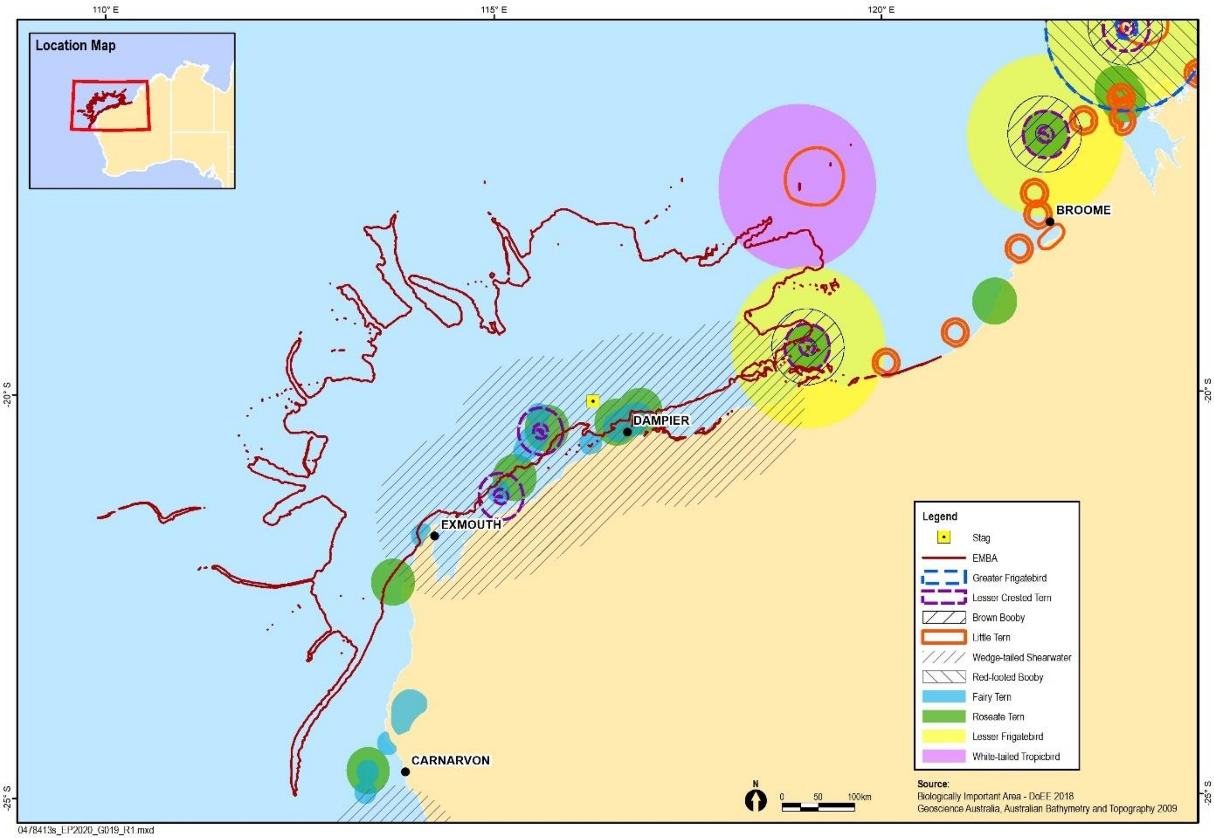


Figure 5-9: Biologically Important Areas for Seabirds

5.6.4.1 Shorebirds

Curlew sandpiper

This species is a migratory shorebird that breeds in north Siberia and spends the non-breeding season from western Africa to Australia (Bamford et al. 2008). The curlew sandpiper occurs around coastal Australia and preferred habitats include coastal brackish lagoons, tidal mud and sand flats, estuaries, saltmarshes and less often inland. Their diet is mainly comprised of polychaete worms, molluscs and crustaceans (Higgins & Davies 1996 in Garnet et al. 2011).

Great knot

The great knot is a migratory shorebird with a global distribution, breeding in north-east Siberia and spending the non-breeding season along coasts from Arabia to Australia. Non-breeding birds migrate to inlets, bays, harbours, estuaries and lagoons with large intertidal mud and sand flats where they feed on bivalves, gastropods, crustaceans and other invertebrates (Higgins & Davies 1996 in Garnet et al. 2011).

Bar-tailed godwit

Two subspecies of the bar-tailed godwit exist, as determined by their breeding locations in Siberia and Alaska (Bamford et al. 2008). Non-breeding birds migrate to the coasts of Australia. The western Alaskan subspecies occurs especially on the north and east coasts of Australia whilst the northern Siberian subspecies occurs especially along the coasts of North-Western Australia (DoE 2014b).

Non-breeding birds are found on muddy coastlines, estuaries, inlets, mangrove-fringed lagoons and sheltered bays, feeding on annelids, bivalves and crustaceans (Higgins and Davies 1996 in Garnet et al. 2011).

Eastern curlew

The Eastern Curlew is a migratory shorebird that breeds in Siberia, Kamchatka and Mongolia and migrates to coastal East Asia and Australia. The South Korean Yellow Sea is an important staging post for this species. Non-breeding birds occur around coastal Australia, are more common in the north and have disappeared or become much rarer at many sites along the south coast (Garnet 2011).

Non-breeding birds are present at estuaries, mangroves, saltmarshes and intertidal flats, particularly those with extensive seagrass (Zosteraceae), where they feed on marine invertebrates, especially crabs and small molluscs (Higgins & Davies 1996 in Garnet 2011).

Greater and Lesser sand plover

The greater sand plover (Mongolian) and lesser sand plover are cogeners that breed in China, Mongolia and Russia. The greater sand plover spends the non-breeding season along coasts from Japan through southeast Asia to Australasia, while the lesser sand plover spends the non-breeding season along coasts from Taiwan to Australasia (Banford et al. 2008). Non-breeding birds occur along all Australian coasts, especially in the north for the greater sand plover (DoE 2014b) and in the east for the lesser sand plover (DoE 2014b).

Non-breeding birds forage on beaches, saltmarshes, coastal bays and estuaries, and feed on marine invertebrates including molluscs, worms, crustaceans and insects (Marchant & Higgins 1993 in Garnet et al. 2011).

Red knot

The red knot is a migratory shorebird and the species includes five subspecies, including two found in Australia, Calidris canutus piersmai and Calidris canutus rogersi. The red knot breeds in Siberia and spends the non-breeding season in Australia and New Zealand. Non-breeding season is spent on tidal mudflats or sandflats where they feed on intertidal invertebrates, especially shellfish (Garnet et al. 2011).

5.6.4.2 Seabirds

Albatross

A protected matters search of the waters in the area of interest identified five albatross species (Campbell, Indian yellow-nosed, shy, black-browed and white-capped) that may occur in the area. All of the identified species predominantly occur in subantarctic to subtropical waters and breed on islands in the southern oceans (DoE 2014b).

The National Conservation Values Atlas (DoE 2014a) and the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DoEE 2011) do not identify any BIA for albatrosses within the EMBA.

Southern and northern giant petrel

The southern giant petrel is listed as endangered and migratory under the EPBC Act, and the northern giant petrel is listed as vulnerable and migratory. They are highly migratory birds which have a large natural range. Both species occur in Antarctic to subtropical waters, so while this species may over-fly the Stag Facility from time-to-time in transit or for foraging, they do not use the area for breeding (August and September) or resting as there are no critical nesting (eggs hatch between October and November) or feeding areas within the EMBA.

Australian painted snipe

The Australian Painted Snipe is a wading bird that has been recorded at wetlands in all states of Australia (Barrett et al., 2003; Blakers et al., 1984; Hall 1910b). It is most common in eastern Australia but has been recorded less frequently in Western Australia (Barrett et al., 2003; Blakers et al., 1984; Marchant and Higgins, 1993; Rogers et al., 2005).

The Australian Painted Snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum Muehlenbeckia or canegrass or sometimes tea-tree (Melaleuca). The Australian Painted Snipe sometimes utilises areas that are lined with trees, or that have some scattered fallen or washed-up timber (Marchant and Higgins 1993). Within the EMBA, the most likely habitat for this species, and therefore likelihood of occurrence, is the wetlands of Eighty Mile Beach and Roebuck Bay (Bennelongia, 2009; Hale and Butcher, 2009).

Soft-plumaged petrel

The soft-plumaged petrel is listed as vulnerable under the EPBC Act. As a mainly sub-Antarctic species they are usually seen in cooler seas but have been noted off southeast Australia between 9.8–21°C (Reid et al., 2002) and are widespread during winter and summer. As with the southern giant petrel, this species may occur foraging or flying over Operational Area waters, but there are no critical nesting or feeding areas known within the EMBA.

Australian fairy tern

Within Australia, the fairy tern occurs along the coasts of Victoria, Tasmania, South Australia and Western Australia, occurring as far north as the Dampier Archipelago near Karratha. The fairy tern nests on sheltered sandy beaches, spits and banks above the high tide line and below vegetation. The subspecies has been found in embayments of a variety of habitats including offshore, estuarine or lacustrine (lake) islands, wetlands and mainland coastline (Higgins and Davies, 1996; Lindsey, 1986a). The bird roosts on beaches at night (Higgins and Davies, 1996). The fairy tern predates on small bait-sized fish (Van de Kam et al., 2004) by diving in shallow waters.

A search of BIAs that overlap the EMBA was undertaken for the threatened species described above, as well as migratory marine species and the results are summarised in **Table** 5-6.

Many of the islands and rocks in the Dampier Archipelago/Cape Preston region are known breeding grounds for a variety of seabirds, including wedge-tailed shearwaters (Puffinus pacificus), caspian terns (Sterna caspia), bridled terns (Sterna anaethetus) and roseate terns (Sterna dougallii). The small islands and islets such as Goodwyn Island, Keast Island and Nelson Rocks provide important, undisturbed nesting and refuge sites (CALM, 2005b).

One-third of the 144 bird species recorded on North-West Cape are seabirds, shorebirds and waders (resident and migratory). There are approximately 33 species of seabirds found in the Ningaloo Marine Park with the main rookeries at Mangrove Bay, Mangrove Point, Point Maud, the Mildura wreck site and Fraser Island. In addition, the Muiron and Sunday islands provide isolated rookeries (CALM, 2005a).

Abbot’s Booby

Currently, Abbott's booby is only known to breed on Christmas Island and to forage in the waters surrounding the island and south-east Asia (DoEE, 2020). Abbott's Booby is a marine species. It spends much of its time at sea but needs to come ashore to breed. It is thought that they may travel up to 400 km to feeding grounds when they are breeding (Becking 1976). Within Christmas Island, most nests are found in the tall plateau forest on the central and western areas of the island, and in the upper terrace forest of the northern coast. The National Conservation Values Atlas does not identify any BIAs for this species in the EMBA.

Table 5-6: Seabird Biologically Important Areas that Overlap the EMBA

Species	BIA Location	Peak times
Wedge tailed shearwater	Foraging and breeding with 100 km buffer along Pilbara coastline and islands including: Dampier Archipelago, Passage Island, Montebello Islands, Lowendal Islands off Barrow Island and islands off Onslow	Mid Aug to April
Roseate tern	Breeding: Islands off Pilbara coast including Dampier Archipelago, Lowendal Is, Frazer I, Bedout Island and around Montebello Islands Resting: North Eighty Mile Beach	Mid-March to July
Lesser crested tern	Breeding: Bedout Island, Lowendal Islands, Thevenard Island	March to June
Lesser Frigatebird	Breeding and 100 km foraging buffer: Bedout Island	March to September
Fairy Tern	Breeding: Pilbara coast incl. Dampier Archipelago and Barrow Island.	July to late September
Brown booby	Breeding and foraging: Bedout Island	Feb to Oct, but mainly Autumn
Little tern	Breeding: Pilbara coastline along Eighty Mile Beach Resting: Rowley Shoals	June- July and Oct
White-tailed tropicbird	Breeding and foraging with 100 km buffer: Rowley Shoals	May to Oct
Great frigate bird	Pilbara coast – northern territory.	

Eighty Mile Beach is particularly significant for migrating shorebird species and is considered one of the most significant sites in Australia for migratory shorebirds (Hale and Butcher, 2009) as well as supporting a high diversity and abundance of wetland birds. Although many birds may then move further on their journey, many others remain at the site for the non-breeding period. Eighty Mile Beach is considered the most significant site (in terms of numbers of birds) in the South-East Asian Flyway for nine international migratory species; Bar-tailed Godwit; Terek Sandpiper, Grey-tailed Tattler, Great Knot, Red Knot, Curlew Sandpiper; Greater Sand Plover, Oriental Plover and Oriental Pratincole (Hale and Butcher, 2009). Further information on Eighty Mile Beach Ramsar Site is in **Section 5.7.4**.

Table 5-7: Summary of Environmental Sensitivities for Marine Fauna within the Operational Area and EMBAs

Marine fauna		Operational Area	EMBA
Plankton	Plankton	Yes - Phytoplankton and zooplankton present within the operational area. Higher concentrations occurring during the winter months (June to August) during the activity and lower in summer months (December to March).	Yes - Phytoplankton and zooplankton present within the EMBA. Higher concentrations occurring during the winter months (June to August) and lower in summer months (December to March).
Invert-ebrates	Benthic	Yes – primarily infaunal species	Yes – will contain both mobile and sessile epifauna and infaunal
	Pelagic	Yes – includes squid, salps and jellyfish	Yes – includes squid, salps and jellyfish

Marine fauna		Operational Area	EMBA
Fish	Demersal and/ or pelagic fish	Yes – Both demersal and pelagic fish species present. Stag Facility infrastructure likely attracts a greater diversity and abundance of fishes than would naturally occur on the soft sediments within the Operational Area. Offshore soft sediment habitat generally supports a lower diversity than other benthic habitats that provide greater structure and feeding opportunities (e.g. rocky and coral reef, seagrass and macroalgae, mangroves)	Yes - Diverse assemblage of demersal and pelagic species distributed throughout the EMBA. Three KEFs within the EMBA likely to support high fish diversity and abundance: Glomar Shoals, Continental Slope Demersal Fish Communities and Mermaid Reef. Shallow water primary producer habitats close to mainland shorelines and offshore islands within the EMBA (e.g. seagrass, macroalgae, hard coral and mangroves) support high abundance and diversity of fishes.
	Whale shark	Yes - Could transit through the operational area, particularly around the time of aggregation at Ningaloo Reef (late March to June)	Yes - Will transit through and aggregate within the EMBA. Main period of the whale shark aggregation off Ningaloo Reef is late March to June, with the largest numbers generally recorded in April
	Grey nurse shark	Yes - Could occur as the Operational Area is within depth range (<200 m) but presence is unlikely since there is lack of natural structured habitat in the Operational Area. Operational area is flat bare sand.	Yes – Likely occurs as residents in some areas where habitat favorable (e.g. near inshore rocky and coral reefs between depths of 10–45 m)
	White shark	Yes - Could transit through the Operational Area although unlikely to be present for extended durations since white sharks are highly mobile species that follow seasonal feeding opportunities (e.g. whale migrations, pinniped colonies) in primarily coastal waters.	Yes – Likely to transit through and feed within the EMBA where feeding opportunities present (e.g. whale migrations, pinniped colonies) in primarily coastal waters.
	Other shark/ ray species	Yes - Could transit through the operational area.	Yes - Could transit through the operational area.
	Sawfish	No - Given their preference for shallower estuarine and coastal waters, they are unlikely to be encountered within the Operational Area.	Yes - Could occur in estuaries and nearby coastal mangrove areas and shallow waters particularly the northern mainland coastline of the EMBA.
Marine mammals	Humpback whale	Yes - Peak northern migration around July. Peak southern migration around Aug/September. Greater likelihood of individuals during northern as opposed to southern migration May transit through the Operational Area as within depth range of migration routes	Yes - EMBA overlaps known migration routes and presence is reliable during migration season.
	Pygmy Blue whale	Yes - Northern migration in April-August and southern migration Oct - Dec. May transit through the Operational Area although migration routes believed to occur in deeper waters	Yes - EMBA overlaps migration routes in water depths of 500–1,000 m.

Marine fauna		Operational Area	EMBA
	Dugongs	No – Given their preference for shallower waters near seagrass meadows dugongs are unlikely to be encountered within the Operational Area	Yes-Dugongs occur within the EMBA associated with seagrass meadow habitat in coastal waters of the mainland or offshore islands.
	Cetacean – various whales and dolphins	Yes – A number of whale and dolphin species may transit the Operational Area. Whales are likely to be transiting during migrations while dolphins may be part of resident coastal populations.	Yes - Could occur transiting through the EMBA but not expected in large numbers as they are either infrequently recorded in Australian waters or primarily migrating through deeper waters. Dolphins may be feeding/ aggregating in shallow coastal waters of the mainland or offshore islands.
Marine Reptiles	Marine Turtles	Yes - May transit through the Operational Area although unlikely to be encountered in large numbers (with the exception of the flatback turtle, activity location is outside inter-nesting areas, ~ 35 km from nearest nesting beach at Dampier Archipelago)	Yes - For all species except Leatherback turtle nesting beaches and breeding/feeding areas occur within the EMBA either on the mainland coastline or offshore islands.
	Sea snakes and kraits	No – Not likely to be encountered given the water depth and distance from shore	Yes - May be encountered in shallow waters habitats of EMBA where feeding habitat is found.
Avifauna	Wetland/ Shorebirds	No – Given the distance offshore, shorebirds or wetland birds are unlikely to be present within the Operational Area	Yes – May occur within the EMBA along shorelines and wetlands feeding or nesting. Areas of particular importance are the Ramsar wetland sites at Eighty- mile Beach. Shorebirds also use Montebello/ Lowendal/Barrow Islands.
	Seabirds	Yes – May utilise the waters of the Operational Area for feeding and may be attracted to the Stag Facility by increased abundance of pelagic fish or as resting habitat.	Yes – May occur within the EMBA, either feeding, migrating or utilising coastal islands or mainland shores as nesting habitat.

5.7 Protected Areas

A search of the EPBC Act Protected Matters Database in December 2020 listed a number of areas that are considered matters of National Environmental Significance (NES) as well as other matters protected under the Act. These are outlined in **Table** 5-8 and discussed in more detail in the following section. **Section 5.8** addresses other sensitivities such as State Reserves.

Table 5-8: Summary of Protected Areas within the EMBA

Area type	Title
World Heritage Area	The Ningaloo Coast
National Heritage Properties	The Ningaloo Coast
	Dampier Archipelago (including Burrup Peninsula)
Commonwealth Heritage Place	Mermaid Reef - Rowley Shoals
	Ningaloo Marine Area - Commonwealth Waters
Wetland of International Importance (Ramsar)	Eighty Mile Beach
	Eighty Mile Beach System

Area type	Title
Wetlands of National Significance	Mermaid Reef
Australian Marine Parks	Gascoyne AMP
	Ningaloo AMP
	Montebello AMP
	Dampier AMP
	Eighty Mile Beach AMP
	Argo-Rowley Terrace AMP
	Mermaid Reef AMP
Key Ecological Features	Ancient coastline at 125 m depth contour
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula
	Commonwealth Waters adjacent to Ningaloo Reef
	Continental Slope Demersal Fish Communities
	Exmouth Plateau
	Glomar Shoals
	Mermaid Reef and Commonwealth Waters
Threatened Ecological Communities	None Identified
State Marine Reserves	Montebello Islands Marine Park
	Barrow Island Marine Park
	Barrow Island Marine Management Area
	Muiron Island Marine Management Area
	Ningaloo Marine Park
	Eighty Mile Beach Marine Park
	Rowley Shoals Marine Park

5.7.1 World Heritage Properties

One World Heritage Property, The Ningaloo Coast, overlaps the EMBA for the Stag Facility. The Ningaloo Coast was granted World Heritage Status in June 2011. The World Heritage Area (WHA) encompasses an area of 7,050 km2, including State and Commonwealth waters, extending 25 km offshore. The WHA is primarily comprised of the Ningaloo Marine Park (State waters and the adjoining Commonwealth waters section). Also included are the Muiron Islands Marine Management Area and Nature Reserve, the Bundegi and Jurabi coastal parks and the Cape Range National Park, plus crown, leasehold and freehold land. The Area is managed under the Ningaloo Coast Strategic Management Framework agreed by State and Commonwealth governments. Both state and commonwealth marine parks and reserves are managed on a day to day basis by the Department of Biodiversity, Conservation and Attractions (DBCADBCA) on behalf of the respective authorities.

The Marine Parks and Reserves protect most of the Ningaloo Reefs, which stretch 290 km from North-West Cape south to Red Bluff comprising the 200 km long Ningaloo Barrier Reef enclosing a lagoon that varies in width from 200 m to 7 km, and extensive fringing reefs to the north and south of the barrier (Commonwealth of Australia 2010). Gaps that regularly intercept the main reef line provide channels for water exchange with deeper, cooler waters (CALM 2005a). The Ningaloo Coast WHA forms the backbone of the nature-based tourism industry in the Exmouth region.

Key features that supported the WHA listing of the Ningaloo Coast (UNESCO 2013; Commonwealth of Australia 2010) include:

- Landscapes and seascapes of the property are comprised of mostly intact and large-scale marine, coastal and terrestrial environments;
- Over 300 species of coral;
- Over 650 species of mollusc (clams, oysters, octopus, cuttlefish, snails);
- More than 1,000 species of fish including over 700 species of reef fish;
- 600 species of crustacean;
- 155 species of sponges;
- A high diversity of echinoderms (sea stars, sea urchins, sea cucumbers) including 25 new species; and
- Habitat for iconic species, including whales, dugong, whale sharks and turtles.

The Parks and Reserves included in the WHA are also important habitat for migratory seabirds and waders, including migratory wading birds listed in the CAMBA and JAMBA agreements (CALM 2005a).

5.7.2 National Heritage Properties

There are two National Heritage Properties that overlap with the EMBA for the Stag Facility:

- Ningaloo Coast (see Section 5.7.1); and
- Damper Archipelago (including Burrup Peninsula)

Dampier Archipelago

Dampier Archipelago was included on the National Heritage List in July 2007. Approximately 36,860 ha at Dampier were listed; comprising parts of the Burrup Peninsula and surrounding islands (**Figure** 5-10). Reefs, shoals and islands of the Dampier Archipelago provide important habitat for many native plant and animals. The Burrup Peninsula has been nominated for UNESCO World Heritage listing (in June 2018) and includes Aboriginal rock art where engravings provide an outstanding visual record of Australia's history. The area contains one of the densest concentrations of rock engravings in Australia with some sites containing thousands or tens of thousands of images. There is a high density of stone arrangements on the Burrup Peninsula including standing stones, stone pits and more complex circular stone arrangements (Commonwealth of Australia, 2007).

5.7.3 Commonwealth Heritage Places

Two Commonwealth Natural Heritage Places were identified from the EPBC Act protected matters search of the EMBA area:

- Mermaid Reef – Rowley Shoals; and
- Ningaloo Marine Area – Commonwealth Waters.

Ningaloo Reef Area has been described in **Section 5.7.1** ('The Ningaloo Coast') and Mermaid Reef has been described in **Section 5.7.6.9** ('Mermaid Reef AMP).

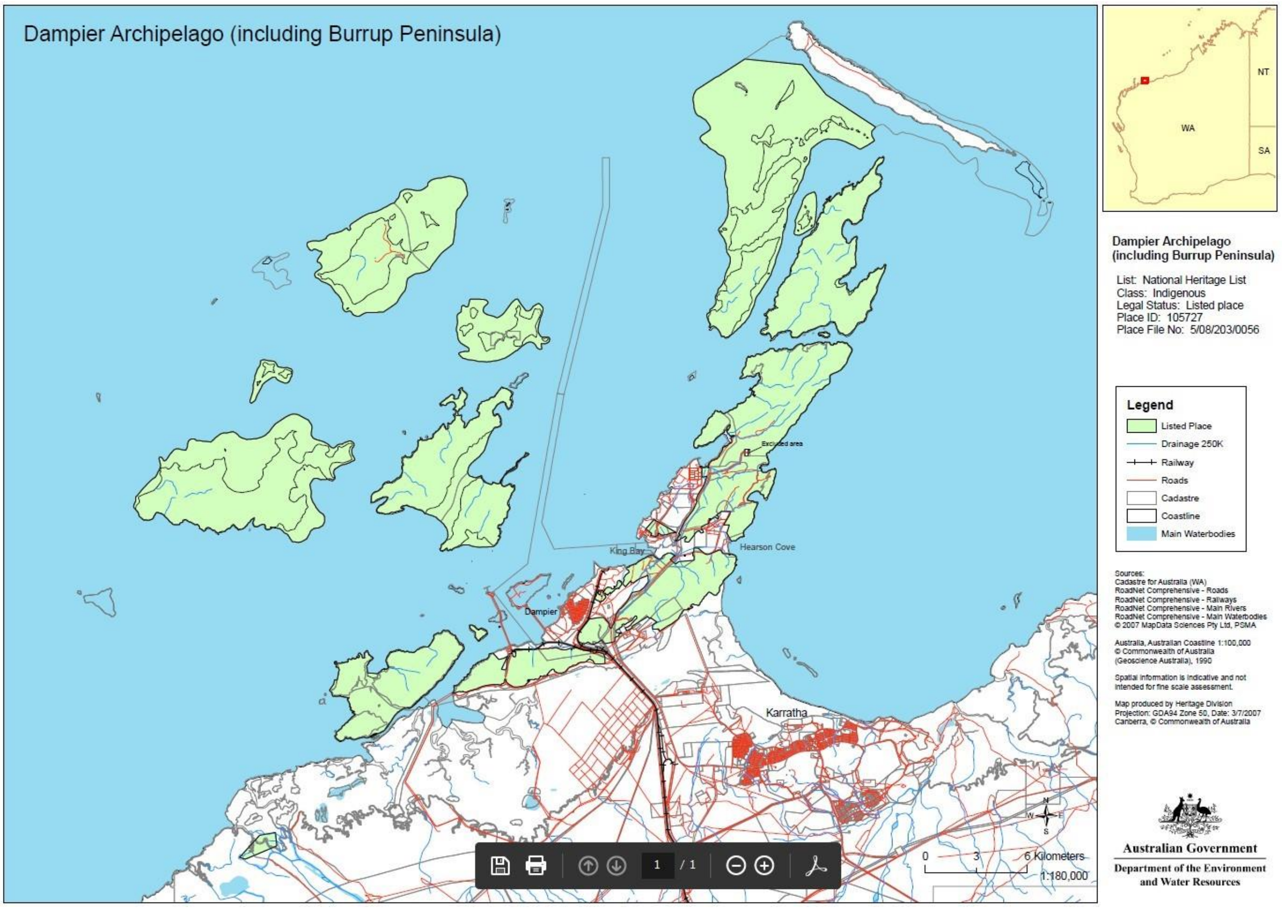


Figure 5-10: National Heritage Features of the Dampier Archipelago

5.7.4 Ramsar Wetland Sites

A 'declared Ramsar wetland' is a wetland area of international importance that has been designated under Article 2 of the Ramsar Convention or declared by the Minister to be a declared Ramsar wetland under Section 16 of the EPBC Act. There is one declared Ramsar site within the EMBA for the Stag Facility: Eighty-mile Beach. Roebuck Bay Ramsar site is not overlapped by the EMBA and will not be affected by an unplanned hydrocarbon spill, and so is not discussed further.

<u>Eighty Mile Beach</u>

The Eighty Mile Beach Ramsar site comprises a 220km beach between Port Hedland and Broome with extensive intertidal mudflats and Mandora Salt Marsh, located 40 km east (Hale and Butcher 2009) totalling 175,487 ha. Eighty Mile Beach is characterised by extensive mudflats supporting an abundance of macroinvertebrates which provide food for large numbers of shorebirds.

Eighty Mile Beach is one of the most important sites for migratory shorebirds in the East Asian Australasian Flyway, with 42 migratory shorebird species recorded at this location. It is estimated that 500,000 shorebirds use Eighty Mile Beach as a migration terminus annually (Hale and Butcher 2009), and more than 472,000 migratory waders have been counted on the mudflats during the September to November period. The location of Eighty Mile Beach makes it a primary staging area for many migratory shorebirds on their way to and from Alaska and eastern Siberia (Hale & Butcher 2009). Although many birds move further on their journey, others remain at the site for the non-breeding period.

Eighty-mile Beach supports more than one per cent of the flyway population (or one per cent of the Australian population for resident species) of 21 waterbirds, including 17 migratory species and four Australian residents. It is one of the most important sites in the world for the migration of Great Knot.

Eighty Mile Beach also supports a high diversity and abundance of wetland birds. A total of 97 wetland bird species have been recorded within the beach portion of the Ramsar site (Hale & Butcher 2009). This includes 42 species that are listed under international migratory agreements CAMBA (38), JAMBA (38) and ROKAMBA (32) as well as an additional 22 Australian species that are listed under the EPBC Act. In addition, there is a single record for Nordmann's Greenshank (Tringa guttifer) from the beach, which is listed as endangered under the IUCN Red List.

The Mandora Salt Marsh area contains an important and rare group of wetlands (Lake Walyarta and East Lake), including raised peat bogs, a series of small permanent mound springs and the most inland occurrence of mangroves in WA (Hale and Butcher 2009). A small number of tidal creeks dissect the beach, including Salt Creek which is fed partly from groundwater and has permanent surface water. The Mandora Salt Marsh lakes fill predominantly from rainfall and runoff in the wet season then dry back to clay beds. The mound springs likely come from water deep within the Broome sandstone aquifer rising through fractures in the rock and resulting in permanent mostly freshwater surface water. Flatback turtles (Natator depressus), listed as vulnerable under the EPBC Act, regularly nest at scattered locations along Eighty Mile Beach.

Eighty Mile Beach is used for beach-based recreation, including four-wheel driving, motorcycling, fishing and shell collecting. Mandora Salt Marsh is mainly used for cattle grazing. The site is traditionally part of Karajarri Country in the north, Nyangumarta Country in the south and Ngarla Country in the southern end of Eighty Mile Beach. The site has artefacts such as middens, pinka (large baler shells used to scoop and carry water for drinking), wilura (used for sharpening spear heads), axes, and flakes, and kurtanyanu and jungari (grinding stones).

5.7.5 Nationally Important Wetlands

The PMST search highlighted three (2) Nationally Important Wetlands within the EMBA:

- Eighty Mile Beach System; and
- Mermaid Reef.

Eighty Mile Beach System

The site comprises Eighty Mile Beach between Cape Missiessy and Cape Keraudren and adjoining tidal mudflats; also, coastal plain with distinct swamps, immediately inland of the beach, mainly near Anna Plains Homestead. Eighty Mile Beach is a megascale (220 km) linear sand-coast; the beach is 100 m wide and includes several muddy, microscale irregular embayments. Adjoining tidal mudflats are 0.5-1 km wide.

The site is one of the most important migration stop-over areas for shorebirds in East Asia–Australasia, supporting more than 300,000 birds. Open-shrubland (mangrove) at the small embayments in periform arrangement; open-tussock grassland in latiform arrangement on the coastal plain, and open-scrub in periform arrangement at the swamps. An outstanding example of a major beach with associated inter-tidal flats and coastal floodplain, located in the arid tropics.

More information on Eighty Mile Beach is presented above in **Section 5.7.4**.

Mermaid Reef

See **Section 5.7.6.9** for relevant information.

5.7.6 Australian Marine Parks

Seven Australian Marine Parks (AMPs) overlap the EMBA (**Figure** 5-11) as outlined in **Table** 5-9.

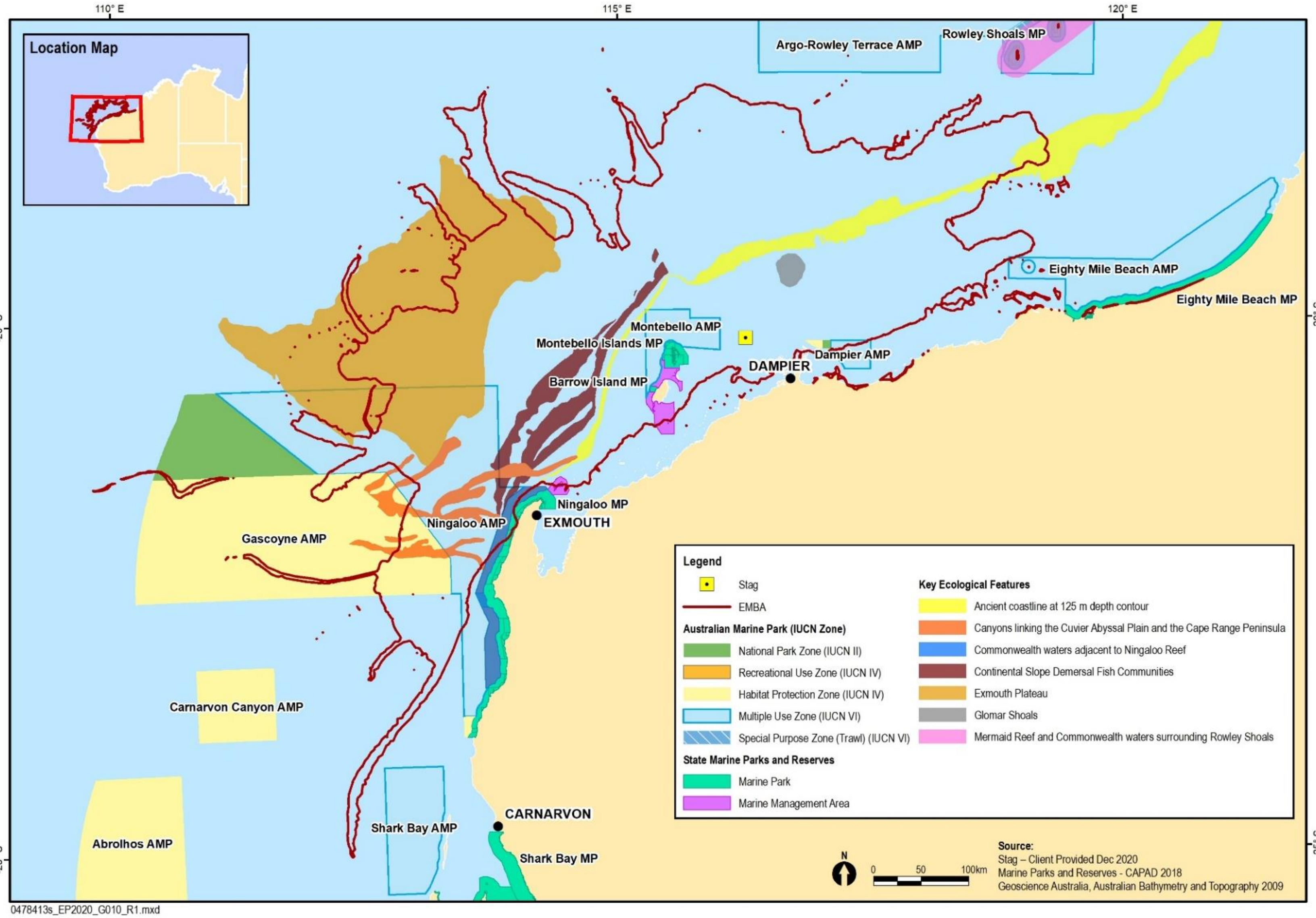


Figure 5-11: State Marine Reserves and Australian Marine Parks and Key Ecological Features

Table 5-9: Australian Marine Parks within the EMBA

Australian Marine Parks	Distance from Stag Facility	IUCN Categories overlapped
Gascoyne AMP	270 km	Multiple Use Zone (IUCN VI) Marine National Park Zone (IUCN II) Habitat Protection Zone (IUCN IV)
Ningaloo AMP	260 km	Recreational Use Zone (IUCN IV)
Montebello AMP	30 km	Multiple Use Zone - IUCN Category VI
Dampier AMP	60 km	Habitat Protection Zone (IUCN IV) Special Purpose Zone (ports) - IUCN Category VI Marine National Park Zone - IUCN Category II
Eighty Mile Beach AMP	280 km	Multiple Use Zone (IUCN VI)
Argo-Rowley Terrace AMP	290 km	Marine National Park Zone (IUCN II) Multiple Use Zone (IUCN VI)
Mermaid Reef AMP	80 km	Marine National Park Zone (IUCN II)

The following descriptions of the major conservation values for each AMP are taken from the Department of the Environment and Energy website.

5.7.6.1 IUCN Principles

Existing and proposed Australian Marine Parks are subject to the Australian IUCN reserve management principles as presented in Schedule 8 of the EPBC Regulations. Until management plans come into effect for the new proposed AMP in the NWMR, transitional arrangements apply, and there are no changes on the water for users of the new proposed reserves (DoE 2014c)).

5.7.6.2 Gascoyne Marine Park

The EMBA overlaps all IUCN categories of the Gascoyne AMP which ranges in depth from ~15 m to 6,000 m. The Gascoyne AMP has the following major conservation values:

- Important foraging areas for:
  - Migratory seabirds,
  - The threatened and migratory hawksbills and flatback turtles,
  - The vulnerable and migratory whale shark.
- The park provides a continuous connectivity corridor from shallow depths around 15 metres out to deep offshore waters on the abyssal plain at over 5,000 m in depth;
- The park provides protection to many seafloor features including canyon, terrace, ridge, knolls, deep hole/valley and continental rise. It also provides protection for sponge gardens in the south of the reserve adjacent to Western Australian coastal waters;
- Examples of the ecosystems of the Central Western Shelf Transition, the Central Western Transition and the Northwest province provincial bioregions as well as the Ningaloo meso-scale bioregion;
- Three key ecological features for the region:
  - Canyons on the slope between the Cuvier Abyssal Plain and the Cape Range Peninsula (enhanced productivity, aggregations of marine life and unique sea-floor feature.
  - Exmouth Plateau (unique sea-floor feature associated with internal wave generation),

  - Continental slope demersal fish communities (high species diversity and endemism - the most diverse slope bioregion in Australia with over 500 species found with over 64 of those species occurring nowhere else)
- The canyons are believed to be associated with the movement of nutrients from deep water over the Cuvier Abyssal Plain onto the slope where mixing with overlying water layers occurs at the canyon heads. These canyon heads, including that of Cloates Canyon, are sites of species aggregation and are thought to play a significant role in maintaining the ecosystems and biodiversity associated with the adjacent Ningaloo Reef; and
- The park therefore provides connectivity between the inshore waters of the existing Ningaloo Marine Park and the deeper waters of the area

5.7.6.3 Ningaloo Marine Park

The EMBA overlaps the Ningaloo Marine Park (recreational use zone) located ~260 km southwest of the Stag Facility. Together with the Ningaloo Marine Park and Muiron Islands Management Area, both in State waters, the Ningaloo Marine Park forms the Ningaloo Coast World Heritage Area. The Ningaloo Marine Park has the following conservation values:

- Foraging areas for vulnerable and migratory whale sharks;
- Foraging areas and adjacent to important nesting sites for marine turtles;
- Includes part of the migratory pathway of the protected humpback whale;
- The park includes shallow shelf environments and provides protection for shelf and slope habitats, as well as pinnacle and terrace seafloor features; and
- Examples of the seafloor habitats and communities of the Central Western Shelf Transition.

5.7.6.4 Montebello Marine Park

The Montebello Marine Park (Multiple Use Zone, IUCN Category VI) overlaps the EMBA and is located approximately 30 km west of the Stag Facility. The park has the following conservation values:

- Foraging areas adjacent to important breeding areas for migratory seabirds;
- Foraging areas for vulnerable and migratory whale sharks;
- Foraging areas adjacent to important nesting sites for marine turtles;
- Part of the migratory pathway of the protected humpback whale;
- Shallow shelf environments with depths ranging from 15 m to 150 m, including shelf and slope habitats, as well as pinnacle and terrace seafloor features;
- Examples of the seafloor habitats and communities of the Northwest Shelf Province, as well as the Pilbara (offshore) meso-scale bioregion; and
- One key ecological feature for the region being the Ancient Coastline (a unique seafloor feature that provides areas of enhanced biological productivity).

5.7.6.5 Dampier Marine Park

The Dampier Marine Park (Marine National Park IUCN II and Habitat Protection Zone IV) is located ~60 km east of the Stag Facility and overlaps the EMBA. The AMP has the following major conservation values:

- Foraging areas adjacent to important breeding areas for migratory seabirds;
- Foraging areas adjacent to important nesting sites for marine turtles;
- Includes part of the migratory pathway of the protected humpback whale;
- The park provides a high level of protection for offshore shelf habitats adjacent to the Dampier Archipelago;

- The park provides high level protection for the shallow shelf with depths ranging from 15 m to 70 m; and
- Examples of the communities and seafloor habitats of the Northwest Shelf Province provincial bioregion as well as the Pilbara (nearshore) and Pilbara (offshore) meso-scale bioregions

5.7.6.6 Eighty Mile Beach Marine Park

The Eighty Mile Beach Marine Park (Multiple Use Zone IUCN VI) overlaps the EMBA and is located 280 km east of the Stag Facility. The AMP has the following major conservation values:

- Foraging areas adjacent to important breeding areas for migratory seabirds;
- Foraging areas adjacent to important nesting sites for marine turtles;
- Includes part of the migratory pathway of the protected humpback whale;
- Adjacent to important foraging, nursing and pupping areas for freshwater, green and dwarf sawfish;
- The park provides protection for the shelf, including terrace and banks and shoal habitats, with depths ranging from 15 m to 70 m; and
- Examples of the communities and seafloor habitats of the Northwest Shelf Province provincial bioregion and the Canning, Northwest Shelf, Pilbara (nearshore), Pilbara (offshore) and Eighty Mile Beach meso- scale bioregions.

5.7.6.7 Argo-Rowley Terrace Marine Park

Based on modelling of the worst-case spill scenario, the EMBA overlaps the Argo Rowley Terrace Marine Park Multiple Use Zone IUCN VI but does not overlap the Marine National Park Zone IUCN II, which is ~50 km from its boundary. The AMP has the following major conservation values:

- Important foraging areas for migratory seabirds and the endangered loggerhead turtle;
- Important area for sharks, which are found in abundance around the Rowley Shoals relative to other areas in the region;
- The park provides protection for the communities and habitats of the deeper offshore waters of the region in depth ranges from 220 m to over 5,000 m;
- The park provides protection for many seafloor features including aprons and fans, canyons, continental rise, knolls/abyssal hills and the terrace and continental slope;
- Examples of the communities and seafloor habitats of the Northwest Transition and Timor Province provincial bioregions;
- The park provides connectivity between the existing Mermaid Reef Marine National Nature Reserve and reefs of the Western Australian Rowley Shoals Marine Park and the deeper waters of the region;
- Two key ecological features (KEFs) are included in the reserve:
  - The canyons linking the Argo Abyssal Plain with the Scott Plateau (unique seafloor feature with enhanced productivity and feeding aggregations of species); and
  - Mermaid Reef and the Commonwealth waters surrounding Rowley Shoals (an area of high biodiversity with enhanced productivity and feeding and breeding aggregations).

5.7.6.8 Mermaid Reef Marine Park

The Mermaid Reef Marine Park (IUCN Category Ia - Strict Nature Reserve) overlaps the EMBA and is located 480 km northeast of the Stag Facility. The reserve has the following major conservation values:

- Mermaid Reef has national and international significance due to its pristine character, coral formations, geomorphic features and diverse marine life;
- Key area for over 200 species of hard corals and 12 classes of soft corals with coral formations in pristine condition;

- Important areas for sharks including the grey reef shark, the whitetip reef shark and the silvertip whaler;
- Important foraging area for marine turtles;
- Important area for toothed whales, dolphins, tuna and billfish;
- Important resting and feeding sites for migratory seabirds;
- The park, along with nearby Rowley Shoals Marine Park, provides the best geological example of shelf atolls in Australia; and
- Examples of the seafloor habitats and communities of the Northwest Transition

5.7.7 Key Ecological Features

Seven marine key ecological features (KEFs) of the NWMR overlap the EMBA (refer **Figure** 5-11). These KEFs are considered to be of regional importance for either the region's biodiversity or ecosystem function and integrity. **Table** 5-10 lists the KEFs together with their distance from the Stag Facility. Details on these KEFs are provided below.

Table 5-10: Distances from Stag Facility to Key Ecological Features within the EMBA

Key ecological feature (KEF)	Distance from Stag Facility
Ancient coastline at 125 m depth contour	~70 km
Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	~215 km
Commonwealth Waters adjacent to Ningaloo Reef	~260 km
Continental Slope Demersal Fish Communities	~110 km
Exmouth Plateau	~210 km
Glomar Shoals	~70 km
Mermaid Reef and Commonwealth Waters	~390 km

<u>Ancient coastline at 125 m depth contour</u>

The shelf of the NWMR contains several terraces and steps, which reflect the gradual increase in sea level across the shelf that occurred during the Holocene. The most prominent of these occurs episodically as an escarpment through the Northwest Shelf Province and Northwest Shelf Transition, at a depth of approximately 125 m. Where the ancient submerged coastline provides areas of hard substrate it may contribute to higher diversity and enhanced species richness relative to soft sediment habitat.

The escarpment may facilitate increased availability of nutrients in particular locations off the Pilbara coast by disrupting internal waves thereby facilitating enhanced vertical mixing of water layers. Enhanced productivity may attract opportunistic feeding by larger marine life including humpback whales, whale sharks and large pelagic fish.

<u>Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula</u>

The canyons on the slope between the Cuvier Abyssal Plain and the Cape Range Peninsula include the Cape Range Canyon and the Cloates Canyon. They are believed to be associated with upwelling as they channel deep water from the Argo Abyssal Plain up onto the slope, where it mixes with the overlying water layers at the canyon heads. The upwelling zones at the canyon heads are sites of species aggregations such as sweetlip emperor fish. The soft bottom habitats within the canyons themselves are likely to support important assemblages of epibenthic species. The canyons are thought to be significant contributors to the biodiversity of the adjacent Ningaloo Reef, as they channel deep water nutrients up to the reef, stimulating primary productivity.

Commonwealth waters adjacent to Ningaloo Reef

Ningaloo Reef is globally significant as the only extensive coral reef in the world that fringes the west coast of a continent and as a seasonal aggregation site for whale sharks. The Australian Commonwealth waters adjacent to Ningaloo Reef and associated canyons and plateau are interconnected and support the high productivity and species richness of Ningaloo Reef.

Refer Ningaloo AMP (**Section 5.7.6.4**) for further details on the values and sensitivities of the KEF.

Continental Slope Demersal Fish Communities

Demersal slope fish assemblages in the Timor Province, the Northwest Transition and the Northwest Province are characterised by high endemism and species diversity. The level of endemism of demersal fish species in these bioregions is high compared to anywhere else along the Australian continental slope. The Northwest Province, specifically the continental slope between North-West Cape and the Montebello Trough, has more than 500 fish species, 76 of which are endemic, making it the most diverse slope bioregion in Australia. The slope of the Timor Province and the Northwest Transition also contains more than 500 species of demersal fish, of which 64 are considered to be endemic, and is the second richest area for demersal fish species across the entire Australian continental slope.

Exmouth Plateau

The Exmouth Plateau covers an area of approximately 50,000 km^2 and consists of a generally rough and undulating surface at water depths of approximately 500 m to more than 5,000 m. The plateau is thought to be dotted with numerous pinnacles. It is an important geomorphic feature that modifies the flow of deep waters and has been identified as a site where internal waves are generated by internal tides. The plateau also receives settling detritus and other matter from the pelagic environment.

Glomar Shoals

The Glomar Shoals are regionally important for their high biological diversity and high localised productivity. The Glomar Shoals are in water depths of 26–70 m and are distinguished by highly fractured molluscan debris, coralline rubble and coarse carbonate sand (Baker et al., 2008). They are an important seafloor feature in Commonwealth waters as they are a raised feature on a relatively featureless continental shelf. They are characterised as a high-energy environment because of current action, thereby resulting in local enhancements in productivity (DSEWPaC, 2012c). Enhanced biological productivity supports significant populations of a number of commercially important fish species such as Rankin cod, brownstripe snapper, red emperor, crimson snapper and frypan bream.

Mermaid Reef and Commonwealth Waters

This key ecological feature is recognised because of its biodiversity (aggregations of marine life) and ecological functioning and integrity (high productivity) values, which apply to both the benthic and pelagic habitats within the feature.

The Rowley Shoals are a collection of three atoll reefs, Clerke, Imperieuse and Mermaid, which are located about 300 km northwest of Broome. This KEF encompasses Mermaid Reef AMP as well as waters from 3 nautical miles out to 6 nautical miles surrounding Clerke and Imperieuse reefs. Further information on the values and sensitivities of the Rowley Shoals are provided in **Section 5.8.5**.

The reefs provide a distinctive biophysical environment in the region as there are few offshore reefs in the northwest. They have steep and distinct reef slopes and associated fish communities. In evolutionary terms, the reefs may play a role in supplying coral and fish larvae to reefs further south via the southward flowing Indonesian Throughflow. Both coral communities and fish assemblages differ from similar habitats in eastern Australia (Done et al., 1994).

5.7.8 Summary of Values and Sensitivities for EPBC Act Protected Matters within the Operational Area and EMBA

Table 5-11 summarises the habitats that may be affected by routine events at the Stag Facility within the Operational Area as well as accidental events that may arise within a larger EMBA.

Table 5-11: Summary of Environmental Values and Sensitivities

Protected matter	Environmental value	Sensitivities overlapped	
		Operational Area	EMBA
World Heritage Areas			
The Ningaloo Coast	Extensive fringing reef and lagunal system. Supports high diversity of corals, molluscs, fish, crustaceans and sponges. Important habitat for protected and iconic turtles (foraging and nesting), whales (migrating and resting) and whale sharks (feeding aggregations).	**No**	**Yes –** oil could potentially reach and coat shoreline habitats and coastal waters at this site.
National Heritage Properties			
Dampier Archipelago (including Burrup Peninsula)	Important site for indigenous rock painting and stone arrangements.	**No**	**No** – sites above high water mark and would not be impacted from any oil spill scenarios.
The Ningaloo Coast	See WHA	**No**	**Yes**
Commonwealth Heritage Place			
Mermaid Reef - Rowley Shoals	See Mermaid Reef AMP	**No**	**Yes**
Ningaloo Marine Area - Commonwealth Waters	See Ningaloo Coast WHA and AMP	**No**	**Yes**
Ramsar sites			
Eighty Mile Beach	This site comprises beach, extensive mudflats and wetlands for feeding/roosting of shorebird/wetland bird species and is an internationally important site for migratory shorebirds.	**No**	**Yes –** oil could potentially reach and coat shorelines and mudflats of this site.
Wetlands of National Significance			
Eighty Mile Beach System	See Ramsar Sites	**No**	**Yes**
Mermaid Reef	See Mermaid Reef AMP	**No**	**Yes**

Protected matter	Environmental value	Sensitivities overlapped	
		Operational Area	EMBA
Commonwealth Marine Parks			
Gascoyne AMP	Contains important foraging areas for seabirds, hawksbill and flatback turtles and whale sharks. Includes seafloor features including canyon, terrace, ridge, knolls, deep hole/valley and continental rise and provides protection for sponge gardens in SW of the reserve.	**No**	**Yes** – sensitivity is only for species (hawksbill and flatback turtles and whale sharks) that use surface waters within the reserve and therefore susceptible to oiling.
Ningaloo AMP	Values in Commonwealth waters are around feeding, migrating and aggregating areas for turtles, whales and whale sharks as well as diverse subtidal benthic habitats.	**No**	**Yes** – sensitivity is for species (e.g. whales, turtles and whale sharks) that use surface waters within the reserve and therefore susceptible to oiling.
Montebello AMP	Contains foraging areas adjacent to important breeding/nesting areas for migratory seabirds and turtles and foraging areas for migratory whale sharks. Part of the migratory pathway of the humpback whale.	**No**	**Yes** – sensitivity is for species (e.g. whales, turtles and whale sharks) that use surface waters within the reserve and therefore susceptible to oiling.
Dampier AMP	Contains foraging areas adjacent to important breeding/nesting areas for migratory seabirds and turtles and foraging areas for migratory whale sharks. Part of the migratory pathway of the humpback whale.	**No**	**Yes** – sensitivity is for species (e.g. whales, turtles and whale sharks) that use surface waters within the reserve and therefore susceptible to oiling.
Eighty Mile Beach AMP	Contains foraging areas adjacent to Important breeding/nesting areas for migratory seabirds and turtles and foraging areas for migratory whale sharks. Part of the migratory pathway of the humpback whale. Adjacent to important foraging, nursing and pupping areas for freshwater, green and dwarf sawfish.	**No**	**Yes – s**ensitivity is for species (e.g. whales, turtles and whale sharks) that use surface waters within the reserve and therefore susceptible to oiling.
Argo-Rowley Terrace AMP	Important foraging areas for migratory seabirds and the endangered loggerhead turtle. Important area for sharks. The reserve provides protection for many seafloor features including aprons and fans, canyons, continental rise, knolls/abyssal hills and the terrace and continental slope and provides connectivity between the existing Mermaid Reef Marine National Nature Reserve and reefs of the Western Australia Rowley Shoals Marine Park and the deeper waters of the region.	**No**	**Yes –** sensitivity is for species (e.g. whales, turtles, seabirds and whale sharks) that use Surface waters within the reserve and therefore susceptible to oiling.

Protected matter	Environmental value	Sensitivities overlapped	
		Operational Area	EMBA
Mermaid Reef AMP	Mermaid Reef has national and international significance due to its pristine character, coral formations, geomorphic features and diverse marine life (e.g. hard coral). Important areas for sharks, toothed whales, dolphins, tuna and billfish. Important foraging habitat for turtles and important resting and feeding sites for migratory seabirds. One of the best geological example of shelf atolls in Australia.	**No**	**Yes –** sensitivity is for species (e.g. whales, turtles, seabirds and whale sharks) that use Surface waters within the Reserve and therefore susceptible to oiling.
Key Ecological Features			
Ancient coastline at 125 m depth contour	Where the ancient submerged coastline provides areas of hard substrate it may contribute to higher diversity and enhanced species richness relative to soft sediment habitat. May facilitate increased availability of nutrients in particular locations off the Pilbara coast. This enhanced productivity may attract opportunistic feeding by larger marine life including humpback whales, whale sharks and large pelagic fish.	**No.**	**Yes –** sensitivity is for species (e.g. whales, turtles, seabirds and whale sharks) that may be in high abundance above feature and therefore susceptible to oiling.
Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	Believed to be associated with upwelling. The upwelling zones at the canyon heads are sites of species aggregations such as sweetlip emperor fish. The soft bottom habitats within the canyons themselves are likely to support important assemblages of epibenthic species.	**No.**	**Yes –**Oil interacting with increased species in upwelled surface waters (e.g. plankton, fish, whale sharks).
Commonwealth waters adjacent to Ningaloo Reef	Sensitivities as for Ningaloo AMP	**No.**	**Yes –** As per Ningaloo Marine Reserve
Continental Slope Demersal Fish Communities	High endemism and diversity of demersal fish species	**No**	**Yes –** oil will not directly impact demersal fish species although may interact with demersal fish larvae and eggs over a larger area.
Exmouth Plateau	Plateau is thought to be dotted with numerous pinnacles. It is an important geomorphic feature that modifies the flow of deep waters.	**No**	**No –** oil will not directly impact this feature or increased benthic diversity associated with this feature.
Glomar Shoals	Regionally important for their high biological diversity and high localised productivity. Enhanced biological productivity supports significant populations of a number of commercially important fish species such as Rankin cod, brownstripe snapper, red emperor, crimson snapper and frypan bream.	**No**	**Yes –** oil could interact with increased productivity within surface waters (e.g. plankton, fish, whale sharks)

Protected matter	Environmental value	Sensitivities overlapped	
		Operational Area	EMBA
Mermaid Reef and Commonwealth Waters	Sensitivity as for Mermaid Reef AMP	**No**	**Yes-** as for Mermaid Reef AMP

5.8 State Marine Reserves

Seven State marine reserves have been identified within the EMBA as outlined in **Figure** 5-11 and **Table** 5-12.

Table 5-12: Distances from Stag Facility location to State Marine Reserves within the EMBA

State Marine Reserve	Distance from Stag Facility
Montebello Islands Marine Park	~65 km
Barrow Island Marine Park	~110 km
Barrow Island Marine Management Area	~75 km
Muiron Island Marine Management Area	~240 km
Ningaloo Marine Park	~260 km
Eighty Mile Beach Marine Park	~340 km
Rowley Shoals Marine Park	~380 km

Further detail on these reserves is provided below.

5.8.1 Montebello/ Barrow Islands Marine Conservation Reserves

Montebello/Barrow Islands Marine Conservation Reserves encompasses three separate reserves: Barrow Island Marine Management Area; Barrow Island Marine Park; and Montebello Islands Marine Park.

As outlined in the Management Plan for the Montebello/Barrow Islands Marine Conservation Reserve 2007–2017 (DEC 2007), the strategic conservation objectives for Reserve are to:

- Maintain and enhance the marine biodiversity of the reserves; and
- Maintain the ecological integrity (i.e. ecosystem structure and function).

While macroalgae-dominated limestone reef and subtidal reef platform/sand mosaic are the main marine habitat types in the Montebello/Barrow islands region, coral reef, mangroves and subtidal sand and soft-bottom habitats are also common. Macroalgal communities, which are the major primary producer for the area, mainly comprise species of brown algae, particularly of the genera Sargassum, Turbinaria and Pandina, while green algae from the genera Caulerpa and Cladophora are also abundant. A wide range of invertebrate life is associated with this habitat. The subtidal coral reef communities in the reserves have a high diversity of invertebrates, with at least 150 species of hard corals recorded from fringing and patch coral reef areas. Sand habitats are generally unvegetated but may have seasonal vegetation or permanent patches of seagrass or macroalgae and a significant invertebrate fauna. Rocky shores are typically undercut, unvegetated, low limestone cliffs, which support a variety of mollusc species and other invertebrates. The six species of mangroves that occur in the reserves represent the unique offshore mangrove communities of the Pilbara, and are considered to be globally significant (Semeniuk, 1997 as cited in EPA 2001). Mangrove communities support a range of invertebrate fauna and provide nursery habitat for fishes and crustaceans. The benthic and shoreline habitats in the reserves are shown in **Figure 5-4**.

Five of the six species of marine turtle found in WA have been recorded in the reserves. Of these, green, hawksbill and flatback turtles regularly nest on the sandy beaches in the reserves, while occasional nesting by loggerheads has also been recorded on Barrow Island. The WA hawksbill turtle population is the only large population of this species remaining in the Indian Ocean. The nesting populations of green and flatback turtles in the reserves are large and significant. The northernmost breeding limit for loggerheads in WA is within the reserves.

Seven species of toothed whale and three species of baleen whale have been recorded from the Montebello/Barrow islands region. Humpback whales use the reserves as a resting area, and some whale migration paths pass through the reserves. Dugongs are found in the vicinity of the Montebello Islands, Lowendal Islands and Barrow Shoals, where they feed on seagrass and algae. The Montebello/Barrow islands region is a significant rookery for at least 15 seabird species, with the largest breeding colony of roseate terns in Western Australia found on the Montebello Islands.

The KPI for the marine park are summarised in **Table** 5-13.

5.8.1.1 Montebello Islands Marine Park

The Montebello Islands Marine Park (MP) is an ‘A’ Class reserve (DEC 2007a) and covers an area of ~ 58,300 ha (DEC 2007a). Zoning within the Montebello Islands MP is a combination of sanctuary, recreation, special purpose (benthic protection), special purpose (pearling) and general use (DEC 2007).

The Montebello Islands comprise over 100 islands, the majority of which are rocky outcrops. The rocky shore accounts for 81% of shoreline habitat (DEC 2007a). Other marine habitats within the marine park include coral reefs, mangroves, intertidal flats, extensive sheltered lagoonal waters and shallow algal and seagrass reef platforms extending to the south of the Montebello Islands to the Rowley Shelf. The complex seabed and island topography create a unique environment in which these diverse habitats occur in close proximity to each other.

Ecologically, the marine park’s values include important turtle nesting sites, feeding and resting areas for migrating shorebirds, seabird nesting areas, dugong foraging areas, globally unique mangrove communities and highly diverse fish and invertebrate assemblages (DEC 2007a). Also, the sediment and water quality of the marine park are considered pristine (DEC 2007a) and are essential to the maintenance of the marine ecosystems and associated biota. The KPI for the marine park are summarised in **Table** 5-13.

Economic values within the Montebello Islands MP include commercial pearl culture, commercial line and trap fishing and an increasing recreational usage. Special purpose zones for pearling are established for the existing leaseholder to allow pearling to be the priority use of these areas (DEC 2007). Commercial fishing includes a trap fishery for reef fishes, mainly in water depths of 30–100 m, and wet lining for reef fish and mackerel. Fish trawling also occurs in the waters near to the Montebello Islands. A tourist houseboat operates out of Claret Bay, at the southern end of Hermite Island, during the winter months. The Montebello Islands are becoming more frequently used by recreational boaters for camping, fishing and diving activities.

5.8.1.2 Barrow Island Marine Park

The Barrow Island Marine Park covers 4,169 ha, all of which is zoned as sanctuary zone (the Western Barrow Island Sanctuary Zone) (DEC, 2007a). It includes Biggada Reef, an ecologically significant fringing reef, and Turtle Bay, an important turtle aggregation and breeding area (DEC, 2007a). Representative areas of seagrass, macroalgal and deep water habitat are also represented within the marine park (DEC, 2007a). Passive recreational activities (such as snorkelling, diving and boating) are permitted but extractive activities such as fishing and hunting are not.

5.8.1.3 Barrow Island Marine Management Area

The Barrow Island Marine Management Area (MMA) is the largest reserve within the Montebello/Barrow Islands marine conservation reserves, covering 114,693 ha (DEC, 2007a). The MMA includes most of the waters around Barrow Island, the Lowendal Islands and the Barrow Island Marine Park, with the exclusion of the port areas of Barrow Island and Varanus Island.

The MMA is not zoned apart from one specific management zone: Bandicoot Bay Conservation Area. This conservation area is on the southern coast of Barrow Island and has been created to protect benthic fauna and seabirds. It includes the largest intertidal sand/mudflat community in the reserves, is known to be high in invertebrate diversity and is an important feeding area for migratory birds.

As for the other reserves in the Montebello/Barrow Islands marine conservation reserves, the Barrow Island MMA includes significant breeding and nesting areas for marine turtles and the waters support a diversity of tropical marine fauna, important coral reefs and unique mangrove communities (DEC, 2007a). Green, hawksbill and flatback turtles regularly use the island's beaches for breeding, and loggerhead turtles are also occasionally sighted. The KPI for the marine park are summarised in **Table** 5-13.

5.8.2 Ningaloo Marine Park

The Ningaloo Marine Park was declared in May 1987 under the National Parks and Wildlife Conservation Act 1975 (Cmlth). The Ningaloo Coast, incorporating both key marine and terrestrial values was later granted World Heritage Status in June 2011. In November 2012, the Ningaloo Marine Park (Commonwealth Waters) was renamed to be incorporated in the North-west Australian Marine Park Network (5.7.6). The park covers an area of 263,343 km^2, including both State and Commonwealth waters, extending 25 km offshore. It is vested in the Marine Parks and Reserves Authority (MPRA) and managed by the WA Department of Biodiversity, Conservation and Attractions (DBCA) on behalf of the Commonwealth.

The park protects a large portion of Ningaloo Reef, which stretches over 300 km from North-West Cape south to Red Bluff. It is the largest fringing coral reef in Australia, forming a discontinuous barrier that encloses a lagoon that varies in width from 200 m to 7 km. Gaps that regularly intercept the main reef line provide channels for water exchange with deeper, cooler waters (CALM 2005). The Ningaloo Marine Park forms the backbone of the nature-based tourism industry, and recreational activities in the Exmouth region. Seasonal aggregations of whale sharks, manta rays, sea turtles and whales, as well as the annual mass spawning of coral attract large numbers of visitors to Ningaloo each year (CALM 2005).

The reef is composed of partially dissected basement platform of Pleistocene marine or Aeolian sediments or tertiary limestone, covered by a thin layer of living or dead coral or macroalgae. Key features that characterise the Ningaloo Reef include (CALM 2005):

- Over 217 species of coral (representing 54 genera);
- Over 600 species of mollusc (clams, oysters, octopus, cuttlefish, snails);
- Over 460 species of fish;
- Ninety-seven species of echinoderms (sea stars, sea urchins, sea cucumbers);
- Habitat for numerous threatened species, including whales, dugong, whale sharks and turtles; and
- Habitat for over 25 species of migratory wading birds listed in CAMBA and JAMBA.

The strategic conservation objectives for Ningaloo Marine Park and the Muiron Islands Marine Management Area are:

- Maintain the marine biodiversity of the reserves; and
- Maintain ecological processes and life support systems (i.e. key ecosystem structure and function).
- To attain these objectives, some of the social and ecological values are monitored as Key Performance Indicators (KPI) including, coral reef communities, water quality, coastal biological communities, finfish, mangrove communities, turtles, Intertidal sand and mudflat communities, Seascapes and Wilderness Table 5-13.

5.8.3 Muiron Island Marine Management Area

The Marine Management Area for the Muiron Islands is located immediately adjacent to the northern end of the Ningaloo Marine Park. This is managed as an integrated area together with the Ningaloo Marine Park under the The Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005 - 2015 (DEC 2005).

Muiron Islands located 15 km northeast of North-West Cape (NWC) and comprise the North and South Muiron Islands and cover an area of 1,400 ha (AHC, 2006). They are low limestone islands (maximum height of 18 m above sea level (ASL)) with some areas of sandy beaches, macroalgae and seagrass beds in the shallow waters (particularly on the eastern sides) and coral reef up to depths of 5 m, which surrounds both sides of South Muiron Island and the eastern side of North Muiron Island. The Muiron Islands Marine Management Area (MMA) was WA's first marine management area, gazetted in November 2004. It covers an area of 28,616 ha and occurs entirely within state waters (CALM, 2005a).

5.8.4 Eighty Mile Beach Marine Park

The Eighty Mile Beach Marine Park covers an area of ~ 200,000 ha stretching for some 220 km from Cape Missiessy to Cape Keraudren, and includes sanctuary, recreation, general use and special purpose zones. The park is managed under the Eighty Mile Beach Marine Park Management Plan 2014-20124 (DBCA, 2014).

The listed ecological values of the Eighty Mile Beach Marine Park include the high sediment and water quality, the juxtaposition of the beach, coastal topography and seabed and the diverse and ecologically important habitats and marine/coastal flora and fauna. The listed values of the marine park are as follows:

- The intertidal sand and mudflat communities supporting a high abundance and diversity of invertebrate life and providing a valuable food source for shorebirds (including migratory species) and other fauna;
- The diverse subtidal filter-feeding communities;
- Macroalgal and seagrass communities providing habitat and feeding opportunities for fish, invertebrates and dugongs;
- High diversity intertidal and subtidal coral reef communities; and
- Mangrove communities and adjacent saltmarshes provide nutrients to the surrounding waters and habitat for fish and invertebrates.

The listed marine and coastal fauna values are as follows:

- A high diversity and abundance of nationally and internationally important shorebirds and waders (including migratory species) are found in the marine park;
- Flatback turtles are endemic to northern Australia and nest at Eighty Mile Beach;
- Dugongs and several whale and dolphin species inhabit or migrate through the marine park;
- A highly diverse marine invertebrate fauna provides an important food source for a variety of animals, including birds, fish and turtles, along with recreational and commercial fishing opportunities;
- A diversity of fish species provide recreational and commercial fishing opportunities; and
- A diversity of sharks and rays, including several protected species, are found in the park.

In addition to these natural values, the marine park contains land and sea important to traditional indigenous owners through identity and place, family networks, spiritual practice and resource gathering. The marine park also has a history of European activity including exploration, pastoralism and commercial fishing (e.g. the pearl oyster fishery). The park contains a historical WWII plane wreck (Dornier Do-24 X-36) and shipwrecks (two pearl luggers). The marine park provides tourism opportunity and recreational value through its remoteness, diversity and abundance of habitats and marine fauna and the pristine nature of the marine and coastal environment.

The marine park contains vast intertidal sand and mudflats that extend up to 4 km wide at low tide and provide a rich source of food for many species. Eighty Mile Beach Marine Park is one of the world's most important feeding grounds for small wading birds that migrate to the area each summer, travelling from countries thousands of kilometres away (DBCA 2014).

Further information on management zoning, cultural, ecological, social and economic values of the marine park are available in the Management Plan (DBCA 2014). The KPI for the marine park are summarised in **Table** 5-13.

5.8.5 Rowley Shoals Marine Park

The Rowley Shoals comprise three oceanic reef systems approximately 30–40 km apart, namely Mermaid Reef, Clerke Reef and Imperieuse Reef (DEC, 2007b). The Rowley Shoals Marine Park comprises the Clerke and Imperieuse Reefs which lie in State Waters. The Rowley Shoals Marine Park was originally gazetted on 25 May 1990 as a Class A reserve and on 10 December 2004 the boundary was amended to extend the Park to the State Waters limit (DEC, 2007b). The Park now covers approximately 87,632 ha (DEC, 2007b). Mermaid Reef lies in Commonwealth waters and comprises the Mermaid Reef Marine National Nature Reserve managed by the Commonwealth Department of Agriculture, Water and Energy (DAWE) (DEWHA 2008).

The Rowley Shoals Marine Park is characterised by intertidal and subtidal coral reefs, diverse marine fauna and high water quality. These attributes and the low level of use of the area contribute to the Park's unique wilderness qualities, which are a significant draw card for visitors. Due to contrasting depths, the Rowley Shoals supports a diverse marine invertebrate community including a number of endemic species. Invertebrate species (excluding corals) at the Rowley Shoals include sponges, cnidarians (jellyfish, anemones), worms, bryozoans (sea mosses), crustaceans (crabs, lobsters, etc.), molluscs (cuttlefish, baler shells, giant clams, etc.), echinoderms (starfish, sea urchins) and sea squirts (DEC & MPRA 2007b). The remoteness of the Shoals and low use have ensured that the marine environment of the Shoals is in a near natural state, particularly relative to other reefs in the Indo-West Pacific region which are subject to intense ongoing human pressures and destructive fishing practices.

Imperieuse Reef is 16 km x 8 km and includes a small sand cay ~3.7 m high and devoid of vegetation (Cunningham Islet) within the northern extremity of the reef. The south-eastern edge has coral boulders that rise 3 m above the water mark while large areas of the reef dry out at low water and there are two lagoons contain coral patches within. Clerke Reef lays 23 km north-west of Imperieuse Reef and is 15 km x 6 km in size. Near the northern end of the reef lies Bedwell Islet, a bare sand cay about 2 m high which is a nesting site for the red-tailed tropic bird (DEC 2007). On the eastern and western sides of the reef there are a number of boulders which fall dry. A narrow passage leads to a lagoon, with many detached coral patches within the reef.

The major habitats of the area include intertidal and subtidal reefs that comprise the typical coral atoll formation and are home to many reef-associated species. Surveys carried out by the Western Australian Museum identified 184 species of corals, primarily Indo-West Pacific species, indicating the strong affinity of the Rowley Shoals communities with Indonesia. In terms of other species, at least 264 species of molluscs, 82 species of echinoderms and 389 species of finfish were also identified. Many of these records were new to WA, reflecting the significant differences between the offshore Indo-Pacific fauna and inshore WA coastal fauna. The faunal assemblages of the Rowley Shoals Marine Park are regionally significant as they contain large numbers of species not found in the more turbid coastal environments of tropical Western Australia (DEC 2007).

Sparse seagrass is found within subtidal coral reef communities of the Rowley Shoals but is not a major habitat type. Although macroalgae is present at the Rowley Shoals, it is not recognised as a key habitat component in the Mermaid Reef Marine National Nature Reserve Plan of Management (EA 2000) or the Rowley Shoals Marine Park Management Plan (DEC & MPRA 2007b) and there is nothing to suggest that it is unique within the Indo-Pacific (Huisman et al. 2009).

The Rowley Shoals are a known foraging area for migratory birds, foraging area for the green and hawksbill turtle, and provide habitat to numerous sharks.

The Rowley Shoals are of national and international significance and provide an important global benchmark for Indo-West Pacific reefs (DEC 2007). Further information is available in the Rowley Shoals Marine Park Management Plan 2007-2017 (DEC 2007). The KPI for the marine park are summarised in **Table** 5-13.

5.8.6 5.8.6 Summary of Values and Sensitivities for State Marine Reserves within the Operational Area and EMBA

Table 5-13 summarises the State marine reserves that may be affected by unplanned events that may arise within a larger EMBA.

Table 5-13: Summary of Environmental Values and Sensitivities for State Marine Reserves

State Marine Reserves	Environmental value	KPI's	Sensitivities within the Operational Area	Sensitivities within the EMBA
Montebello Island Marine Park	Comprise over 100 islands, with habitats including rocky shorelines, coral reefs, mangroves, intertidal flats, extensive sheltered lagunal waters, and shallow algal and seagrass reef platform. Contains important nesting/breeding and foraging sites for turtles, nesting and resting areas for migrating shorebirds, seabird nesting areas, dugong foraging areas, globally unique mangrove communities, and highly diverse fish and invertebrate assemblages.	Coral reef communities Mangrove communities Macroalgae and seagrass Turtles Fin fish Water quality	**No**	**Yes –** oil could potentially reach shoreline, intertidal and shallow subtidal habitats as well as Marine species using these habitats (e.g. turtles, seabirds, shorebirds, dugongs)
Barrow Island Marine Park	Includes Biggada Reef, an ecologically significant fringing reef, and Turtle Bay, an important turtle aggregation and breeding area. Includes representative areas of seagrass, macroalgal and deepwater habitat.	Coral reef communities Mangrove communities Macroalgae and seagrass Turtles Fin fish Water quality	**No**	**Yes –** oil could potentially reach and coat shoreline, intertidal and shallow subtidal habitats as well as marine species using these habitats (e.g. turtles)

State Marine Reserves	Environmental value	KPI's	Sensitivities within the Operational Area	Sensitivities within the EMBA
Barrow Island Marine Management Area	Includes most of the waters around Barrow Island, the Lowendal Islands and the Barrow Island Marine Park. Includes Bandicoot Bay Conservation Area on the southern coast of Barrow Island created to protect benthic fauna and seabirds. It includes the largest intertidal sand/mudflat community in the reserves and is an important feeding area for migratory birds. Includes significant breeding and nesting areas for marine turtles, important coral reefs and unique mangrove communities.		**No**	**Yes –** oil could potentially reach and coat shoreline, intertidal and shallow subtidal habitats as well as marine species using these habitats (e.g. turtles and migratory shorebirds)
Muiron Island Marine Management Area	Adjacent to Ningaloo Marine Park around Muiron Island. Regionally significant loggerhead turtle nesting beaches. Contains coral reef and macroalgae habitat.	Coral reef communities Water quality Coastal biological communities Finfish Mangrove communities Turtles Seascapes Wilderness	**No**	**Yes –** oil could potentially reach and coat shoreline, intertidal and shallow subtidal habitats as well as marine species using these habitats (e.g. turtles) or aggregating/migrating offshore from these habitats (whale sharks and whales)

State Marine Reserves	Environmental value	KPI's	Sensitivities within the Operational Area	Sensitivities within the EMBA
Ningaloo Marine Park	Extensive fringing reef and lagoonal system. Supports high diversity of corals, molluscs, fish, crustaceans and sponges. Important habitat for protected and iconic turtles (foraging and nesting), whales (migrating and resting) and whale sharks (feeding aggregations) as well as sea and shorebirds.	Coral reef communities Water quality Coastal biological communities Finfish Mangrove communities Turtles Seascapes Wilderness	**No**	**Yes –** oil could potentially reach and coat shoreline, intertidal and shallow subtidal habitats as well as marine species using these habitats (e.g. turtles and migratory shorebirds) or aggregating/migrating offshore from these habitats (whale sharks and whales)
Eighty-mile Beach Marine Park	Contains Ramsar site and one of the world's most important feeding grounds for migratory shorebirds and wetland birds. Also supports dugongs, inshore dolphins, sharks, rays, tropical fish, sponges, coral reefs and several threatened turtle species. Significant nesting population of flatback turtles within the park.	Intertidal sand and mudflat communities Mangrove communities and salt marshes Waterbirds including migratory species Marine turtles (also see species info on other tab) Scalefish Remote seascapes	**No**	**Yes –** oil could potentially reach and coat shoreline, intertidal and shallow subtidal habitats as well as marine species using these habitats (e.g. turtles, dugongs, dolphins and migratory shorebirds).

State Marine Reserves	Environmental value	KPI's	Sensitivities within the Operational Area	Sensitivities within the EMBA
Rowley Shoals Marine Park	Comprises the Clerke and Imperieuse Reefs. Characterised by intertidal and subtidal coral reefs, rich and diverse marine fauna and high water quality. Shoals are thought to provide a source of invertebrate and fish recruits for reefs further south and as such are regionally significant The Rowley Shoals provide an important global benchmark for Indo- West Pacific reefs	Water quality Intertidal coral reef communities Subtidal reef communities Invertebrates Fin fish Seascapes Wilderness	**No**	**Yes –** oil could potentially reach and coat shoreline, intertidal and shallow subtidal habitats as well as marine species using these habitats (e.g. turtles, seabirds, cetaceans)

5.9 Socio-Economic Environment

The Stag Field is approximately 60 km offshore from the Port of Dampier. Smaller coastal fishing and tourism settlements occur at Onslow, approximately 200 km to the south, and Point Samson, some 100 km to the southeast.

Dampier, Karratha and Port Hedland are the main service and population centres for the region. Although initially developed for the iron ore industry, these towns have expanded to service the oil and gas industry located on the North-West Shelf (NWS).

5.9.1 Commercial Fisheries and Aquaculture

Offshore and coastal waters in the NWS region support a valuable and diverse commercial fishing industry, dominated by Pilbara fisheries. The major fisheries in the Pilbara region target tropical finfish, large pelagic fish species, crustaceans (prawns and scampi) and pearl oysters (AFMA, 2011; Fletcher and Santoro, 2013).

<u>Commonwealth Fisheries</u>

Commonwealth fisheries are those within the 200-nautical mile Australian Fishing Zone (AFZ) managed by Australian Fisheries Management Authority (AFMA) and are, on the high seas, and, in some cases, by agreement with the States and Territory, to the low water mark. Commonwealth managed fisheries are permitted to operate within Stag Operational area (not including restricted zone) and EMBA, but effective fishing effort is either non-existent or of very limited nature (**Table** 5-14).

The North-West Slope Trawl Fishery (NWSTF) fishery is limited to waters deeper than 200 m isobath and so does not overlap the operational area, although it did have active fishing in 2014/2015 within the EMBA. It must be noted that only one vessel was active (CoA 2016).

The boundary of the Western Deepwater Trawl Fishery (WDTF) management area is more than 100 km from the operational area but is overlapped by the EMBA. However, no fishing was undertaken in the 14/15 season, and prior to that, effort was south off Shark Bay and limited to only three vessels (CoA 2016).

Other Commonwealth fisheries, such as the Western Tuna and Billfish Fishery (WTBF), Southern Bluefin Tuna Fishery (SBFTF) and the Skipjack Tuna Fishery (Western; WSTF), refer **Figure 5-13**, although licenced to fish in the region, have had no historical fishing effort reported near the Operational Area or within the EMBA (CoA 2016).

A summary of Commonwealth and State managed fisheries operating in the vicinity of the Stag Facility is provided in **Table 5-12** and **Table** 5-14.

<u>State Fisheries</u>

State fisheries are managed by the WA Department of Fisheries (DoF) with specific management plans, regulations and a variety of subsidiary regulatory instruments under the Fish Resources Management Act 1994 (WA). The information provided on State managed fisheries has been derived from the State of Fisheries Report 2014/2015 (Fletcher and Santoro, 2015). Commercial fishery zones that have boundaries that overlap the Stag Facility Operational Area are listed below, presented in **Figure 5-14** and summarised in **Table 5-12**.

North Coast Bioregion

- Onslow Prawn Managed Fishery (OPMF);
- Mackerel Managed Fishery (all areas) (MF);
- Pilbara Demersal Scalefish Fishery (Line, Trap and Trawl);
- Pearl Oyster Managed Fishery; and
- Pilbara Developing Crab Fishery.

Whole of State Fisheries

- Beche-de-mer Fishery;

- Marine Aquarium Fish Fishery; and
- Specimen Shell Managed Fishery.

While some fisheries have permitted fishing zones that overlap the Operational Area (**Figure 5-13**), not all have significant fishing effort in this area **Table** 5-14. The Stag location is too deep for any dive based fisheries (i.e. Pearl Oyster, Roe's Abalone, Beche-de-Mer, Marine Aquarium Fish, Specimen Shell Fishery), is too far offshore for the prawn Fisheries and does not contain seabed features or reef that attract target species within the Mackerel Fishery or Pilbara Trap Fishery. The Operational Area also represents a 500m restricted zone around Stag Facility infrastructure where fishing is prohibited.

Fisheries that do not overlap the operational area but are overlapped by the EMBA include:

North Coast Bioregion

- Nickol Bay Prawn Managed Fishery (NBMF);
- Broome Prawn Managed Fishery (BMF);
- The Kimberley Gillnet and Barramundi Managed Fishery (KGBF);
- Northern Demersal Scalefish Managed Fishery (NDSF);
- WA North Coast Shark Fishery; and
- Pilbara Developing crab Fishery.

Gascoyne Coast Bioregion

- Exmouth Gulf Prawn Fishery;
- Gascoyne Demersal Scalefish Fishery.

West Coast Bioregion

- Roe's Abalone Fishery; and
- West Coast Rock Lobster Managed Fishery.

Whole of State Fisheries

- West Coast Deep Sea Crab (Interim) Managed Fishery.

<u>Aquaculture</u>

The only aquaculture activity within the EMBA is pearl farming of pearl oysters (Pinctada maxima) in protected waters (Fletcher and Santoro, 2015). Pearl farm locations within the EMBA are at the Montebello Islands.

5.9.2 Recreational Fisheries

Recreational fisheries and charter boat operators are managed by the DoF; the area covered by the EMBA of this EP falls primarily within the North Coast Bioregion (Fletcher and Santoro, 2012). Within the North Coast Bioregion, recreational fishing is experiencing significant growth, with a distinct seasonal peak in winter when the local population increases significantly from tourists visiting the Exmouth/Onslow area and Dampier Archipelago (Fletcher and Santoro, 2012). Increased recreational fishing has also been attributed to those involved in the construction or operation of developments within the region. Offshore islands, coral reefs and continental shelf provide species of major recreational interest including saddletail snapper, red emperor, cods, coral and coronation trout, sharks, trevally, tuskfish, tunas, mackerels and billfish (Fletcher and Santoro, 2012). Advice received from DoF (pers. com. C. Telfer, 2012) indicates that charter boat fishing effort in permit area WA-15-L has been recorded in the last five years. Offshore shoals, such as Glomar Shoals and Rankin Bank attract occasional recreational and charter boat visitations, however these trips are generally of a short duration and sporadic. The distance of these destinations offshore means that only a limited number recreational fishing trips can be expected each year.

Table 5-14: Fisheries Resources

North Coast Bioregion			
Fishery or resource	***Catch returns recorded in past 3 years (noting if any returns in North-West Shelf Bioregional province)***	***Are breeding stocks/ effort for target species in fishery acceptable?***	***Permitted fishing method***
North Coast Prawn Managed Fisheries (including Onslow Prawn Managed Fishery; Nickol Bay Prawn Managed Fishery; Broome Prawn Managed Fishery and Kimberley Prawn Managed Fishery)	Yes (including NWS)	Yes	Otter trawl
North Coast Nearshore and Estuarine Fishery resource (including Kimberley Gillnet & Barramundi Managed Fishery)	Yes	Yes	Gill net
North Coast Demersal Fisheries (including Pilbara Fish Trawl (Interim) Managed Fishery, Pilbara Trap and Line Managed Fishery and Northern Demersal Scalefish Managed Fishery)	Yes (including NWS)	Yes	Hand/ dropline, fish traps
Mackerel Managed Fishery	Yes (including NWS)	Yes	Trolling, jig or handline
Pearl Oyster Managed Fishery	Yes (including NWS)	Yes	Hand collection
Beche-de-mer Fishery	Yes (including NWS)	Yes	Hand collection
North Coast Crab Fishery (including Kimberley Developing Mud Crab Fishery and Pilbara Developmental Crab Fishery)	Yes (including NWS)	Yes	Baited traps, trawl
North-West Slope Trawl	Yes	Not reported	Trawl
Northern Prawn Fishery	Yes (note limited extent of fishery in Area of Interest)	Yes	Trawl
Skipjack Tuna Fishery			
Small Pelagic Fishery			
Southern Bluefin Tuna Fishery			
The Western Deepwater Trawl	Yes	Yes	Trawl
Western Tuna and Billfish Fishery (WTBF)	Yes	No (Striped Marlin overfished)	Longline

Within the Operational Area there are no known natural seabed features that would aggregate fishes and which are typically targeted by recreational fishers. However, the Stag CPF, pipeline, CALM buoy and associated vessels are likely to attract pelagic fish and therefore could also attract recreational fishers target pelagic species. Nevertheless, fishing in the immediate vicinity of the Stag facilities is not permitted since a 500 m Restricted Zone is in place. This could have an impact on requiring extra distance travelled when traversing the region, how this would be small compared to total distance travelled in any trip given the remoteness of the location.

5.9.3 Oil and Gas Industry

The surrounding waters are also used for petroleum exploration and development. The nearest production activities to the Stag Facility include:

- Wandoo Production Platforms located in Exploration Permit WA-14-L, ~ 20 km northeast; and
- Gas pipelines run from the Reindeer platform (~ 29 km north) to the mainland (north to south). To the east (~ 6 km), another gas pipeline runs east to west, ~ 10 km north of the Stag Facility.

5.9.4 Commercial Shipping

Commercial shipping moves through the offshore waters en route to or from the marine terminals at Thevenard, Barrow and Varanus Islands. Shipping using NWS waters includes iron ore carriers, third-party tankers and other vessels proceeding to or from the ports of Dampier, Cape Preston, Port Walcott and Port Hedland; however, these are predominantly heading north from these ports. Large cargo vessels carrying freight bound or departing from Fremantle, transit along the WA coastline heading north and south in deeper waters. Shipping activities in relation to the Stag Operational Area are illustrated in **Figure 5-12**. The Stag platform is located 3.1 nautical miles (5.7 km) north-west of a shipping fairway that experiences heavy concentrations of commercial traffic as vessels transit into and out of Cape Preston and Barrow Island.

5.9.5 Tourism

Aquatic recreation such as boating, diving and fishing occurs near the coast and islands off the Pilbara and Ningaloo coast and to a lesser extent the Rowley Shoals. These activities are concentrated in the vicinity of the population centres such as Exmouth, Dampier and Onslow

Water-based tourism activities undertaken across NWS include:

- Whale watching;
- Recreational boating;
- Charter fishing;
- Snorkelling/diving;
- Surfing; and
- Recreational fishing.

In the waters immediately surrounding the Stag Facility, tourism activities are limited due to its distance from the mainland and island shorelines.

5.9.6 Native Title

Within the SEMBA any sheen or impact on environmental values may impact the associated cultural values or use. Within the SEMBA the following have been identified (NTT 2017):

- Schedule of Native Title Determination Applications;
- Register of Native Title Claims;
- Native Title Determinations;
- Register of Indigenous Land Use Agreements; and
- Notified Indigenous Land Use Agreements.

Table 5-15: Native title determinations

Native Title Determinations	
Karajarri People (Area A)	Native title exists (exclusive)
Karajarri People (Area B)	Native title exists (non-exclusive)
Ngarluma/Yindjibarndi	Native title exists (non-exclusive)
Rubibi Community	Native title exists (non-exclusive)
Ngarla and Ngarla #2 (Determination Area A)	Native title exists (non-exclusive)
Registered Native Title Claims	
Yaburara & Mardudhunera People	Accepted for registration
Gnulli	Accepted for registration
Kariyarra People	Accepted for registration
Jabirr Jabirr	Accepted for registration
Goolarabooloo People	Accepted for registration
Bindunbur	Accepted for registration
Indigenous Land Use Agreements	
Yawuru Prescribed Body Corporate ILUA - Broome	ILUA registered
Yawuru Area Agreement ILUA	ILUA registered
RTIO Ngarluma Indigenous Land Use Agreement (Body Corporate Agreement)	ILUA registered
Kuruma Marthudunera and Yaburara and Coastal Mardudhunera Indigenous Land Use Agreement	ILUA registered
Anketell Port, Infrastructure Corridor and Industrial Estates Agreement	ILUA registered
Cape Preston Project Deed (YM Mardie ILUA)	ILUA registered
Yawuru Nagulagun / Roebuck Bay Marine Park ILUA	ILUA registered
FMG – Kariyarra Land Access ILUA	ILUA accepted for notification

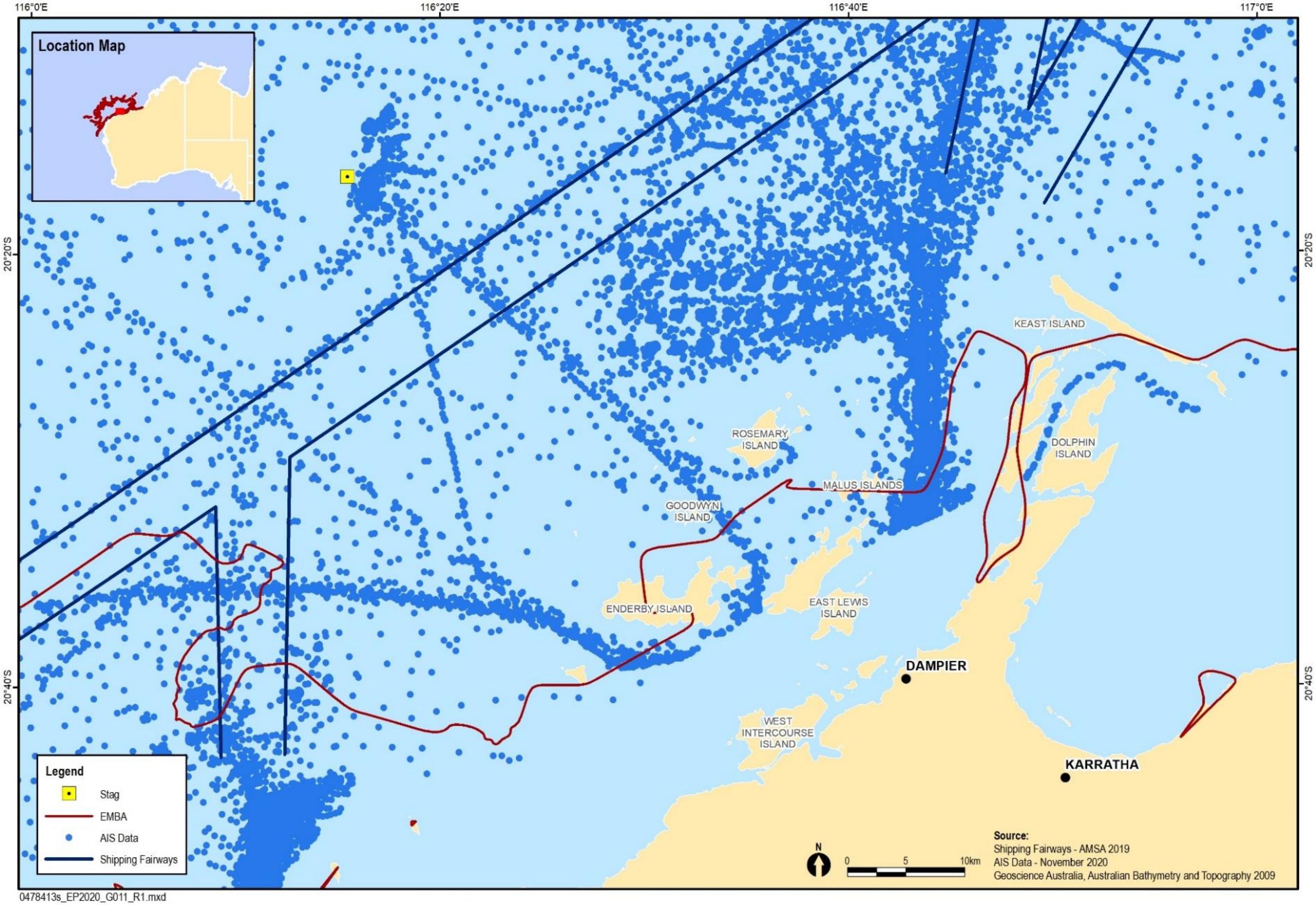


Figure 5-12: AMSA shipping records and designated shipping routes in the vicinity of the Stag Field (AMSA 2016)

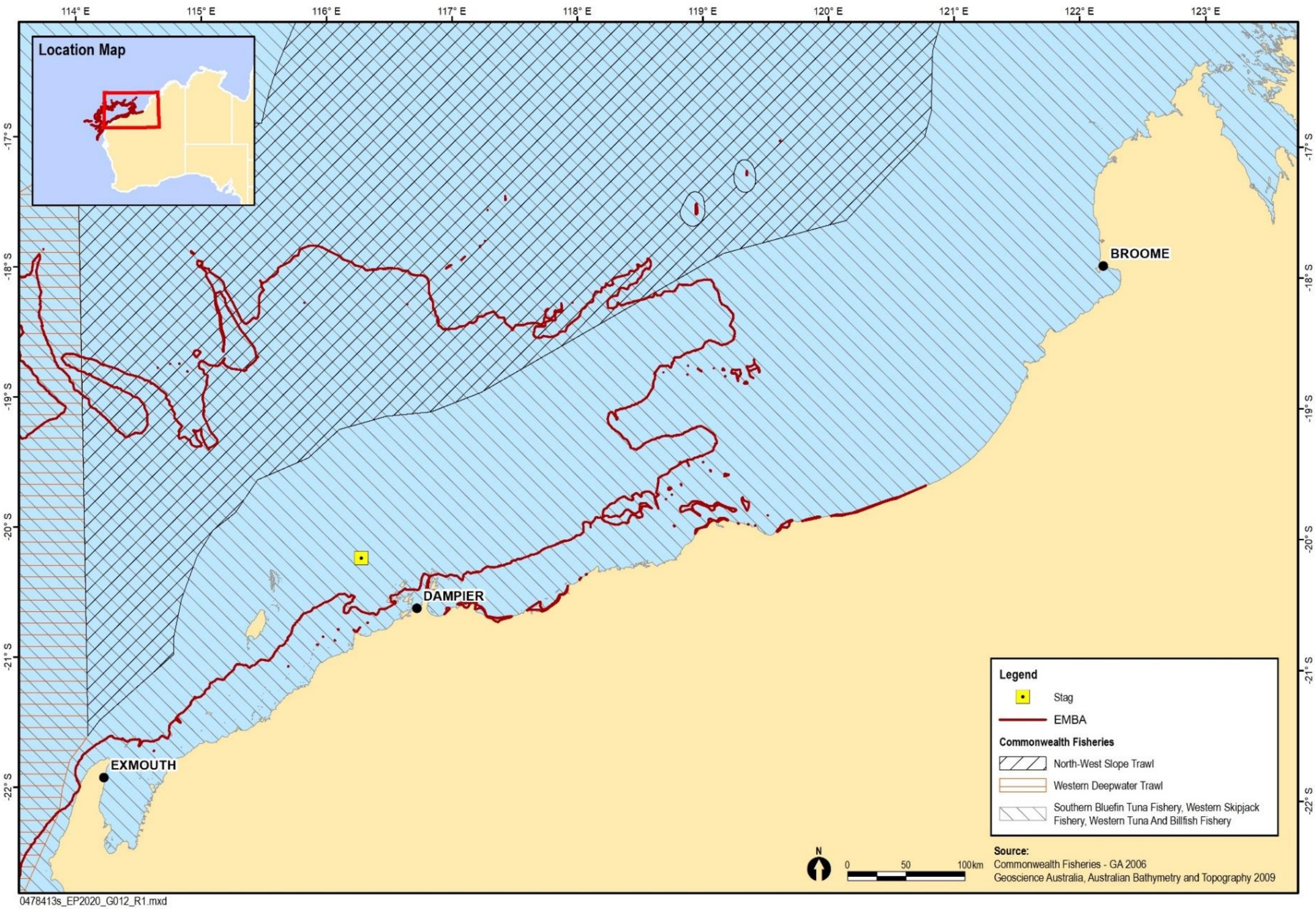


Figure 5-13: Commonwealth Commercial Fishing Zones in the vicinity of the Stag facility

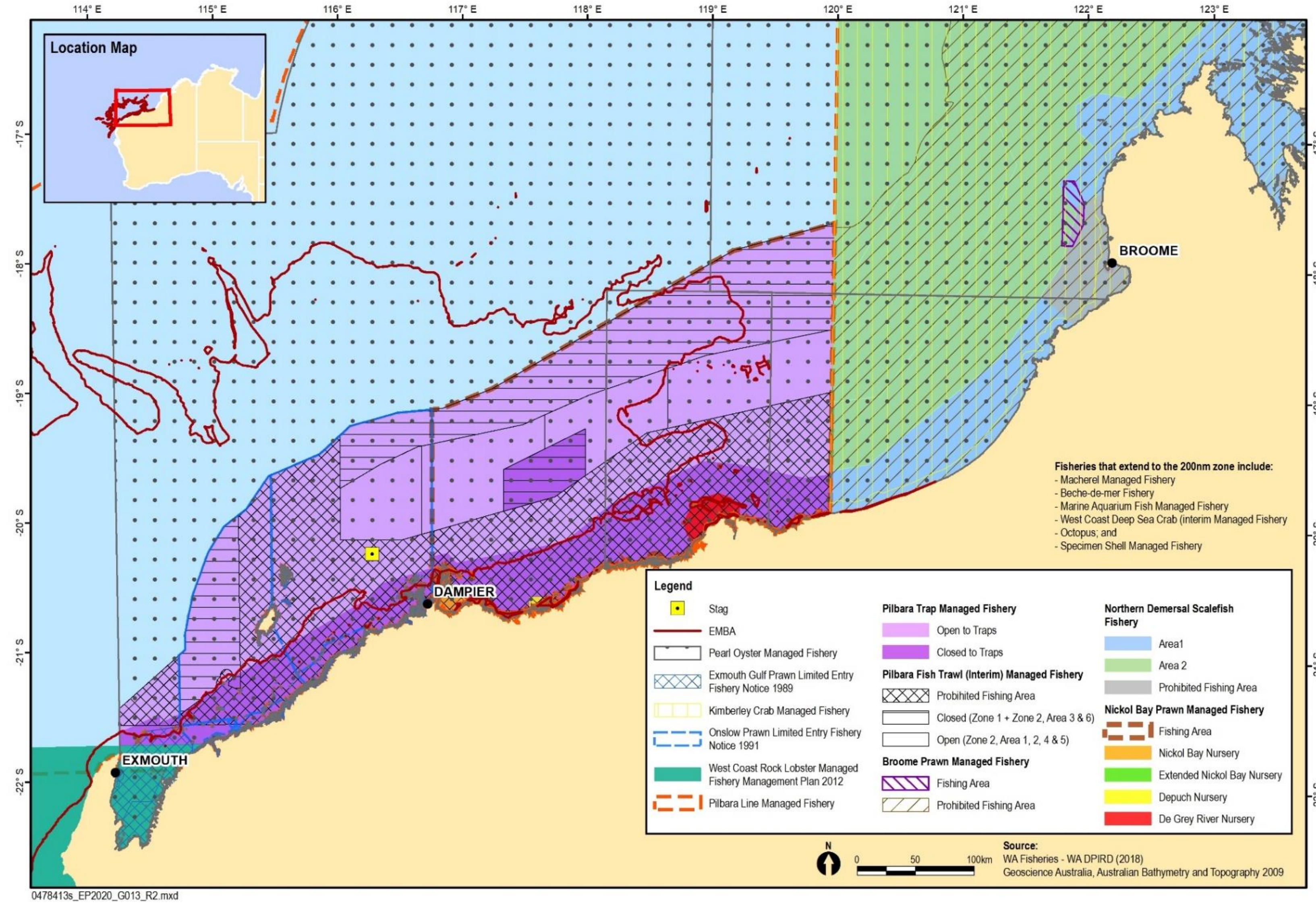


Figure 5-14: State Commercial Fishing Zones in the Vicinity of the Stag Facility

Table 5-16: Summary of Commercial Fisheries licences to fish in the vicinity of the Stag Facility Operational Area or EMBA

Fishery	Target Species	Fishing Method and Area
Commonwealth-managed Fisheries		
North-West Slope Trawl	Scampi (crayfish): velvet scampi (*Metanephrops velutinus*) and boschmai scampi (*Metanephrops boschmai*). Deepwater prawns (penaeid and carid): pink prawn (*Parapenaeus longirostris*), red prawn (*Aristaeomorpha foliacea*), striped prawn (*Aristeus virilis*), giant scarlet prawn (*Aristaeopsis edwardsiana*), red carid prawn (*Heterocarpus woodmasoni*) and white carid prawn (*Heterocarpus sibogae*).	Demersal trawl seaward of the 200m isobath, but no current effort in vicinity of the operational area and limited effort within EMBA. Only 1 vessel active in 2014/15
Western Deepwater Trawl	Deepwater bugs and ruby snapper are the target species.	Demersal trawl seaward of the 200m isobath, and west of North-West Cape – does not overlap operational area, but small overlap of EMBA. No fishing was undertaken in the 14/15 season, and prior to that, effort was south off Shark Bay and limited to only three vessels.
Western Skipjack	Skipjack tuna (*Katsuwonus pelamis*) is the only target species. Landings of species other than skipjack (may include bigeye (*Thunnus obesus*), and yellowfin tuna (*T. albacares*), frigate mackerel (*Auxis thazard*), sharks, mahi mahi, rays and marlins are believed to be much less than 2% of the total landings.	Purse seine November to June. Historically fishing limited to waters off SA and not WA. No fishing effort since 2008-2009 (CoA 2016)
Western Tuna and Billfish	Broadbill swordfish (*Xiphias gladius*), yellowfin tuna, bigeye tuna, albacore tuna (*Thunnus alalunga*) and longtail tuna (*T. tonggol*).	Pelagic longline year-round. Historically effort has concentrated off south-west WA and SA (CoA 2016). No current effort on the NWS.
Southern Bluefin Tuna	Southern bluefin tuna (*Thunnus maccoyii*).	Most of the Australian catch is taken by purse-seine vessels in the Great Australian (CoA 2016). No current effort on the NWS.

Fishery	Target Species	Fishing Method and Area
State-managed Fisheries		
Onslow Prawn Managed Fishery	Western king prawn (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*) and endeavour prawns (*Metapenaeus* spp.)	Otter trawls used within the boundaries of the OPMF being 'all the Western Australian waters between the Exmouth Prawn Fishery and the Nickol Bay prawn fishery east of 114º39.9' on the landward side of the 200m depth isobath. The 2014 season opened on 21 April and closed on 8 October, and only 1 vessel fished
Nickol Bay Prawn Managed Fishery	Primarily targets banana prawns (*Penaeus merguiensis*)	Otter trawls used within the boundaries of the NBPMF being 'all the waters of the Indian Ocean and Nickol Bay between 116°45' east longitude and 120° east longitude on the landward side of the 200m isobath. The 2014 season opened on 24 March and closed on 31 October. 7 vessels fished intermittently in 2014.
Broome Prawn Managed Fishery	Western king prawns (*Penaeus latisulcatus*) and coral prawns (a combined category of small penaeid species)	Otter trawls used within the boundaries of the BPF being all Western Australian waters of the Indian Ocean lying east of 120° east longitude and west of 123°45' east longitude on the landward side of the 200m isobath. The Fishery opened on 1 June and officially closed on 8 Oct. Fishing effort limited to waters off Broome. No vessels fished in 2014
The Kimberley Gillnet and Barramundi Managed Fishery	Primarily Barramundi (*Lates calcarifer*), king threadfin (*Polydactylus macrochir*) and blue threadfin (*Eleutheronema tetradactylum*)	Operates in the nearshore and estuarine zones of the North Coast Bioregion from the WA/NT border (129ºE) to the top end of Eighty Mile Beach, south of Broome (19ºS). In late 2013, Roebuck Bay and the northern end of Eighty Mile Beach to 19ºS were closed to commercial fishing. Encompasses the taking of any fish by means of gillnet in inshore waters and estuarine waters (0-20m) the taking of barramundi (*Lates calcarifer*) by any means.
Northern Demersal Scalefish Managed Fishery (NDSF)	The main species landed by this fishery are red emperor and goldband snapper	Demersal traps are used within waters off the north coast of Western Australia east of longitude 120°E. These waters extend out to the edge of the Australian Fishing Zone. 8 Vessels fished in 2014.

Fishery	Target Species	Fishing Method and Area
Mackerel Managed Fishery	Spanish and grey mackerel	Trolling or handline year-round in all waters to the 200-nautical mile AFZ between 114º E to 121º. Fishing effort recorded within EMBA for Area 2 (Pilbara). 11 vessels operated in 2014.
Pilbara Demersal Scalefish Fishery (Line, Trawl and Trap)	Variety of demersal scalefish including goldband snapper (*Pristipomoides multidens*), red emperor (*Lutjanus sebae*) and bluespotted emperor (*Lethrinus punctulatus*).	Demersal trawl and trap in various zones and operate year-round. Trawl area is closed within operational area, but trap fishing is permitted. Northern portion of EMBA overlies both trawl and trap areas. In 2014 3 vessels used in the Pilbara Fish Trawl Fishery; 3 vessels in the Trap Fishery; and 7 vessels in the line fishery.
Pearl Oyster Managed Fishery	Silver-lipped pearl oyster (*Pinctada maxima*)	Drift diving restricted to shallow divable depths generally less than 35 m. In 2014 catch was taken from Zones 1 and 2/3. Main area though is zone 2/3.
WA North Coast Shark Fishery	Sandbar (*Carcharhinus plumbeus*), blacktip (*Carcharhinus* spp.), tiger (*Galeocerdo cuvier*) and lemon (*Negaprion acutidens*) sharks	Area between North-West Cape and a line of longitude at 120° E and all waters south of latitude 18° S has been closed indefinitely to protect shark stocks.
Pilbara Developing Crab Fishery	Blue swimmer crab (*Portunus armatus*)	Hourglass traps used in inshore waters from Onslow through to Port Hedland with most commercial and activity occurring in and around Nickol Bay.
Exmouth Gulf Prawn Fishery	Target western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.) and banana prawns (*Penaeus merguiensis*).	Otter trawls used within Exmouth Gulf. In 2014, 6 boats trawled.

Fishery	Target Species	Fishing Method and Area
Gascoyne Demersal Scalefish Fishery	A range of demersal species including pink snapper (*Pagrus auratus*), goldband snapper (*Pristipomoides* spp., mainly *P. multidens*), red emperor (*Lutjanus sebae*), emperors (Lethrinidae, includes spangled emperor, *Lethrinus nebulosus*, and redthroat emperor, *L. miniatus*), cods (Serranidae), ruby snapper (*Etelis carbunculus*), pearl perch (*Glaucosoma burgeri*), mulloway (*Argyrosomus japonicus*), amberjack (*Seriola dumerili*) and trevallies (Carangidae).	The GDSF licensed vessels fish throughout the year with mechanised handlines in the waters of the Indian Ocean and Shark Bay between latitudes 23°07'30"S and 26°30'S. Peak fishing period for pink snapper is June-July when the oceanic stock aggregates to spawn. In 2014, 17 vessels actively fished.
West Coast Rock Lobster Managed Fishery	Western rock lobster (*Panulirus cygnus*)	Baited pots fished along the west coast of Australia. between Latitudes 21°44´ to 34°24´ S
Beche-de-mer Managed Fishery	Sandfish (*Holothuria scabra*) and deepwater redfish (*Actinopyga echinites*).	Hand-harvest fishery, animals caught principally by diving (restricted to diving depths) and a smaller amount by wading.
Marine Aquarium Fish Managed Fishery	Fish, coral, algae, live rock	Dive based fishery operating all year throughout WA waters, but restricted by diving depths
Specimen Shell Managed Fishery	Shells (cowries, cones)	Dive based fishery operating all year throughout WA waters, but restricted by diving depths
West Coast Deep Sea Crustacean Managed Fishery	Crystal (Snow) crabs (*Chaceon albus*), Giant (King) crabs (*Pseudocarcinus gigas*) and Champagne (Spiny) crabs (*Hypothalassia acerba*)	Baited pots in waters lying north of latitude 34° 24' S (Cape Leeuwin) and west of the Northern Territory border on the seaward side of the 150m isobath out to the extent of the Australian Fishing Zone, mostly in 500 to 800 m of water. Year round.

Source: CoA (2016); Fletcher and Santoro (2015)

5.9.7 Summary of Values and Sensitivities of the Socio-Economic Environment within Operational Area and EMBAs

Table 5-17 outlines those socioeconomic values that may be affected by routine events at the Stag Facility within the Operational Area as well as unplanned events that may arise within a potentially larger area (EMBA).

Table 5-17: Summary of Socio-economic values and sensitivities

Socio-economic value		Sensitivities within Operational Area	Sensitivities within EMBA
Commonwealth fisheries	North-West Slope Trawl	**No** – Not within Operational Area, restricted to depths >200 m	**Yes** – Limited effort within EMBA seaward of 200 m isobaths. Oil could disrupt fishing activity and potentially contact eggs and larvae of target species although no direct contact with target species.
	Western Deepwater Trawl Fishery	**No** – Not within Operational Area, restricted to depths >200 m and south of Operational Area	**Yes** – Limited effort within EMBA seaward of 200 m isobaths, unlikely that area of EMBA would be fished. Oil could disrupt fishing activity and potentially contact eggs and larvae of target species although no direct contact with target species.
	Western Skipjack	**No** - No effort on the NWS	**No** - No effort on the NWS
	Western Tuna and Billfish	**No** - No effort on the NWS	**No** - No effort on the NWS
	Southern Bluefin Tuna	**No** - No effort on the NWS	**No** - No effort on the NWS
State fisheries	Onslow Prawn Managed Fishery	**No -** Effort within coastal areas	**Yes** – oil may reach shallow coastal waters and shorelines (most likely in Area 3 of fishery) affecting fishery habitat and fishing activity
	Nickol Bay Prawn Managed Fishery	**No -** Effort within coastal areas	**Yes** – oil may reach shallow coastal waters and shorelines affecting fishery habitat and fishing activity
	Broome Prawn Managed Fishery	**No -** Effort within coastal areas	**Yes** – oil may reach shallow coastal waters and shorelines affecting fishery habitat and fishing activity
	The Kimberley Gillnet and Barramundi Managed Fishery	**No -** Effort within coastal areas	**Yes** – oil may reach shallow coastal waters and shorelines affecting fishery habitat and fishing activity
	Northern Demersal Scalefish Managed Fishery	**No –** No overlap with fishing zones	**Yes** – Oil may enter Area 1 and 2 of the fishery. Oil may interact with demersal fish, eggs and larvae within the plankton assemblage. Oil may interfere with fishing activities.

Socio-economic value		Sensitivities within Operational Area	Sensitivities within EMBA
	Mackerel Managed Fishery	**Yes** - Area 2 overlaps Operational Area but interaction unlikely as fishery targets coastal reefs and headlands <40 m and 500 m restricted zone exists around Stag Facility.	**Yes** – Areas 1, 2 and 3 may be impacted by oil. Adult fish unlikely to be impacted due to depth of their habitat but eggs and larvae within plankton assemblage and shallow coastal juvenile fish habitat may be contacted by oil.
	Pilbara Demersal Scalefish Fishery (Line, Trap and Trawl)	**Yes** – Trap fishing zone only overlaps Operational Area but interaction unlikely as fishery targets reef areas (no reef areas exist near Operational Area) and 500 m restricted zone exists around Stag Facility.	**Yes** – Trawl, Trap and Line fishing activities may be disrupted by an oil spill. Adult demersal fish unlikely to be impacted due to depth of their habitat but eggs and larvae within plankton assemblage and shallow coastal juvenile fish habitat may be contacted by oil.
	Pearl Oyster Managed Fishery	**No** – Zone 1 overlaps Operational Area but collection of pearl oysters is performed by diving and Operational Area is beyond dive-able depths for the fishery. A 500 m restricted zone also exists around Stag Facility.	**Yes** – Fishing activity in Zones 1, 2 and 3 could be disrupted by an oil spill. Shallow water habitats and pearls could be directly impacted by oil but most likely would remain underneath floating oil.
	WA North Coast Shark Fishery	**No** – Shark fishery closed in vicinity of the Operational Area	**No** – fishery has been closed since 2009.
	Pilbara Developing Crab Fishery.	**No** – Fishing occurs in coastal waters inshore of the Operational Area	**Yes** - Fishing activity between Onslow and Port Hedland could be disrupted by an oil spill and oil could contact the shallow coastal habitats used by blue swimmer crabs.
	Exmouth Gulf Prawn Fishery	**No –** Fishing occurs within Exmouth Gulf only	**Yes** – EMBA boundaries indicate small degree of overlap only possible with the fishery. Fishing activity could be disrupted by an oil spill and oil could contact prawn eggs and larvae in upper water column.
	Gascoyne Demersal Scale Fishery	**No** – Restricted to Gascoyne waters and so permitted fishery management area does not overlap operational area.	**Yes** – EMBA boundaries indicate small degree of overlap possible with the fishery. Fishing activity could be disrupted by an oil spill and oil could contact demersal fish eggs and larvae in upper water column although no direct contact with target species.
	West Coast Rock Lobster Fishery	**No** – Restricted south of North-West Cape	**Yes** – EMBA boundaries indicate small degree of overlap possible with the fishery if fishing occurs off Ningaloo coastline. Fishing activity could be disrupted by an oil spill and oil could contact lobster eggs and larvae in upper water column although

Socio-economic value		Sensitivities within Operational Area	Sensitivities within EMBA
			benthic juveniles and adults are unlikely to be contacted.
	Beche-de-mer Managed Fishery	**No** – Restricted to shallow diveable depths or wading depths	**Yes -** Fishing activity between could be disrupted by an oil spill and oil could contact the shallow coastal habitats used by beche-de-mer, marine aquarium fish and specimen shell species.
	Marine Aquarium Fish Managed Fishery		
	Specimen Shell Fishery		
	West Coast Deep Sea Crustacean Managed Fishery	**No** – Fishery extends from 150 m contour therefore no overlap with Operational Area.	**Yes** – Fishing activities may be disrupted by an oil spill. Adult crabs unlikely to be impacted due to depth of their habitat but eggs and larvae within plankton assemblage may be contacted by oil.
Recreational fishery		**No** – Usually closer to land	**Yes** - Fishing activities may be disrupted by an oil spill. Target species and habitat or target species may be directly impacted by oil. Eggs and larvae of target species within the plankton community may also be contacted by oil.
Aquaculture		**No -** None within Operational Area	**Yes** – Pearl farming occurs within the EMBA at Montebello Islands. Oil could interfere with the production process or impact on pearl oysters directly through reduced water quality.
Oil and Gas		**No -** None within Operational Area	**Yes** - oil and gas activities within the EMBA could be disrupted by an oil spill.
Shipping		**Yes** - No designated shipping route within operational area with nearest located ~ 5 km northwest, other vessels may wish to transit the area although shipping traffic excluded from the Operational Area	**Yes** - Shipping routes are located within the EMBA. Shipping activities could be disrupted by an oil spill.
Tourism		**No** - None within operational area.	**Yes** - Tourist activities within coastal areas of EMBA could be disrupted and long term impact to tourism could occur if tourist areas (e.g. coral reefs, beaches) are impacted by oil.
Cultural Heritage		**No** - None within or near the Operational Area	**Yes** –oil entrained oil could potentially contact the subsea *Tryal* shipwreck at Trial Rocks NW of the Montebello islands

6. CONSULTATION OF RELEVANT PERSONS

6.1 Consultation Process and Feedback

Jadestone is required under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 to prepare a strategy for the identification and consultation of relevant persons for the activity. Jadestone has developed a Consultation Plan specific to the Stag Operations EP to address this requirement (refer **Appendix E**). Within this plan, the process is outlined for:

- Identification and classification of stakeholders;
- Justification for sufficiency of information; and
- Ongoing consultation.

Stag is an existing facility that has been in operation since 1998. The previous operator had a Consultation Strategy that incorporated updates to relevant persons of Stag related activities. As a result, relevant persons identified for Stag have been informed and consulted on a regular basis for some time. There are no new risks or changes to operations due to Jadestone becoming operator that have been identified. The scope of the Stakeholder Consultation Plan is limited to the ongoing consultation required to support the acceptance and duration of the EP, and covers ongoing Stag operations and planning for consultation in the event of any unplanned events as identified in the EP.

Relevant persons were originally identified and classified according to criteria outlined in the consultation plan based on their interest/ activity/ function for the operations activity in 2016 (**Table** 6-1). A review of the originally identified and classified relevant persons was undertaken in June 2020 when the operational activity was planned to change from having an FSO in field, to a third-party tanker. Given there is no change in the risks or impacts to relevant persons due to changed activities it was determined that generally no additional consultation was required (refer environmental performance standard 004). AMSA as a regulator now having jurisdiction of the tankers infield however, were notified of the change.

An assessment of the merit of concerns, objections and claims is provided in **Table** 6-2

As a result of applying the processes set out in the Stag EP Consultation Plan (**Appendix E**), no objections or claims about adverse impact were received in relation to the operation of the Stag facility. Some feedback and clarification was received which is summarised in **Table** 6-2.

Table 6-1: Relevant persons identified for the Stag Facility operations

Relevant persons	Classification	Engagement
Department of Defence (ADF Airspace, Australian Hydrographic Service (AHS) and Australian Navy)	Government	Involve
Department of Environment and Energy	Government	Consult
Department of Industry and Science	Government	Inform
NOPSEMA	Government	Involve
Western Australian Department of Transport	Government/Response organisation	Consult
Australian Maritime Safety Authority	Government/Response organisation	Collaborate
Australian Marine Oil Spill Centre (AMOSC)	Government/Response organisation	Collaborate

Relevant persons	Classification	Engagement
Minister for Environment & Energy	Government	Inform
Minister for Resources and Northern Australia	Government	Inform
Minister for Industry, Innovation & Science	Government	Inform
Member for Durack	Government	Inform
WA Department of Mines and Petroleum	Government	Consult
WA Department of Fisheries (now Department of Primary Industries and Regional Development)	Government	Consult
Department Parks and Wildlife	Government	Inform
Minister for Mines & Petroleum	Government	Inform
Minister for Fisheries	Government	Inform
Minister for Environment	Government	Inform
Minister for State Development; Transport	Government	Inform
Shadow Minister for State Development; Energy; Mines and Petroleum; Ports	Government	Inform
Member for Gosnells Shadow Minister for Environment	Government	Inform
Member for Pilbara	Government	Inform
Member for Mining and Pastoral	Government	Inform
Member for Mining and Pastoral	Government	Inform
Member for Mining and Pastoral	Government	Inform
Member for Mining and Pastoral	Government	Inform
Member for Mining and Pastoral	Government	Inform
Member for Mining and Pastoral	Government	Inform
Australian Fisheries Management Authority (AFMA)	Government	Inform
BHP	Interested party	Inform
Chevron Australia	Interested party	Inform
Eni Australia	Interested party	Inform
Quadrant Energy	Interested party	Inform
Vermillion Energy Inc	Interested party	Inform
A Raptis and Sons	Potentially affected party – unplanned event	Consult
Austral Fisheries	Potentially affected party – unplanned event	Consult
Australian South Bluefin Tuna Industry Association (ASBTIA)	Interested party	Consult

Relevant persons	Classification	Engagement
Commonwealth Fisheries Association (CFA)	Interested party	Consult
Marine Tourism WA	Interested party	Inform
MG Kailis Group	Potentially affected party – unplanned event	Consult
Ocean Wild Tuna	Potentially affected party – unplanned event	Consult
Pearl Producers Association	Potentially affected party – unplanned event	Consult
Recfishwest	Interested party	Consult
W.A. Seafoods Direct	Potentially affected party – unplanned event	Consult
Western Australian Fishing Industry Council (WAFIC)	Interested party	Consult
WestMore Seafoods & Shark Bay Seafoods	Potentially affected party – unplanned event	Consult
Pilbara Port Authority	Government	Inform
Dampier Port Authority	Government	Inform
City of Karratha	Interested parties	Inform
Karratha Chamber of Commerce and Industry	Interested parties	Inform
Mackerel Managed Fishery (State)	Potentially affected parties - operations	Consult
Pearl Oyster Fishery (State)	Potentially affected parties – operations	Consult
Onslow Prawn Managed Fishery (State)	Potentially affected parties – operations	Consult
Beche-de-mer Fishery (State)	Potentially affected parties – operations	Consult
Marine Aquarium Managed Fishery (State)	Potentially affected parties – operations	Consult
Specimen Shell Managed Fishery (State)	Potentially affected parties – operations	Consult
Pilbara Trawl Managed Fishery (State)	Potentially affected parties – operations	Consult
Pilbara Trap Managed Fishery (State)	Potentially affected parties – operations	Consult
Pilbara Line Fishery (State)	Potentially affected parties – operations	Consult
Pilbara Developing Crab Fishery (State)	Potentially affected parties – operations	Consult

Relevant persons	Classification	Engagement
Karajarri People	Potentially affected party – unplanned event	Inform
Ngarluma/Yindjibarndi	Potentially affected party – unplanned event	Inform
Rubibi Community	Potentially affected party – unplanned event	Inform
Ngarla	Potentially affected party – unplanned event	Inform
Yaburara & Mardudhunera People	Potentially affected party – unplanned event	Inform
Gnulli	Potentially affected party – unplanned event	Inform
Jabirr Jabirr	Potentially affected party – unplanned event	Inform
Goolarabooloo People	Potentially affected party – unplanned event	Inform
Bindunbur	Potentially affected party – unplanned event	Inform
Kimberley Land Council Aboriginal Corporation	Potentially affected party – unplanned event	Inform
Yamatji Marlpa Aboriginal Corporation	Potentially affected party – unplanned event	Inform
Australian Specimen Collectors Associated of WA	Interested party	Inform
Professional Specimen Shell Fishermen Association	Potentially affected party – unplanned event	Inform
North West Slope Trawl (Commonwealth)	Potentially affected party – unplanned event	Inform
Western Deepwater Trawl Fishery (Commonwealth)	Potentially affected party – unplanned event	Inform
Exmouth Game Fishing Club	Potentially affected party – unplanned event	Inform
Nickol Bay Sport Fishing Club	Potentially affected party – unplanned event	Inform
Onslow Visitor Centre	Potentially affected party – unplanned event	Inform
Port Hedland Game Fishing Club	Potentially affected party – unplanned event	Inform
Conservation Council of Western Australia	Interested party	Inform

Table 6-2: Assessment of Merit of Concerns, Objections and Claims, and Jadestone Response

Stakeholder	Stakeholder Concern, Objection or Claim	Jadestone Energy Assessment of merit	Jadestone Energy's Response
WA Department of Fisheries (now Department of Primary Industries and Regional Development) 1 Dec 2017	DoF acknowledged that the procedures and plans referenced in the EP including the Scientific Monitoring Plan would be Jadestone's responsibility, however DoF confirmed it was happy to provide advice during the development of these documents if desired.	***No objection, concern or claim.*** ***Request only:*** DoF is the key regulatory agency for the management of State fisheries and provides significant input for EP consideration. Jadestone Energy considers these comments and DoF input into the SMPs have merit.	DoF is listed as relevant person and will be advised of updates to the project, in addition to ongoing requests for advice as requested. DoF would be consulted during the implementation of any relevant SMP.
WA Department of Fisheries 19 Jul 2017	Key items raised by DoF regarding the Stag operational area were:	DoF is the key regulatory agency for the management of State fisheries and provides significant input for EP consideration.	
	Consultation Request for Jadestone Energy to consult with: • WAFIC, PPA, Recfishwest, and TOs • Individual commercial fishers and charter operators with entitlement to fish in the affected area	• Jadestone Energy agrees with DoF comments and has undertaken consultation with the representative bodies requested. Consultation with TO's will be triggered in event of spill. This is consistent with the approach applied to other stakeholders in the larger EMBA area. • Consultation with individual commercial operators has been undertaken. Charter operators were omitted from the original consultation in error and an additional mail-out to these operators will be undertaken.	Additional triggered consultation included in Table 9-2 for TO's in the event of a spill. **Trigger** – Oil spill event **Action** - Notification of DoF via environment@fish.wa.gov.au within 24 hours of incident report. Notification of TO's and all other stakeholders identified in Table 4 within 72 hours of event. Attempt to electronically notify all relevant persons listed in Stag EP Consultation plan within 72 hours of spill.

Stakeholder	Stakeholder Concern, Objection or Claim	Jadestone Energy Assessment of merit	Jadestone Energy's Response
			Jadestone Energy will implement consultation with Charter operators.
	Timeframes • Advice provided valid for duration of activity commencing within six months of the date this letter is signed. • Request to be advised of actual commencement date and any changes to this proposal a minimum of three months prior to the commencement of any activity. • Response to any updated advice provided at this time required.	Jadestone Energy considers these comments have merit and have incorporated these into the EP.	• Timeline for validity of advice noted. • Item included in implementation section of EP to ensure notification within three months of commencement (Table 9-1).
	Pollution Emergency Plans • Request for notification of any oil spill or discharge of any other pollutant within 24 hours. • Request that when developing OPEP Jadestone Energy collects baseline marine data to compare against post spill monitoring. Baseline data should be made available to the Department. • Consideration of spawning grounds and nursery areas should be included in OPEP.	Jadestone Energy considers these comments have merit and have incorporated these into the EP.	• Item included in implementation section of EP to ensure notification within 24 hrs of spill or discharge. • Pollution emergency plans and spill contingency plans Baseline sampling was undertaken by Apache (Kinhill 1997, 1998) and as part a more contemporary work by Oceanica (2015). These reports can be made available to the DPIRD. • Fish spawning and nursery areas have been considered in the EP and in selection of spill response strategies: Fish spawning is described in the EP in **Section 5.5.3** and **Table 5-2** identifies the Spawning Dates for Key

Stakeholder	Stakeholder Concern, Objection or Claim	Jadestone Energy Assessment of merit	Jadestone Energy's Response
			Fish Species which are likely to spawn in the EMBA. **Table 8-8** of the EP identifies the spill response strategies that have been considered (and either adopted or rejected) and the environmental benefits, of which fish life cycles are a part of. Specific strategies for mitigation of risks to spawning grounds and nursery areas include source control, operational monitoring, containment and recovery, shoreline clean-up and scientific monitoring. **Table 8-9** of the EP identifies the rationale for the determination of 'Fish spawning is described in **Section 5.5.3** and **Table 5-2** identifies the Spawning Dates for Key Fish Species which are likely to spawn in the EMBA. **Table 8-8** of the EP identifies the spill response strategies that have Protection Priorities for Spill Response allowing for the varying types of contact that an oil spill can have on the marine environment: floating oil, entrained oil, dissolved oil. Entrained and dissolved oil can have an impact on fish spawning and nursery areas via direct contact,

Stakeholder	Stakeholder Concern, Objection or Claim	Jadestone Energy Assessment of merit	Jadestone Energy's Response
			although duration and concentration of contact is highly variable and intermittent. '
	Biosecurity • Jadestone Energy must take reasonable measures to minimise the biosecurity risk. Two ways to demonstrate commitment: 1. Utilise the Departments Vessel Check tool and complete actions to manage any activity related to vessels to a low/acceptable risk rating. 2. Actively use a biofouling management plan and record book that meets requirements under International Organisation's Guidelines for the Control and Management of Ships' biofouling to minimise the Transfer of Invasive Aquatic Species. • Recommendation that residual risk after using above measures is managed. Recommended this could be achieved by follow-up marine pest inspection around 75 days after arrival if the vessel is still in WA waters. • Request that any suspected marine pest or disease be reported within 24 hours.	Jadestone Energy considers these comments have merit and have incorporated these into the EP. The residual risk is considered low and follow-up inspections of vessels is not considered practical or required. It is unlikely that any IMS entering the Operational Area will establish on the natural benthic habitat (soft sediments at the seabed). The depth of the Operational Area (49 m), open ocean conditions and lack of available light at this depth provides a very different environment to that within sheltered port and shallow coastal areas which have historically been colonised by IMS.	• ALARP assessment of biosecurity risk included in Section 8.1, including management of residual risks. This includes a performance standard (Section 8.1.3) that all vessels sourced from outside WA must use the DoF Vessel check process and for this assessment to indicate low/acceptable risk rating. Vessels mobilised from international waters will have DAWR approval and Ballast Management Plans and Ballast Record Books. • Item included in implementation section of EP to ensure notification within 24 hrs of biosecurity incident. **Trigger** - Biosecurity incident: suspected marine pest or disease **Action** - Notification of DoF via biosecurity@fish.wa.gov.au or 1800 815 507 within 24 hours.
Department of Mines and Petroleum (State) 29 Nov 2016	Request notification when EP accepted by the regulator and Jadestone is the operator of the asset.	***No objection, concern or claim.*** ***Request only:*** Key State government agency.	Jadestone notes the Department's request to be notified when EP accepted by NOPSEMA and action

Stakeholder	Stakeholder Concern, Objection or Claim	Jadestone Energy Assessment of merit	Jadestone Energy's Response
			included in implementation section of EP to ensure this is done within three months of approval.
Australian Maritime Safety Authority (AMSA) 12 Dec 2016	Noted Stag Facilities long history in the area. Noted 3 nm cautionary zone and shipping fairway 5.7km to the South of the facility, which is predominantly support vessel traffic for the oil and gas industry.	***No objection, concern or claim.*** ***Request only:*** AMSA is the key regulatory agency for the management of shipping and maritime safety in Australia.	Shipping traffic advice from AMSA is noted and referenced in Section 5.9.4.
Australian Maritime Safety Authority (AMSA) 8 July 2020	Confirming in writing following meeting held on 2nd July 2020, that Jadestone Energy proposing to use a third-party tanker to undertake slow uptake from a CALM buoy. AMSA confirming that the vessel will not be a facility within the meaning of that term in s 640 of the OPGGSA, and consequently the Navigation Act will continue to apply to the vessel throughout. AMSA request Jadestone contact the Acting Manager for Ship Inspection and Registration to discuss the technical requirements of operations from an AMSA perspective	***No objection, concern or claim.*** ***Request only:*** AMSA is the key regulatory agency for the management of shipping and maritime safety in Australia.	Jadestone held meeting on 14th July with AMSA to discuss the technical requirements and contact AMSA upon tanker charter confirmation, to discuss vessel arrival dates, clearances, previous PSC history and inspection plans
AMSA 22 Nov 2017	Arrangements need to be in place regarding access to national plan resources including chemical dispersants and the FWADC.	***No objection, concern or claim.*** ***Request only:*** MOU needs to be in place to ensure access to logistical support	MOU in place with AMSA outlining access arrangements to national plan resources.
WAFIC 1 Dec 2016	WAFIC accepts 500m restricted zone around the facility for safety reasons, with additional cautionary zone as charted where vessels should 'avoid navigating, anchoring or fishing' however are not excluded from the area.	***No objection, concern or claim.*** ***Request only:*** Peak industry body for commercial fishing in Western Australia.	Jadestone Energy notes acceptance of restricted zone.

Stakeholder	Stakeholder Concern, Objection or Claim	Jadestone Energy Assessment of merit	Jadestone Energy's Response
Australian Marine Oil Spill Centre (AMOSC) 22 Nov 2016	AMOSC advised they are able to support the response requirements identified for the activity however membership will not be finalised until first board meeting of 2017. Noted requirement for Jadestone to have a service arrangement with AMOSC as an interim measure.	***No objection, concern or claim.*** ***Request only:*** AMOSC is a key and respected source of input in the EP in relation to response to unplanned events.	MSA agreement in place 1 July 2017.
AMOSC 5 Dec 2016	AMOSC response to Jadestone Energy specific questions on capability assessment support as requested. Technical and editorial advice on OPEP including suggestions to improve implementation of OPEP, reference material and technical corrections.	***No objection, concern or claim.*** ***Response only*** AMOSC is the key agency for the coordination of spill response and provides significant input for OPEP consideration. Jadestone Energy considers these comments and editorial corrections have merit.	Jadestone Energy have noted AMOSC response and incorporated advice where appropriate in developing the OPEP capability assessment support. Jadestone Energy incorporated all comments on OPEP from AMOSC.
AMOSC 7 Jan 2021	Jadestone provided a summary of resultant reduction of spill volumes that reflect the reduced risk profile due to the permanent relinquishment of the FSO and subsequent modifications to operations	***No response received to date***	Jadestone will continue to liaise with AMOSC regarding spill response arrangements, as outlined in the activity OPEP.
Department of Transport 29 June 2017	DoT noted separate IMT arrangements for cross jurisdiction spills.	DoT is a key regulatory agency and response agency in an unplanned event.	Jadestone will continue to work with DoT regarding spill response arrangements, as outlined in the activity OPEP.
	Comments on OPEP and supporting documents provided 8 June 2017, including:	Jadestone Energy considers these comments and editorial corrections have merit and have incorporated them as outlined below:	A written response to comments was provided to DoT.
	There are a number of references throughout the OPEP and supporting documentation that appear to rely on Department of Transport (DoT) resources and decision making as part of the	Jadestone acknowledges the expectation that capability independent of DoT and AMSA is in	MSA agreement in place with AMOSC 1 July 2017. Arrangements in place

Stakeholder	Stakeholder Concern, Objection or Claim	Jadestone Energy Assessment of merit	Jadestone Energy's Response
	primary response capabilities. In accordance with the DoT Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (January 2017) (IGN), while DoT may opt to deploy members of the State Response Team, request deployment of members of the National Response Team and use DoT resources during a cross-jurisdictional spill event, it is an expectation that Jadestone Energy is suitably prepared independent of DoT resources. This includes Jadestone Energy providing an appropriate number of qualified persons and having sufficient contracts/arrangements in place for resourcing, as required for their given activity.	place. Jadestone has identified SRT and NRT resources as potential capability however the primary capability for personnel rests within arrangements held with AMOSC (core group and mutual aid) and labour hire providers.	with various logistics companies as outlined in stakeholder log.
	There is insufficient clarification of the minimum number of personnel required to be provided by Jadestone Energy to the DoT Incident Management Team (IMT) and Forward Operations Base in the event of a cross-jurisdictional spill event as outlined in the IGN. In addition, please show references as to the roles required to be filled, the number of personnel required and the time and locations that they are to be deployed to. It is not clear that Jadestone Energy have sufficient personnel, contracts and resources in place to deal with a spill event and to resource DoT's IMT and response.	The OPEP has been developed for a worst-case spill scenario of an instantaneous spill of Stag Crude. Operationally, once the spill moves from Commonwealth waters into State Waters, the majority of the Jadestone IMT will be working on response activities in conjunction with DoT meaning that a skeleton IMT for Commonwealth issues will only be required to be populated by Jadestone. Forward Operating Bases will be managed by AMOSC on behalf of Jadestone. AMOSC core group and mutual aid arrangements will be used to supplement Jadestone IMT functions.	Information updated.
	Ensure that Table 4-1 of the Oil Spill Response Arrangements (JS-70-PLN-I-00037) (OSR) correctly aligns with Western Australian STATE HAZARD PLAN Maritime Environment	Comment of merit	Table 4-1 corrected.

Stakeholder	Stakeholder Concern, Objection or Claim	Jadestone Energy Assessment of merit	Jadestone Energy's Response
	Emergencies (MEE), October 2019 regarding the responsible Jurisdictional Authorities and Controlling Agencies.		
	Include some diagrams to illustrate the Control and Coordination structure and IMT structure for a cross-jurisdictional spill event. DoT is happy to meet with Jadestone Energy to discuss IMT arrangements and ensure there is clarity around cross jurisdictional arrangements.	Comment of merit	Updated diagrams included.
	Will assessment of dispersant use applicable to the location and conditions at the time of a spill be undertaken prior to initial dispersant application? Or is it just assumed that chemical dispersant will be used as a response in all relevant scenarios and then a NEBA will be done after application to determine whether continuing with this option is viable?	A NEBA is conducted before the application of dispersant as part of the IAP process.	No update to document required.
	If dispersant is to be used in Commonwealth waters, but is likely to enter State waters, DoT request to be notified prior to dispersant application.	DoT is listed on the notification list in the OSRA document and will be kept appraised through SITREPS.	No update to document required.
	There is very little detail in the way of communication equipment available for use or what communication equipment can be sourced in the event of a spill.	Comment of merit and clarification provided.	Communication support for radios, mobile phones, satellite phones, computers and tablets will be provided by existing arrangements with Telstra and if required additional service providers at the time. Additional support for communications equipment and operators can be accessed through groups such as the Pilbara District Emergency Management Committee.
	Is there an Incident Management System in place to help with the document and records part of managing an incident? For	Jadestone uses systems in accordance with the incident management plan.	No change required

Stakeholder	Stakeholder Concern, Objection or Claim	Jadestone Energy Assessment of merit	Jadestone Energy's Response
	example, a way to manage standardised notification and reporting procedures, tracking and logging of communications, decision making, record keeping etc?		
	There are a number of references in the OPEP back to the OSR, particularly in the initial response part of the document. Jadestone is reviewing structure and ergonomics of the OPEP and OSRA documents to ensure ease of use. However, it is not clear which sections of the OSR they are referring to which would make it time consuming and possibly confusing in a spill event. Consider cross-referencing specific sections for both documents to make it easy to use in a spill event.	Comment of merit.	Jadestone is reviewing structure and ergonomics of the OPEP and OSRA documents to ensure ease of use.
	The OSR states that the Stag Field Environment Plan Permit WA-15-L – Framework for Scientific Monitoring Plan is attached as Attachment A, however, this appears to be missing from the document. Does this document detail the termination criteria for ongoing scientific monitoring?	This was an omission and has now been corrected.	Determining end points for scientific monitoring is addressed in this document.
	Are there any media plans in place in the event of a spill incident?	Media arrangements for all emergencies sit within the Jadestone Energy Incident Management Response Plan document	No change required
	There is very little detail regarding any insurance measures in place to deal with cost recovery in a spill event.	Jadestone's insurance for oil spill response activities is aligned with the financial assessment method developed by APPEA. NOPSEMA considers the method developed by APPEA to be generally suitable for determining the level of financial assurance for most circumstances in Australia's offshore areas. The APPEA	No change required.

Stakeholder	Stakeholder Concern, Objection or Claim	Jadestone Energy Assessment of merit	Jadestone Energy's Response
		method considers reasonably estimable costs, expenses and liabilities associated with responding to an incident, cleaning up and monitoring.	
DoT 7 Jan 2021	Jadestone provided a summary of resultant reduction of spill volumes that reflect the reduced risk profile due to the permanent relinquishment of the FSO and subsequent modifications to operations	DoT requested to review final version of the OPEP so they can provide comments	Jadestone will provide OPEP upon submission to NOPSEMA and continue discussion with DoT and respond to any comments.
DoT 03 Mar 2021 and 16 Mar 2021	DoT provided further comments on the OPEP and the amended Appendix A7	Jadestone confirmed via email and through a follow-up phonecall that no further comments were pending	Jadestone has updated the OPEP with DoT's comments and provided as a new revision to NOPSEMA.
DAWE 7 Jan 2021 and 11 Mar 2021	Jadestone provided an update the department to state the shift to an operating model that requires only a third-party tanker and thereby permanent relinquishment of the FSO from the field.	Stakeholder has not yet provided a response, Jadestone expects a response to the proposed change in operations to be received and will remain in correspondence with DAWE.	JSE will continue to work with DAWE regarding biosecurity management of vessels entering the operational area.

6.2 Environmental Performance

Hazard		**Stakeholder consultation (EPH-1)**		
Performance outcome		**Relevant persons are kept informed of activities**		
ID	**Management controls**	**Performance standards**	**Measurement criteria**	**Responsibility**
001		Relevant persons identified according to current Regulatory requirements	Consultation records	Country Manager

Hazard		Stakeholder consultation (EPH-1)		
Performance outcome		**Relevant persons are kept informed of activities**		
ID	**Management controls**	**Performance standards**	**Measurement criteria**	**Responsibility**
002	Consultation for Environmental Approvals procedure (JS-70-PR-I-00034)	Relevant persons provided a minimum 4-week period to respond to proposed planned activities		Country Manager
003		If there is a potential change in the risks or impacts to relevant persons due to planned activities relevant persons are to be consulted prior to the activity commencing	Consultation records	Country Manager
004		Charter operators will receive a mail-out advising on operations of the Stag Facility within two months of acceptance of this EP.	Consultation records	Country Manager

7. HAZARD ASSESSMENT – PLANNED ACTIVITIES

This section of the EP describes the environmental impacts that may or will arise from planned activities associated with operation of the Stag facilities. In addition, mitigation and management measures that will be implemented to reduce impacts to an acceptable level are defined.

The impact assessment process identified nine environmental hazards associated with planned operating activities. The residual consequence rankings for the hazards listed are summarised in **Table 7-1** and presented in detail in this section.

Table 7-1: Summary of the Environmental Consequence Assessment Rankings for Hazards Associated with Planned Activities

Hazard	Residual Consequence Ranking
1. Light	1
2. Noise	1
3. Atmospheric emissions	1
4. Discharge of produced water	1
5. Discharge of liquid wastes	1
6. Interaction with other users	1
7. Interaction with fauna	1
8. Physical footprint	1
9. Spill response activities	3

The evaluation of impacts identified during the assessment process for hazards associated with planned activities is provided as follows:

- Description of the hazard;
- Impacts – a discussion and assessment of the environmental impacts associated with the proposed activity;
- Environmental performance – a description of a measurable level of performance required for the management of environmental aspects to ensure that the environmental impacts and risks will be of an acceptable level; and a statement of performance required of a control measure. This includes a description of the control measures in place to reduce the impacts; and
- Demonstration of ALARP and Acceptability – a demonstration that the environmental impacts will be reduced to ALARP and will be of an acceptable level, and the rationale for these statements.

For noting, a cumulative impact assessment of the brines and cooling water has been provided in **Section 7.5**, as this is a mixed effluent stream with a common discharge point at the CPF. The produced water discharge stream at the CPF is separate and distinct from the cooling water and brine discharges and so was therefore not considered in the cumulative impact assessment of the brines and cooling water discharges; the impacts of the produced water discharge from the CPF have been considered in **Section 7.4**.

Jadestone believes that with the information provided for liquid discharges as presented in the EP, adequate information is available to be able to undertake a comprehensive evaluation of the impacts and risks to the environment due to these discharges, and their subsequent management.

A further review of the potential planned impacts was undertaken in January 2021 as a result of the FSO being removed from the field. However, the consequence for all planned activities was considered unchanged, in many cases the consequences could be assessed as lower due to the removal of some aspects (e.g. less light and air emissions); however the previous planned impact assessment identified the aspects as already having the lowest possible consequence of 'negligible'. The only one with a moderate consequence is spill response operations, and this is still required in the event of any spill, therefore the consequence remains the same.

7.1 Light

7.1.1 Description of Hazard

Aspect	Light emitted from the CPF and support vessels, as well as flaring associated with production at the CPF.

7.1.2 Impacts

Direct light spill on surface waters will be limited to the area directly adjacent to the CPF and support vessels present from time to time within the Operational Area.

Depending on weather conditions, the Stag Facility lighting, is visible at distances of tens of kilometres, with intensity attenuating with distance. Light from support vessels is visible over shorter distances since lights on vessels are closer to the sea surface. In all cases (Stag Facility, support vessels and flaring), lighting is not expected to illuminate any beaches with the closest being >30 km away (Dampier Archipelago).

There are no expected environmental impacts due to light emissions.

There is no evidence to suggest that artificial light sources adversely affect the migratory, feeding or breeding behaviours of cetaceans. Cetaceans predominantly utilise acoustic senses to monitor their environment rather than visual sources (Simmonds et al., 2004). Therefore, light from the Stag Facility is not considered to be a significant factor in influencing cetacean behaviour or survival.

Potential impacts to marine fauna from artificial lighting associated with the Stag Facility are:

- Disorientation, attraction or repulsion; and
- Disruption to natural behavioural patterns and cycles.

These potential impacts are dependent on:

- Density and wavelength of the light emitted and the extent to which light spills into areas that are significant for breeding and foraging;
- Timing of overspill relative to breeding and foraging activity; and
- Resilience of the fauna populations that are affected.

Turtles are known to use a variety of cues for navigation when in the water. However, light is not thought to be an important cue for adults, although adults are considered to have a preference for non-illuminated beaches (EPA 2010).

The most significant risk posed to marine turtles from artificial lighting is the potential disorientation of hatchlings following their emergence from nests. Hatchlings use the light of the oceanic horizon to orientate themselves towards the sea when making their way into the water for the first time; the oceanic horizon is almost always brighter than the elevated landward horizon (EPA 2010). Hatchling behaviour may therefore be affected when exposed to an artificial light source at certain intensities and distributions, potentially leading to disorientation when attempting to migrate to the ocean. The diffuse glow from light sources can cause disorientation to hatchlings up to 4.8 km from the light source (Limpus, 2006, in EPA, 2006).

National Light Pollution Guidelines for Wildlife have also been published in draft (Commonwealth of Australia 2019). According to the draft National Light Pollution Guidelines for Wildlife, a 20 km threshold provides a precautionary limit based on observed effects of sky glow on marine turtle hatchlings demonstrated to occur at 15-18 km and fledgling seabirds grounded in response to artificial light 15 km away. The effect of light glow may occur at distances greater than 20 km for some species and under certain environmental conditions (Commonwealth of Australia 2019)..

The Flatback BIA (inter-nesting areas) overlaps the Stag facility. Although there may be transient individuals most females inter-nest close to their nesting beaches, typically in shallow (0–10 m) nearshore waters within 5–60 km of nesting beach (Chevron 2008), the Stag facility is in 49 m depth, and the nearest significant nesting beaches are 32 km away on Dampier Archipelago and the Montebello/ Barrow/ Lowendal Islands (75 km SW).

Adult turtles transiting through the Stag Field area may temporarily alter their behaviour while attracted to the light spill from infrastructure. However, given that the nearest turtle nesting beaches and shallow water feeding habitats are at considerable distances away from lighting associated with operational activities at the Stag facility, operational lighting is not expected to have any impact on adult nesting turtles or feeding/ breeding aggregations.

The Stag Facility is distant from the turtle nesting beaches of the Montebello Islands and Dampier Archipelago and therefore negligible impact to marine turtle hatchlings is expected.

The light from the operating production facilities and the flare may provide enhanced capability for seabirds to forage at night (BHPB, 2005). Studies in the North Sea indicate that migratory birds are attracted to lights on offshore platforms when travelling within a radius of 3–5 km from the light source. Outside this area their migratory path will be unaffected (Marquenie *et al.*, 2008). Given that only a small number of seabirds are likely to be affected by light spill from the Stag facility whilst in transit, any behavioural disturbances that may occur such as disorientation and attraction are expected to be minor and temporary. The BIA (foraging area) of the EPBC migratory species – Wedge tailed shearwater overlaps the Stag facility. However, light emissions are not identified as a threat to the species (SPRAT Wedge-tailed shearwaters, DEE 2017as).

Due to the paucity of information, the direct effect of artificial light on sea snakes is largely unknown. Sea snakes may experience indirect effects such as changes in predator-prey relationships and disorientation, attraction or repulsion may occur. Sea snakes are thought to occur more commonly on reef habitats that are not present in the Operational Area. It is recognised that some pelagic sea snake individuals may occur and be attracted to the light from the CPF and vessels. However, while such individuals may come to investigate the light source it is considered unlikely that they will stay within the area. As such impacts to sea snakes are considered negligible.

7.1.3 Environmental Performance

Hazard		Light (EPH-2)		
Performance outcome		**Activity lighting managed in accordance with navigational and safety requirements**		
ID	**Management controls**	**Performance standards**	**Measurement criteria**	**Responsibility**
005	Performance Standards Report (PS-04 Navigational Aids (GA-70-REP-F-00007) ensures navigation aids and equipment meet regulatory and safety requirements	Facility navigation lights are visible at a range of 6 NM for masthead lights and 3 NM for side and stern lights as per COLREGs requirements.	CMMS confirms navigational equipment is maintained	Integrity Supervisor
006	Performance Standards Report: PS-04 Navigational Aids (GA-70-REP-F-00007) ensure navigational lights are present and working	Aircraft warning lights mark tall objects that may be an obstruction to a helicopter approach to the helideck. Marine Navigational lights are positioned on the platform and CALM buoy such that at least one light is visible to a vessel approaching from any direction.	Formal inspection every 90 days confirms lights present and functioning, recorded in Bassnet	Stag OIM

7.1.4 ALARP Assessment

On the basis of the impact and risk assessment process completed, Jadestone considers the control measures described above are appropriate to manage the risk of light emissions to ALARP.T the residual risk ranking for this potential impact is considered Low, and therefore ALARP has been demonstrated, no further controls are required. Additional controls considered but rejected are detailed below.

Rejected Control	Hierarchy	Practicable	Cost Effective	Justification
All activities completed in daylight hours only	Eliminate	No	No	Daylight operations only considered to introduce unnecessary cost (i.e. 12 vs 24 hr ops.), whilst delivering little / no environmental benefit. The operations cannot be shut down on a daily basis, and there would be a >50% reduction in production over the course of a year resulting in significant costs. Light from the Stag facility does not illuminate beaches where receptors (including turtle hatchlings) sensitive to light emissions are present.
Replace external lights or reduce the lighting	Substitute	No	No	Lights are required to create illumination levels needed for safe working, emergencies and navigational requirements. No additional cost; but introduces unacceptable safety risks to personnel and vessels. Little benefit given relatively low numbers of turtles and seabirds in operational area and surrounding waters.
Add filters to lights or re-design placement/ positioning	Engineering	No	No	Lighting has been positioned such that maximum illumination of work surfaces within facility structures is achieved. Costly and considered grossly disproportional to any gain when considering the distances that the facility is from turtle or seabird nesting areas.
Reduce usage of lighting in peak sensitive receptor windows	Isolation	No	N/a	To ensure lighting meets health and safety requirements, lighting is required throughout the day/ night and across the year. To isolate usage such that lights were not used during sensitive receptor windows would create a non-conformance with health and safety requirements.
None identified	Administrative	N/a	Na/a	N/a

7.1.5 Acceptability Assessment

The potential impacts due to light emissions are considered 'Broadly Acceptable' in accordance with the Environment Regulations, based on the acceptability criteria outlined below. No control measures are proposed as a reduction below maintenance of light levels in accordance with health and safety regulations as is currently the case.

Policy compliance	Jadestone's HSE Policy objectives are met.
Management system compliance	**Section 9** demonstrates that Jadestone's HSE Management System is capable of meeting environmental management requirements for this activity.

Social acceptability	Stakeholder consultation has been undertaken (see **Section 6**), and no stakeholder concerns have been raised with regards to impacts from lighting on sensitive receptors.
Laws and standards	Lighting on the Stag facility has been designed to meet health and safety requirements. All vessels in Australian waters adhere to the navigation safety requirements contained within the Navigation Act 2012 and subordinate Marine Orders with respect to navigation and workplace safety equipment (including lighting). There are no standards for acceptable levels of lighting to seabirds or turtles.
Industry best practice	Lighting on the Stag facility is designed to be at minimum safe operational levels.
Environmental context	While there is direct light spill to sea surface immediately around the Stag facility, the impact and risk assessment process indicates that the light spill will not cause significant behavioral effect to adult turtles and marine mammals that may transit the Operational Area. Light is identified in the National recovery plan for Turtles (2017) as a threat to turtles on nesting beaches only. There will be no light spill on nesting beaches and therefore the activity is considered to be conducted in a manner that is consistent with the Recovery Plan and the draft National Light Pollution Guidelines for Wildlife (Commonwealth of Australia 2019).. Light is not identified as a threat to the wedge tailed shearwater which BIA overlaps the Stag Facility. The potential impact is considered acceptable after consideration of: - Potential impact pathways - Preservation of critical habitats - Assessment of key threats as described in species and Area Management /Recovery plans - Consideration of North-West Bioregional Plan; and - Principles of ecologically sustainable development ESD
ALARP	The residual risk has been demonstrated to be ALARP.

7.2 Noise

7.2.1 Description of hazard

Aspect	Noise is generated by activity vessels (including support vessels) and helicopters. Highest noise levels are likely to occur where vessels use bow thrusters. Noise is also generated by equipment such as generators and pumps on the CPF. The median sound level for five FPSOs on the NWS has been recorded at 181 dB re 1 µPa (Erbe et al., 2013). Side-scan sonar (SSS) is an activity that may be used during inspection, maintenance and repair work, likely to be applied for several days at a time every few years.

7.2.2 Impacts

Under normal operating conditions when vessels are idling or moving between sites, support vessel noise would be detectable only over a short distance (tens of metres). When a support vessel is using main engines and bow thrusters to hold position, the noise may be detectable above background noise levels for hundreds of metres or more during calm weather conditions, although this range of audibility will be reduced under noisier (windier) background conditions (BHPB, 2005).

The main acoustic source associated with helicopters is the impulsive noise from the main rotor and high-speed impulsive noise related to trans-sonic effects on the advancing blade. Dominant tones in noise spectra from helicopters and fixed wing aircraft are generally below 500 Hz (McCauley, 1994). Other tones associated with the main and tail rotors and other engine noise can result in a larger number of tones at various frequencies (BHPB, 2005).

Sound travelling from a source in the air (e.g. helicopter) to a receiver underwater is affected by both in-air and underwater propagation processes, which are further complicated by processes occurring at the air-seawater surface interface. The received level underwater depends on source altitude and lateral distance, receiver depth, water depth, and other variables. The angle at which the line from the aircraft and receiver intersects the water surface is important. In calm conditions, at angles greater than 13° from vertical, much of the sound is reflected and does not penetrate into the water (Richardson et al., 1995; NRC, 2003). Therefore, strong underwater sounds are detectable for a period roughly corresponding to the time the helicopter is within a 26° cone above the receiver (BHPB, 2005).

Noise from platform operations is expected to be low as operating equipment including generators, engines and machinery is above sea level. The frequency and noise level received underwater will depend on a number of variables including the type of infrastructure; the types and sizes of engines; as well as the local hydro-acoustic and geo-acoustic environment.

For the IMR activities covered in the EP, side-scan sonar (SSS) is a rare activity that would only occur for several days at a time within the operational area every few years. The maximum potential duration of exposure is limited to the time taken for a migrating whale to pass a vessel performing side-scan sonar in the operational area, potentially only minutes per individual.

No impacts to marine fauna are expected to occur due to operating activities at the Stag Facility.

Potential impacts to marine fauna due to noise and vibration in the underwater environment may occur, and can result in a range of responses including (Richardson *et a*l., 1995; Southall *et a*l., 2007):

- Injury to hearing or other organs: hearing loss may be temporary (temporary threshold shift (TTS)) or permanent (permanent threshold shift (PTS));
- Masking or interfering with other biologically important sounds (including vocal communication, echolocation, signals and sounds produced by predators or prey); and
- Disturbance leading to behavioural changes or displacement of fauna. The occurrence and intensity of disturbance is highly variable and depends on a range of factors relating to the animal and situation.

EPBC Act listed and threatened migratory species that may be present near the activities include whales migrating through the operational area, whale sharks and turtles. Noise is identified as a threat within the conservation advice or recovery plans (refer **Table** 5-3) for a number of the EPBC species that may occur in the operational area.

Whales are low-frequency hearing cetaceans with an estimated functional hearing frequency range of 7–22 kHz (Southall *et. al.*2007). The large hearing structure of the whale shark will be most responsive to long-wave, low-frequency sound (Myberg 2001) in the range of 20 and 800 Hz and so outside the frequency range of the SSS. The auditory sensitivity of marine turtles is reported to be centred in the 400–1,000 Hz range, with a rapid drop-off in noise perception on either side of this range (Richardson *et al.* 1995). This auditory range matches their vocalisation abilities, which are also in the low frequency range (100–700 Hz). Therefore, noise associated with SSS is outside the hearing ranges of whales, whale sharks and marine turtles and does not pose a credible hazard that could cause injury or death to fauna.

Ambient underwater noise levels are dependent on location, and are often dominated by local wind noise, waves, biological noise and ship traffic. Wind speed and seabed conditions have a clear influence on the ambient noise level. Coral reefs are one of the noisiest habitats in the ocean, with sources such as breaking swells, snapping shrimp and fish choruses (Amoser and Ladich, 2005). Broadband levels on reefs are typically 95–110 dB re 1 µPa with a high proportion of low frequency noise (Tolimieri *et al*., 2000). Fish choruses are capable of raising background noise levels to 120–130 dB re 1 µPa (McCauley, 2011). Baseline noise levels in the Otway Basin, Victoria were measured to oscillate between 94–99 dB re 1 µPa. Anthropogenic underwater noise sources in the region of the Operational Area comprise shipping and small vessel traffic, petroleum production and exploration/ drilling activities and sporadic petroleum seismic surveys.

Underwater noise generated by operating activities at the Stag facility may cause behavioural changes or a masking of other acoustic cues necessary for normal behaviour and/or ecological functioning.

There are indications of no (or very limited) responses of cetaceans to received levels of noise below 120 dB re 1 µPa and an increasing probability of avoidance and other behavioural effects in the 120 to 16 dB re 1 µPa range (Southall et al., 2007). Contextual variables (e.g. source proximity, novelty, operational features) may be at least as important as exposure level in predicting response type and magnitude. Initial reactions of marine mammals to noise may in some conditions diminish with repeated exposure and individual experience.

Generally, birds can detect a narrower range of frequencies compared to mammals. Hearing in most species is less than 10 kHz, with best hearing at frequencies between ~1 and 5 kHz (Dooling and Popper, 2007). There is little information however, specific to seabird/ shorebird hearing and thresholds for disturbance.

A considerable body of fisheries literature exists on behavioural response of fish to the noise of approaching vessels (Olsen, 1990). These studies have shown that fish do avoid approaching vessels to some degree, usually by swimming down or horizontally away from the vessel path (BHPB, 2005).

The degree of observed effect weakens with depth and the effect is temporary with normal schooling patterns resuming shortly after the source has passed. Surface and mid-water dwelling fishes may be affected by noise generated during vessel movements and normal production operations.

Electro-physical studies have indicated that the hearing range for marine turtles is between 100–700 Hz (McCauley, 1994; Bartol and Musick, 2003), within the range of noise generated by support vessels. No absolute thresholds are known for the sensitivity to underwater noise or the levels required causing pathological damage. A startle response in marine turtles has been demonstrated to sudden noises. For example, McCauley *et al*. (2000) found that turtles showed behavioural responses to approaching seismic survey noise at approximately 166 dB re 1 µPa, and more significant disturbance at 175 dB re 1 µPa. However, such a response is less likely for the continuous noise sources from Stag facility operations.

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

In summary, impacts expected to marine fauna due to noise emissions from the Stag operating activities are limited to short-term behavioural effects; no impacts resulting in injury or death are expected.

7.2.3 Environmental Performance

Hazard		**Noise (EPH-3)**		
Performance outcome		**Procedures implemented to minimise potential harmful impacts to marine fauna from noise**		
ID	**Management controls**	**Performance standards**	**Measurement criteria**	**Responsibility**
007	Noise Survey undertaken to record noise levels and compare with previous levels	'Noise Survey Review' conducted every five years to determine whether noise conditions have increased above required levels and whether additional monitoring / survey is required.	Record of Noise Survey Review in Bassnet	OIM
008	Vessel contract reviewed to ensure that support vessels comply with EPBC Regulations 8.05 and 8.06	Support Vessel Masters will comply with relevant parts of EPBC Regulation (2000): Reg. 8.05 & 8.06 respectively, where safe to do so: - Within the caution zone for a cetacean (including a calf) (within 300 m of a cetacean), the Vessel Master must operate the vessel at a constant speed of less than 6 knots and minimise noise; and - If a calf appears within an area that means the vessel is then within the caution zone of the calf, the Vessel Master must immediately stop the vessel and turn off the vessel's engines, or disengage the gears or withdraw the vessel from the caution zone at a constant speed of less than 6 knots.	Vessel Contract includes compliance with EPBC Regulations prior to mobilisation Bassnet SAFIR incident reports records any incidences of non-compliance with EPBC Regulations 2000 - Part 8 Division 8.1 (interacting with cetaceans)	Operations Manager
009	Helicopter contract reviewed to ensure that support vessels comply with EPBC Regulations 8.07	Helicopters will comply with the following elements of EPBC Regulations 2000 Regulation 8.07, except during take-off/ landing, during an emergency or when action is required to maintain safe operations: - A helicopter will not operate at a height lower than 1,650 feet or within a horizontal radius of 500 m of a cetacean; and	Helicopter Contractor's procedures include compliance with EPBC Regulations	Logistics Lead

Hazard		Noise (EPH-3)		
Performance outcome		**Procedures implemented to minimise potential harmful impacts to marine fauna from noise**		
ID	**Management controls**	**Performance standards**	**Measurement criteria**	**Responsibility**
		- A helicopter will not deliberately approach a cetacean from head-on. Helicopter operators are required to report any instances where these standards are breached, and any event involving injury to or death of marine fauna due to helicopter operations.	Bassnet SAFIR incident reports records any incidences of non-compliance with EPBC Regulations 2000 - Part 8 Division 8.1 (interacting with cetaceans)	
010	Valid Flag State Certificate indicates vessel engines and equipment is certified and maintained	Vessel machinery is maintained in accordance with Flag State certification requirements. Maintenance is conducted in accordance with the vessel maintenance management system.	Flag State Certificate / ISM.	Operations Manager
011	Planned maintenance of engines and equipment	All engines, compressors and machinery on the CPF are maintained via a maintenance management system	CMMS shows maintenance has been satisfactorily completed as scheduled	Stag OIM
			Bassnet confirms maintenance completed on engines	Engineering & Maintenance Manager

7.2.4 ALARP Assessment

On the basis of the impact and risk assessment completed, Jadestone considers the control measures described above are appropriate to manage the impact and risk of noise due to operation of machinery, vessels and helicopters. The residual risk ranking for this potential impact is considered Low, and therefore ALARP has been demonstrated, no further controls are required. Additional controls considered but rejected are detailed below.

Rejected Control	Hierarchy	Practicable	Cost-effective	Justification
Remove machinery that emits noise	Eliminate	No	N/a	Noise from vessels, helicopters and machinery cannot be eliminated. Without vessels, helicopters and machinery the operation cannot be undertaken. SSS is necessary for integrity
Replace machinery that emits noise with quieter machinery	Substitute	No	No	All equipment as listed is required; no opportunities for substitution were identified.
Provide additional muffling on machinery, or design to reduce noise emissions	Engineering	No	No	Machinery is generally designed with human health hearing requirements taken into consideration, reducing operating noise to as low as efficiently and cost effectively as possible.
Do not operate noisy machinery in areas of sensitivity	Isolation	No	N/a	The Activity is located at distance from sensitive receptors and the coastline. Other fauna in the vicinity may experience short term behavioral effects only and cannot be prevented from being in the vicinity of the activity
Additional facility specific noise emissions procedures for vessels, helicopters and machinery	Administrative	No	No	Through the application of EPBC Regulation 8 for helicopter and vessel marine fauna interaction procedures, and application of machinery maintenance, potential impacts are reduced. No further procedures are considered necessary.

7.2.5 Acceptability assessment

The potential impacts of machinery, helicopter and vessel noise emissions are considered 'Broadly Acceptable' in accordance with the Environment Regulations, based on the acceptability criteria outlined below. The control measures proposed are consistent with relevant legislation, standards and codes.

Policy compliance	Jadestone's HSE Policy objectives are met.
Management system compliance	**Section 9** demonstrates that Jadestone's HSE Management System is capable of meeting environmental management requirements for this activity.
Social acceptability	Stakeholder consultation has been undertaken (see **Section 6**), and no stakeholder concerns have been raised with regards to impacts from noise on sensitive receptors.

Laws and standards	Noise emissions from topsides equipment on the CPF, supply and support vessels machinery are managed through maintenance of equipment as per safety legislative and regulatory requirements administered by NOPSEMA and Flag State. EPBC Regulation 8 and the Australian National Guidelines for Whale and Dolphin Watching 2005 (DEH 2006)
Industry best practice	Noise from CPF, helicopters and vessel equipment is designed to be at minimum safe operational levels. The APPEA Code of Environmental Practice (CoEP) (2008) objectives are met with regards to offshore production operations.
Environmental context	While there are noise emissions to sea surface immediately around the Stag facility and high frequency noise associated with SSS, the impact and risk assessment process indicates that noise will not result in death, injury or significant behavioral effects to marine fauna. This is in alignment with relevant conservation advice and recovery plans for EPBC species that may occur in the Operational Area including humpback, blue whale and whale sharks. Jadestone intends that any impacts from noise generating activities are not inconsistent with protected area management plans or relevant IUCN principles. The potential impact is considered acceptable after consideration of: - Potential impact pathways - Preservation of critical habitats - Assessment of key threats as described in species and Area Management /Recovery plans - Consideration of North-West Bioregional Plan; and - Principles of ecologically sustainable development ESD
ALARP	The residual risk has been demonstrated to be ALARP.

7.3 Atmospheric Emissions

7.3.1 Description of Hazard

Aspect	Sources of atmospheric emissions include: • Power generation and process heating; • Production gas and flaring; • Engine exhausts; and • Venting and fugitive emissions.

A summary of the carbon dioxide air emissions at the Stag facility in 2016 is provided in **Figure 7-1**.

Combustion emissions of Stag crude oil are vented to atmosphere. Gas that is excess to the fuel requirements for heating in the production process and excess blanket gas from the gas flotation unit, is burned as a continuous release through a flare system present on the CPF. Approximately 20% of the gas produced is used as fuel for equipment on board the CPF. The balance (80%) is flared. Low volumes of gas are associated with the Stag oilfield with volumes declining over the life of the field.

The auxiliary boiler, which provides steam for heating in the production process to aid in the separation of the crude oil and produced water uses fuel gas (natural gas) recovered from the process to fire it. Products of combustion of the gas are exhausted to the atmosphere.

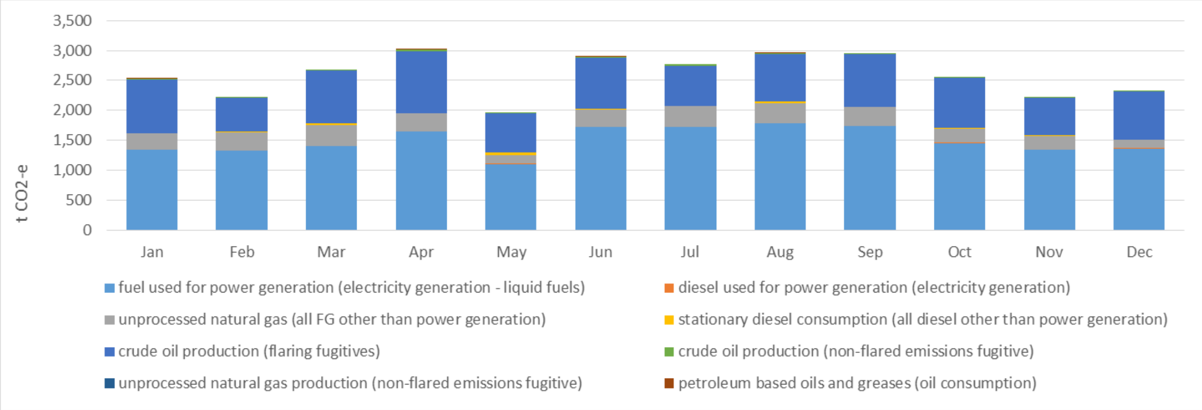


Figure 7-1: Air emissions due to combustion sources at Stag Facility in 2016

Fuel (crude oil, diesel and avgas) burning equipment on the CPF, as well as helicopters and support vessels will contribute to emissions of gases including carbon dioxide, carbon monoxide and nitrogen oxides. The crane on the platform is driven by a diesel engine which exhausts directly to atmosphere. Other diesel-powered portable equipment will also generate localised point source emissions from their operation on an intermittent basis.

The flare system is designed to handle a continuous flaring rate which ranges between 0.3 and 10 mmscfd, and typically operates at approximately 0.3 mmscfd. In addition, the flare system is able to accommodate an instantaneous flaring rate of 15 mmscfd.

Minor amounts of fugitive emissions occur due to venting and from leak paths. Hydrocarbon vapours are released from storage tanks and equipment on filling of the CPF day tanks and continuous minor venting. Emissions of Volatile Organic Compounds (VOCs) are extremely low during crude offloading, as Stag crude has low VOCs due to its weathered nature (Batelle, 1998). Blanket gas (inert gas from the boiler flue gas) is pumped into cargo tanks of the third-party tanker minimising any fugitive VOC emissions.

7.3.2 Impacts

Emissions can reduce air quality in the immediate vicinity of the Facility or vessels present in the Operational Area. The quantities of gaseous emissions are relatively small, and will under normal circumstances, quickly dissipate into the surrounding atmosphere.

As Stag Facility operations occur in offshore waters, the combustion of fuels in such remote locations will not impact on air quality in coastal towns or other sensitive locations, and impacts to nearby petroleum activities such as Wandoo facility operated by Vermillion Energy (approximately 20 km north east) are not expected.

7.3.3 Environmental Performance

Hazard	**Atmospheric emissions (EPH-4)**			
Performance outcome	**No unplanned emissions to the atmosphere** **Emissions to air meet requirements of MARPOL 73/78 Annex VI and Marine Order 97**			
ID	**Management controls**	**Performance standards**	**Measurement criteria**	**Responsibility**
012	Ultrasonic flare flow meter (FQI 3110) measures gas volumes	Flare flow meter measures the volume of gas passing through the flare continuously and is monitored by production monitoring system	Production monitoring system (P2) records	Production Maintenance Supervisor
013	Flag State Certificate (IAPP) certifies measures are in place to manage air emissions	A current International Air Pollution Prevention (IAPP) Certificate that confirms: - Incinerators are certified to meet prescribed emissions standards - Diesel engines >130 kW are certified to meet prescribed emission standards - Current waste management plan	Valid and current statutory Certificate (IAPP) Waste Management Plan	Operations Manager
014	Planned maintenance of engines and equipment	All engines, compressors and machinery on the CPF are maintained via a maintenance management system	CMMS shows maintenance has been satisfactorily completed as scheduled	Stag OIM
			Bassnet confirms maintenance completed on emission generating equipment	Engineering & Maintenance Manager
015	International Air Pollution Prevention (IAPP) Certificate valid to certify measures are in place to manage ODS emissions	A current International Air Pollution Prevention (IAPP) Certificate certifies that measures to prevent ozone-depleting substance (ODS) emissions are in place.	Valid and current IAPP	OIM

7.3.4 ALARP Assessment

On the basis of the impact and risk assessment completed, Jadestone considers the control measures described above are appropriate to manage atmospheric emissions from production and operations equipment, as well as vessels and helicopters. The residual risk ranking for this potential impact is considered Low, and therefore ALARP has been demonstrated, no further controls are required. Additional controls considered but rejected are detailed below.

Rejected control	Hierarchy	Practicable	Cost effective	Justification
All emissions producing equipment is removed	Eliminate	No	N/a	Atmospheric emissions from production and operating equipment including vessels and helicopters is required to undertake the Activity. Equipment cannot be removed completely.
All emissions producing equipment is substituted for equipment that does not produce emissions	Substitute	No	N/a	All production and operation equipment as listed are required. The option of waste being transported to shore for disposal rather than incineration was considered: emissions associated with disposal transport on water and on land was considered to have similar or possibly more detrimental airshed impacts given the closer proximity to communities to onshore disposal options.
Equipment is re-designed/ replaced with equipment designed to reduce emissions. The facility is modified to reduce air emissions e.g. new well for reinjection, scrubbers	Engineering	Yes	No	Risk and impact reduction are achieved through planned maintenance ensuring clean and efficient running of engines. While scrubbers could be installed on generators and the boiler, to purchase the scrubbers would be high (more than $500,000 per piece of equipment), a cost higher than the generator itself, for example. Reinjection of produced natural gas would require a new well, a high-pressure gas compressor (which in turn produces emissions) and gas turbines to drive the compressor. The estimated cost of this infrastructure is $20M (including rig costs). Given the volumes of emissions generated, and the low impact considerations due to the location, the costs associated with alternative processing arrangements are considered disproportionate to the benefits that would be gained.
None identified	Isolation	N/a	N/a	The Activity is located at distance from sensitive receptors and the coastline.
None identified	Administrative	N/a	N/a	Compliance with relevant and appropriate MARPOL requirements

7.3.5 Acceptability Assessment

The potential impacts of atmospheric emissions are considered 'Broadly Acceptable' in accordance with the Environment Regulations, based on the acceptability criteria outlined below. The control measures proposed are consistent with relevant legislation, standards and codes.	
Policy compliance	Jadestone's HSE Policy objectives are met.
Manageme33nt system compliance	**Section 9** demonstrates that Jadestone's HSE Management System is capable of meeting environmental management requirements for this activity.
Social acceptability	Stakeholder consultation has been undertaken (see **Section 6**), and no stakeholder concerns have been raised with regards to impacts from atmospheric emissions on sensitive receptors.
Laws and standards	Atmospheric emissions from production, operation and asset equipment are compliant with MARPOL and AMSA Marine Orders.
Industry best practice	Atmospheric emissions from production, operation and asset equipment is designed to be at a minimum safe operational level. The APPEA Code of Environmental Practice (CoEP) (2008) objectives are met with regards to offshore production operations.
Environmental context	While there are atmospheric emissions to sea surface immediately around the Stag Facility, the impact and risk assessment process indicates that emissions will not result in significant effects to marine fauna. The potential impact is considered acceptable after consideration of: - Potential impact pathways - Preservation of critical habitats - Assessment of key threats as described in species and Area Management /Recovery plans - Consideration of North-West Bioregional Plan; and Principles of ecologically sustainable development ESD
ALARP	The residual risk has been demonstrated to be ALARP.

7.4 Discharge of Produced Water

7.4.1 Description of Hazard

Aspect	Water produced during the recovery of hydrocarbon from the reservoir and during the oil/ water separation production process, is termed produced water. Produced water from the Stag field contains a mixture of dissolved hydrocarbons and suspended oil droplets, naturally occurring radioactive materials (NORMs), dissolved inorganic salts, dissolved metals, dissolved gases as well as low residual concentrations of a small number of chemical additives that are introduced during the production process such as corrosion and scale inhibitors and biocides. A continuous produced water stream is discharged overboard at hull level of the CPF (approximately 5 m above sea level) currently at an average monthly rate of 83,684 kL (approximately 2,751 kL per day) with an average oil-in-water (OIW) concentration of approximately 9.5 mg/L. Historically, produced water pushed forward to the FSO discharged this to ocean on occasion; however, this no longer occurs.

In describing the produced water discharges made from the Stag CPF, the following information is provided:

- Source and production: an outline of where produced water originates during the Activity and how the discharge is modified/ added to during topside production (Section 7.4.1.1);
- Characterisation: a list of produced water constituents and concentrations, and ecotoxicological information gathered from Whole Effluent Toxicity (WET) testing (Section 7.4.1.2);
- Volume and loads: a history of produced water discharge volumes and loads (Section 7.4.1.3); and
- Area of Impact: the area of dispersion within the marine environment from produced water discharges as determined by modelling and verification of the modelling with field data (Section 7.4.1.4).

7.4.1.1 Source and production

Formation water is trapped for hundreds of millions of years with oil and natural gas in a reservoir comprising a porous sedimentary rock formation between layers of impermeable rock within the earth's crust (Collins, 1975). Therefore, when a hydrocarbon reservoir is penetrated by a well the produced fluids may contain formation water in addition to the oil, natural gas and/ or gas liquids. In addition, production chemicals and seawater are commonly injected into a reservoir to enhance hydrocarbon recovery rates, and to improve the safety of operations.

Produced water contains a mixture of dissolved and particulate organic and inorganic chemicals, resulting from the combination of formation and injected water containing production chemicals.

Onboard the Stag CPF, produced water recovered in the process separators and water recovered from the slops tanks (which receive deck drainage and over-specification produced water) is directed to two Corrugated Plate Interceptor (CPI) vessels operated in parallel. Periodically an emulsion breaker is injected into the feed water upstream of the CPIs to assist in the oil/ water separation process.

A number of chemicals are used during processing of the crude oil. Those chemicals that may be present in discharged produced water are included in **Table** 7-2 with a description of their use, approximate concentration within the produced water stream and the environmental risk ranking assigned via the Chemical Selection, Evaluation and Approval Procedure (JS-70-PR-I-00033).

Table 7-2: Chemicals present in produced water discharge

Chemical/ application	Injection point	[ ] in produced water[1]	Risk ranking
Corrosion inhibitor	Process	~24 µg/L	Low
Neutralising amine	Boiler	~0.2 µg/L	Low
Oxygen scavenger	Boiler	~0.1 µg/L	Low
Reverse emulsion breaker	Process	~13 µg/L	Low
Scale inhibitor	Boiler	~0.17 µg/L	Low
Scale inhibitor	Process	~37 µg/L	Low
Biocide (THPS)	Slops tanks	~14 µg/L	Low

[1] Determined from average chemical usage rates and average produced water discharge rate

Recovered oil from the CPIs is pumped back to the second stage separator to join the export oil stream. Water from the CPIs enters a Gas Flotation Unit (GFU) which aerates and coalesces the water to capture remaining oil. A continuous small bleed of produced water from the gas flotation unit is directed through an oil-in-water (OIW) fluorescence monitor to provide an indication of OIW concentrations and performance of the water treatment circuit. This small bleed volume of produced water is then discharged, unless OIW concentration exceeds 30 mg/L or the maximum OIW daily load is greater than 57 kg.

If OIW concentrations exceed 15 mg/L an alarm is activated and recorded in the central control room and logged in the alarm log book. A check of the alarm and manual samples to confirm oil in water concentrations are then taken. If oil in water concentrations reach 30 mg/L or the daily OIW load is greater than 57 kg the discharge is diverted inboard to slops tanks T411 and/or T412 or is sent to the third-party tanker.

The slops tanks have capacity for up to one hour of produced water at normal production levels (storage capacities of 245 and 250 m^3, respectively), during which time production upsets (e.g. hydrocarbon characteristics, chemical injection, boiler function, etc.) affecting the OIW concentration of produced water may be rectified without affecting production. If capacity of the slops tanks is reached, production may be shut in so that produced water discharges with high OIW concentrations do not occur. Following return to normal operations produced water in the slops tanks is pumped to the second stage separators. For maintenance and integrity purposes, the slops tanks are dosed with a biocide.

7.4.1.2 Characterisation

The main contaminants of concern in discharged produced water are (Neff et al., 2011):

- Oil in water (OIW);
- Aromatic hydrocarbons as a component of OIW;
- Trace metals and nutrients; and
- Naturally occurring radioactive materials (NORMs).

Particularly, it is the aromatic hydrocarbons, PAHs and alkylphenols that are the main toxicants present in produced water (Neff et al., 2011).

To understand the potential impacts of the mixed effluent discharge in the receiving environment, produced water characterisation and toxicity testing (microtoxicity and whole effluent testing) are used to assess the discharge stream. Provided below is a rationale for these monitoring approaches.

Chemical Characterisation

Chemical characterisation of the produced water stream is undertaken biannually.

Provided below is an outline of the main constituents within the produced water discharge for the CPF, wherever the data is available. For noting, while variability is evident in the analytes measured, generally the measured concentration ranges (minimum to maximum/ average) are reasonable; ranges are not extreme (e.g. orders of magnitude variation observed over time). These results suggest that while the discharge stream varies in quality, the variability is tolerable. Given a tolerable level of variability in the monitoring data, this underpins a position to continue the frequency of characterisation (i.e. biannually).

<u>Oil in water</u>

Routine measurement of the OIW concentration of produced water discharged from the CPF measures the total hydrocarbon content. Analysis of manually collected produced water samples taken at the CPF between 2002 and 2016 recorded an average OIW content of 9.5 mg/L (**Figure** 7-2).

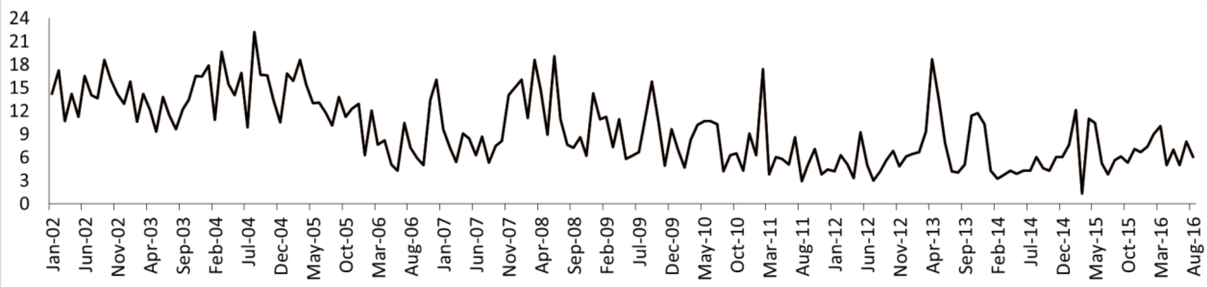


Figure 7-2: Oil in water concentration (mg/L) of produced water discharged from the CPF 2002–2016

Aromatic hydrocarbons

Dissolved hydrocarbons in produced water comprise monocyclic aromatic hydrocarbons (MAH), such as BTEX (benzene, toluene, ethylbenzene and xylene), and lower molecular weight polycyclic aromatic hydrocarbons (PAHs) such as naphthalene, phenanthrene and their alkyl homologues (Neff *et al.*, 2011a).

Biannual analysis of CPF produced water samples taken between 2011 and 2016 revealed total BTEX concentrations have been <0.006 mg/L (<6 µg/L) over this period, with individual BTEX chemicals all <0.003 mg/L (<3 µg/L) (**Table** 7-3**)**.

Table 7-3: Concentrations of BTEX and hydrocarbon chain ranges measured in CPF produced water biannual sampling 2011–2016

Parameter	Average (mg/L)	Min (mg/L)	Max (mg/L)
Hydrocarbons C6–9	0.029	<0.02	0.11
Hydrocarbons C10–14	0.470	<0.02	0.64
Hydrocarbons C15–28	2.847	<0.04	17
Hydrocarbons C29–36	0.404	<0.01	3.5
Hydrocarbons > C36	1.815	0.12	5
Total Hydrocarbons C6–36	1.815	0.12	5
Benzene	0.001	<0.001	<0.001
Toluene	0.001	<0.001	<0.001
Ethyl-Benzene	0.001	<0.001	<0.001
Xylene	0.003	<0.003	<0.003
Sum BTEX	0.006	<0.006	<0.006

These results are likely attributable to Stag crude oil being highly weathered and thus having a smaller component of volatile hydrocarbons such as BTEX (Battelle, 1998), as well as this component being quickly lost during processing due to its volatility (Terrens and Tait, 1996). PAHs account for a small proportion of Stag crude oil (~5% by mass of the semi-volatile cut; Intertek, 2008).

Trace metals and nutrients

The type and concentration of trace metals within produced water depends on the geology of the reservoir formation from which it is produced (Neff *et al.*, 2011a). The metals most frequently found at elevated concentrations in produced water include barium, iron, manganese, mercury and zinc (Neff *et al*., 2011a).

According to biannual sampling of produced water from the CPF (**Table** 7-4), concentrations of trace metals recorded at or above analytical detection limits include arsenic, barium, copper, iron, manganese, strontium and zinc.

The average total organic carbon (TOC) concentration measured in CPF produced water over the sampling period was 8.91 mg/L and the average chemical oxygen demand was 380 mg/L (**Table** 7-4). Ammonia, nitrate, total nitrogen and total phosphorous concentrations were also measured in CPF produced water discharges (**Table** 7-4).

Table 7-4: Concentrations of trace metals, nutrients and pH measured in CPF produced water biannual sampling 2011–2016

Parameter	Average (mg/L)	Min (mg/L)	Max (mg/L)
Total Organic Carbon	8.91	1	15
Ammonia	39.36	26	46
Nitrate	0.01	0.001	0.01
Total Kjeldahl Nitrogen	41.55	26	52
Total Nitrogen	41.55	26	52
Tertiary Amines	0.17	0.01	0.5
Total Phosphorous	3.85	1.8	7.2
Total Dissolved Solids	35,100	4,100	49,000
Total Suspended Solids	62.59	2.5	180
Arsenic	0.019	0.007	0.033
Barium	3.465	0.96	6
Cadmium	0.0001	0.0001	0.0001
Chromium	0.005	0.001	0.01
Hexavalent Chromium	0.002	0.001	0.002
Copper	0.002	0.001	0.003
Iron	4.137	0.02	7.4
Lead	0.001	0.001	0.001
Manganese	0.113	0.09	0.13
Mercury	0.0001	0.0001	0.0001
Nickel	0.001	0.001	0.003
Silver	0.001	0.0005	0.001
Strontium	26.25	21	32
Zinc	0.012	0.005	0.041
pH	6.89	6.7	7.1

Parameter	Average (mg/L)	Min (mg/L)	Max (mg/L)
Oil and Grease	9.818	5	42
Chemical Oxygen Demand	380	130	550

Naturally Occurring Radioactive Materials

Naturally occurring radioactive materials (NORMs) are present within geological formations and are typically found in produced water. Within produced water the most abundant radionuclides are ^{226}Ra and ^{228}Ra, derived from the radioactive decay of ^{238}U and ^{232}Th, respectively (Bou-Rabee *et al*., 2009). Other radionuclides have been identified in produced water including ^{212}Bi, ^{214}Bi, ^{228}Ac, ^{210}Pb, ^{212}Pb and ^{214}Pb, however, activities of these radionuclides are typically lower than that of ^{226}Ra and ^{228}Ra (Bou-Rabee *et al*., 2009).

When formation water is brought to the surface, the rapid drop in temperature and pressure causes NORMs (primarily ^{226}Ra and ^{228}Ra) to precipitate out, which may result in accumulation of sludge and hard scales in the gas processing equipment (OGP, 2005). However, ^{226}Ra and ^{228}Ra may also remain dissolved within produced water.

A review of the ^{226}Ra and ^{228}Ra concentrations in produced water by Neff *et al*. (2011a) across discharges worldwide indicated that ^{226}Ra activity ranges from 0.002 to 1,119 Bq/L and ^{228}Ra activity ranges from 0.3 to 180 Bq/L. This compares to natural levels within ocean surface waters of 0.001–0.0015 Bq/l and 0.0002–0.0011 Bq/L for ^{226}Ra and ^{228}Ra, respectively (Neff *et al*., 2011a).

ANZECC/ARMCANZ (2018) provides guidelines on NORMs within waters based on gross alpha and gross beta activity levels. The guidelines explain that the recommendation to monitor in this format is to simplify screening measurements and monitoring procedures. They do advise however that if the recommended trigger values are exceeded to undertake specific radionuclide analyses.

Historically, NORMs activity has been measured within CPF produced water of the dissolved fraction (i.e. not including the particulate fraction). Jadestone requested analysis of gross alpha and gross beta activity levels be measured on filtered/ dissolved and unfiltered/ total produced water samples. The results and trigger values are provided in **Table** 7-5.

Table 7-5: Gross alpha and gross beta activity levels measured in filtered (dissolved) and unfiltered (total) produced water samples collected at Stag CPF

Parameter	Filtered (Bq/L)	Total (Bq/L)	Particulate (Bq/L)	Trigger value (Bq/L)*
Gross alpha	2.04	2.51	0.47	0.1
Gross beta	2.29	4.15	1.86	0.1

** ANZECC/ARMCANZ (2018) Trigger value for radioactivity in waters used for recreation*

The Stag CPF has four hydrocyclones that are in place to remove particles from the fluid production stream, including the produced water stream. The hydrocyclones are designed to remove particles sized 20 µm and larger from the fluid stream. As such, particulate material suspended within the produced water discharge leaving the platform will comprise particle sizes less than 20 µm.

Microscopic particles less than 0.5 mm or 500 µm, and colloidal particles, do not sink and are freely suspended (Bochdansky et al., 2010). As such, particulates within the produced water discharge stream will remain suspended, their fate a function of metabolic process rather than being deposited in a benthic environment. With this in mind, the dilution factor of 1:332 used to define the area of impact by the produced water discharge stream is relevant and can be applied to evaluate if the NORMs activity level data provided in **Table** 7-5 is acceptable. In applying a rate of 1:332, the gross alpha and gross beta activity levels for filtered and total samples (0.006–0.013 Bq/L) all meet the ANZECC/ ARMCANZ (2000) recommended trigger values for radioactivity in waters with recreational use (0.1 Bq/L).

Microtox® Testing

Microtox**®** is an in vitro testing system which uses bioluminescent bacteria (*Allivibrio fischeri*) to detect toxic substances in different substrates, including water and sediment. When exposed to a toxic substance, the respiratory process of the bacteria is disrupted reducing light output. Response to toxicity is then observed as a change in luminescence. This change can be used to calculate a percent inhibition of *Allivibrio fischeri* that directly correlates to toxicity.

A range of test concentrations of produced water are tested for toxicity using the Microtox® test. The results of the tests are expressed as a reduction in light output and an EC_{50} concentration is produced. In the case of the Microtox® test, a biological effect on 50% of the bacteria is equivalent to a 50% reduction in light output by the bacteria. The EC_{50} concentration in Microtox® tests is usually estimated from the reduction in light output resulting from exposure to four different dilutions of the sample being tested.

Historical assessment of produced water quality at Stag has not included the Microtox® test assay. While historical test data does not exist for this effluent specifically, the test has been in use as a standard laboratory assay for many years and will be used as a complementary measure in the produced water monitoring program to chemical characterisation and whole effluent toxicity testing.

Whole of Effluent Toxicity Testing

A WET test of CPF produced water was undertaken by Ecotox Services Australia and Hydrobiology Pty Ltd using a sample of Stag produced water collected on the 9th of April 2008 (Hydrobiology 2009).

The average OIW content of produced water sampled over that day was 24.2 mg/L and the monthly average for April 2008 was 14.7 mg/L. These values are higher than the CPF produced water OIW content averaged over 2002–2016 (8.5 mg/L; **Figure** 7-2). The sample taken for WET testing was collected downstream of the point where production chemicals were added.

WET testing used the method described in the Australian and New Zealand water quality guidelines (ANZECC/ ARMCANZ, 2018). The selection of the test species used (**Table** 7-6) satisfies the requirements of ANZECC/ARMCANZ (2018) guidelines for the assessment of toxicants in receiving waters, by having at least five species from four trophic levels as part of the testing suite. As there were both acute (i.e. fish and tiger prawn tests) and chronic (i.e. the remaining four species) toxicity tests conducted, an acute to chronic ratio (ACR) was used to convert acute data to estimates of chronic toxicity. A default ACR of ten is recommended by ANZECC/ ARMCANZ (2018). The chronic tests exposed a sensitive life stage of the test organism, and for the purposes of the derivation of dilution factors, can therefore be treated as chronic toxicity data.

The no observed effect concentration (NOEC) results (i.e. raw data) for each test were used to derive the protective concentration (PC) (**Table** 7-6). The BurrliOZ software package was used to calculate the species sensitivity distribution (SSD) (**Figure** 7-3). The most conservative protective concentration of PC99 was used to generate safe dilution and dispersion boundaries for the discharge activity. The PC99 is expected to protect 99% of species in the ecosystem being considered.

The fit of the Burr Type III distribution to the above set of data was acceptable for the number of data points available for curve derivation (**Figure** 7-3). From the SSD, an ecological trigger value of 0.31% (produced water sample) was derived that would protect 99% of marine species; 0.31% produced water equates to a produced water dilution factor of 332:1.

Table 7-6: WET test results of Stag CPF produced water

Test	% of produced water		
	EC_{50}	NOEC	LOEC
Chronic: 72 h sea urchin larval development test using *Heliocidaris tuberculata*	14.8	6.25	12.5
Chronic: 72 h macroalgal germination test using *Hormosira banksii*	8.5	6.25	6.25
Chronic: 48 h larval development test using the rock oyster *Saccostrea commercialis*	14.7	6.25	12.5
Acute: 96 h acute (survival) test using the tiger prawn *Penaeus monodon*	34.1	25 [2.5 ACR]	50
Acute: 96 h fish imbalance test using the striped trumpeter *Latris lineata*	14.9	12.5 [1.25 ACR]	25
Chronic: 72 h marine algal growth test using *Isochrysis aff. galbana*	62.9	12.5	25

EC_{50} *= Median effective concentration (required to induce a 50% effect);* ***NOEC*** *= No observable effect concentration (these values were used to derive trigger values);* ***LOEC*** *= Lowest observable effect concentration; Data summarised from Hydrobiology Pty Ltd (2009)*

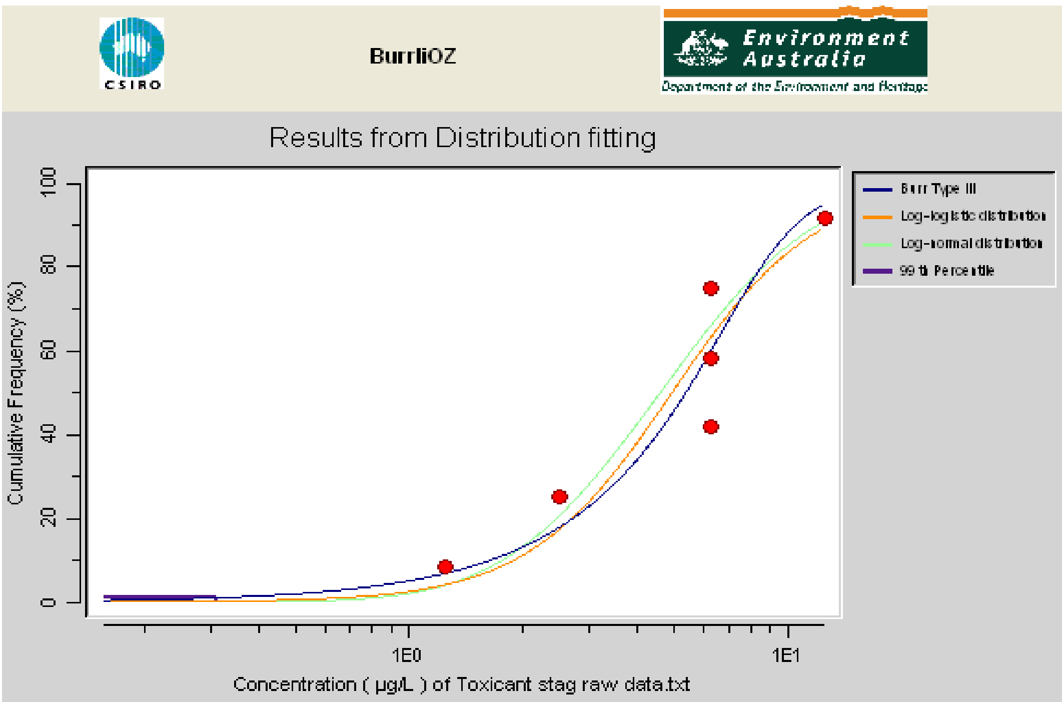


Figure 7-3: Species sensitivity distribution output from BurrliOz for Stag produced water

7.4.1.3 Volumes

The volumes of produced water discharged from the CPF to the marine environment vary from month to month depending on production profiles and rates. The average monthly produced water discharge volume between 2007 and 2016 was 83,684 kL (**Figure** 7-4).

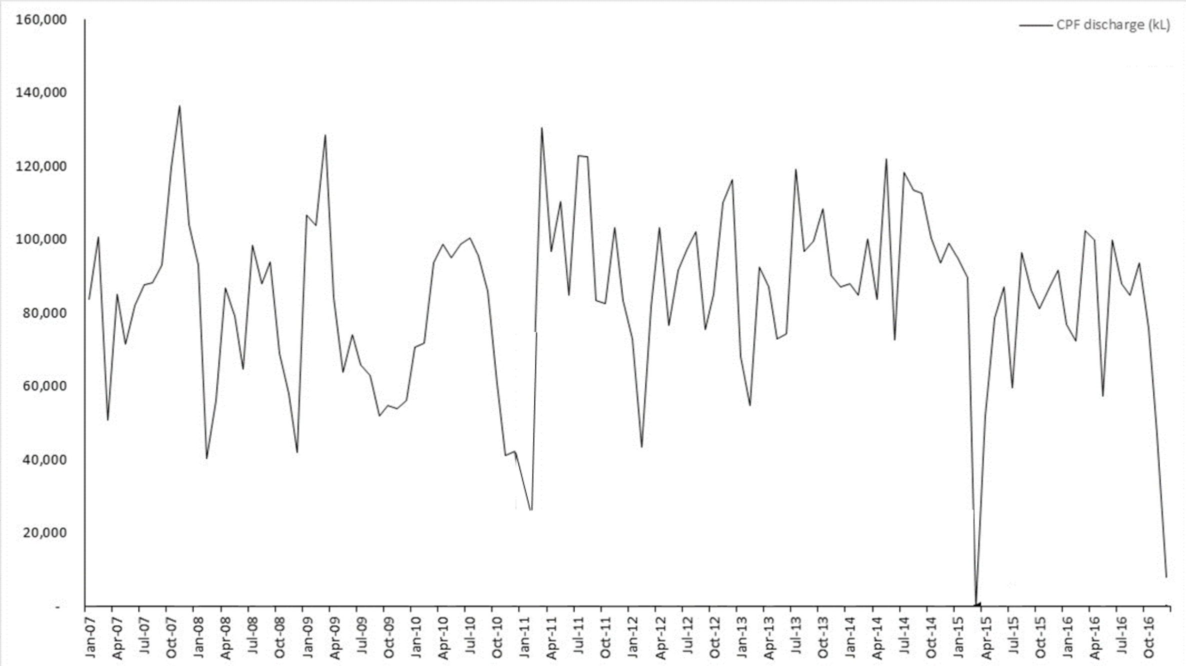


Figure 7-4: Produced water discharge volumes (kL per month) 2007–2016 from the CPF

7.4.1.4 Area of impact

Modelling

The area of impact from the discharge of produced water from the CPF was estimated based on the following information:

- Discharge points: describes the produced water discharge point;
- Discharge composition: water quality characteristics as determined from contaminant concentrations measured biannually for several years in produced water samples collected at the CPF were used to estimate the area of impact to water quality; see Section 7.4.1.2 for detail. For the purpose of estimating sedimentation rates, the average concentration of suspended solids (106.7 mg/L) was applied. Sinking and sedimentation rates are dependent on the size and density of negatively-buoyant particles. Particles in discharge waters at the CPF are relatively fine, having passed through separation processes which include two hydrocyclones (centrifuges). Hence, a distribution was modelled using data for the particle size distribution of fine silt and clay particles, with a maximum size of 1 mm. The assumed distribution is biased towards coarser sizes however, which yields conservative (high) estimates of deposition rates;
- Modelling approach: describes the methodology behind dispersion modelling of the discharge;
- Near field mixing results: describes the initial dilution of the produced water discharge. The end of the near field mixing zone was judged as being either when the buoyance or momentum of the plume had ceased, or the plume had resurfaced;
- Far field mixing results: describes the produced water discharge behaviour as the plume disperses in the marine environment. The far field mixing zone considers dispersion at sea surface, through the water column and to benthic habitats; and
- Verification: Field data collected to verify the area of impact predicted by the model.

Discharge points

Produced water discharge from the CPF is from a pipe of 10” diameter.

Modelling approach

Asia-Pacific Applied Science Associates (APASA) provided liquid dispersion modelling to predict the area of impact affected by the discharge of produced water.

The discharge scenario modelled was:

1. Discharge from the CPF – continuous release of 3,816 m^3/d[1] from a 10” diameter pipe.

The produced water characteristics considered in the model were based on biannual characterisation data (refer **Section 7.4.1.2**). The model considered the dilution of water-soluble components and sedimentation rates of negatively buoyant particulates.

Near field modelling

The near field mixing zone refers to the initial region around the discharge where the hydrodynamics of the discharge dominate over background processes. Typically, the momentum or buoyancy (or both) of the discharge are the strongest influence on the dilution process within the near field mixing zone.

The modelling of the near field mixing zone considered the dilution of soluble constituents of the produced water discharge, which are expected to disperse in the upper water column. Consequently, ambient current data for the upper surface layer (<10 m) were extracted for waters at the Stag Facility from a 10-year composite data set that accounted for mesoscale and tidal currents. This data set was analysed to calculate the 5%, 50% and 95% exceedance values for current magnitudes at the discharge locations (**Table** 7-7). These long-term statistical estimates are applied to represent lower and upper limit cases for the near field mixing zone:

- 5% exceedance case – fast current, high dilution and typically rapid advection to nearby areas;
- 50% exceedance case – median currents, average dilution and average advection; and
- 95% exceedance case – slow currents, low dilution and slow advection.

Table 7-7: Ambient current speeds representing distribution of current magnitudes at the discharge location

Location	Current speed (m/s)		
	5% exceedance	50% exceedance	95% exceedance
CPF	0.47	0.24	0.06

The near field mixing parameters reported included plume diameter (or width), plume trapping depth (height of the plume in the vertical after initial dilution) and the distance from the release site. The dilutions and concentrations presented are the average dilutions/ concentrations across the entire plume width at the end of the near field mixing zone. The end of the near field mixing zone was judged as being either when:

- The buoyancy and momentum of the plume had ceased; or

[1] Approximately 114,480 kL per month

- The plume resurfaced.

Dilution rates varied across the zone, with higher dilution rates at the edge of the zone and lower at the centre. Average dilutions across the near field mixing zone have been presented.

Far field modelling

Once the momentum of the discharge is lost at the boundary of the near field mixing zone, the local hydrodynamics of the ocean become the dominant influence on the dilution and dispersion process. At this point, the plume is considered to be in the far field. Further dilution in the far field is a function of diffusion and transport by ambient currents occurring over longer time scales and larger spatial areas.

Far field modelling was carried out to quantify the dispersion of the produced water discharge. The far field modelling expands on the near field assessment by simulating for longer discharge periods and allowing the effect of time-varying currents to be included, together with the potential for recirculation of the discharge plume back to the discharge location.

For each near field mixing zone scenario, a sample of independent simulations was performed with start times randomly selected within the period of the 10-year current dataset. The replicate simulations starting at random dates allowed for a wide range of possible environmental conditions to be modelled. One hundred simulations of the CPF discharge scenario were run, with each representing continuous discharge for seven days.

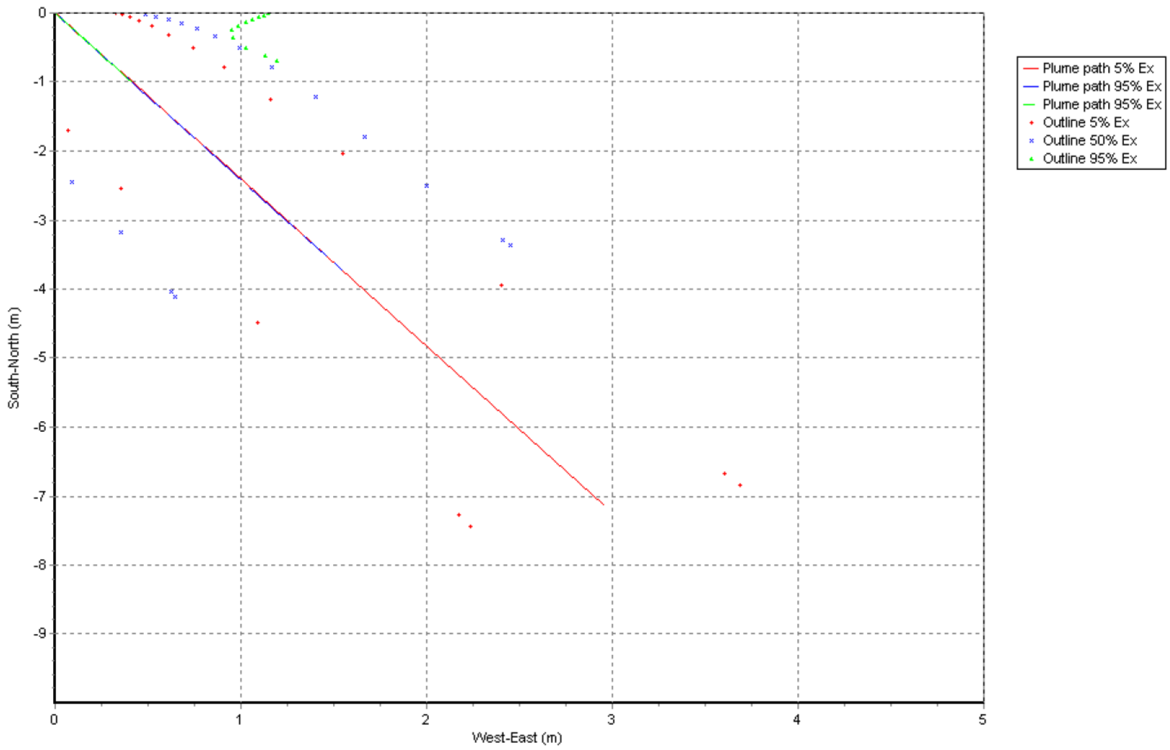
Near field mixing results

Modelling of the discharge configuration from the CPF prepared by APASA, involving discharge of heated water with greater buoyancy than ambient water, was predicted to result in rise of the produced water plume once the momentum of the downward plunge was lost. The plume was predicted to reach sea surface within a horizontal distance of 8 m from the discharge location, with this distance greatest when the current was strongest. Dilutions at the outer edge of the near field mixing zone were predicted to range from 7.9 to 19.7 depending on the prevailing current. The range in the height of the plume in the vertical after initial mixing was between 0.27 m and 0.78 m below surface.

A summary of the near field mixing zone characteristics for the produced water discharge from the CPF under different ambient current speeds is provided in **Table** 7-8. Conceptual plots of the near field discharge plume for the three current scenarios modelled are provided in **Figure** 7-5.

Table 7-8: CPF produced water plume parameters at end of near field for each current speed

Current scenario	Current speed (m/s)	Dilution	Max. horizontal distance of centre line from release point (m)	Trapping depth (m)
5%	0.47	19.7	7.74	0.78 (surface)
50%	0.24	15.4	4.05	0.94 (surface)
95%	0.06	7.9	1.08	0.27 (surface)



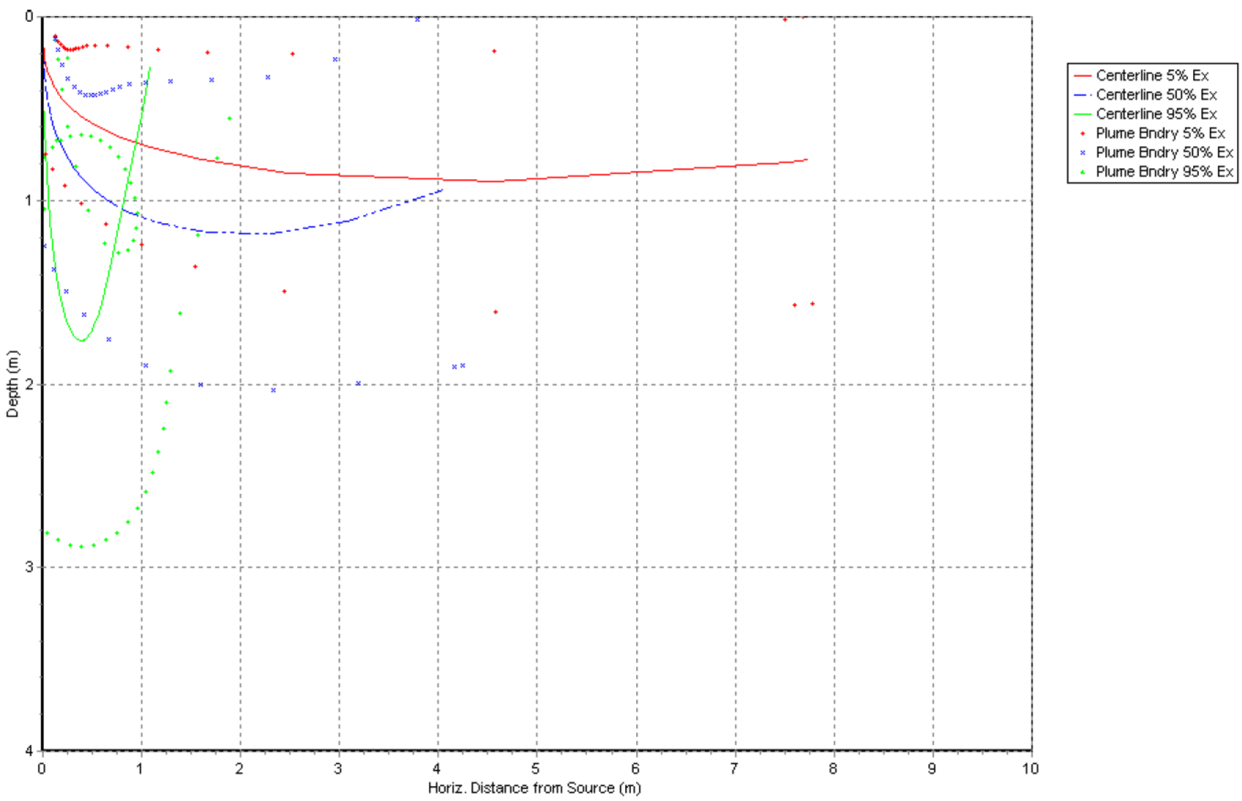


Figure 7-5: Near field CPF produced water discharge plume for three current scenarios showing a plan view (top plot) and a cross section through the water column (bottom plot)

Far field mixing results

The results for each simulation of a given current scenario were combined and statistically analysed to produce percentile contours of dilution. Average dilution fields are presented to represent the central tendency for the modelling predictions generated.

To indicate the outer extents of the dilution fields, the 80th and 95th percentile dilution contours have been calculated. The 80th percentile contour represents the extent that would not be exceeded for 20% of the time. The 95th percentile contour would not be exceeded for 5% of the time. Note that these figures do not represent the plume's location at any point in time but are a statistical summary of the percentage of time that dilution values occur across all replicate modelling runs and time steps.

Dilution values can be applied to any conservative component in the discharge to determine final concentrations at a location around the source. For example, for oil with a concentration in the produced water discharge of 9 ppm, a dilution of 100 is equivalent to a final concentration of 0.09 ppm (90 ppb). Note that this estimation of dilution assumes that the concentration of that constituent as measured in the produced water is zero in the marine environment. The dissolved oxygen concentration is determined differently due to the presence of dissolved oxygen in the receiving waters.

Table 7-9 below summarises the resulting concentrations of oil and chemical oxygen demand for 50-, 100-, 200- and 400-times dilution. These concentrations were considered when interpreting the contour plots of percentile dilutions.

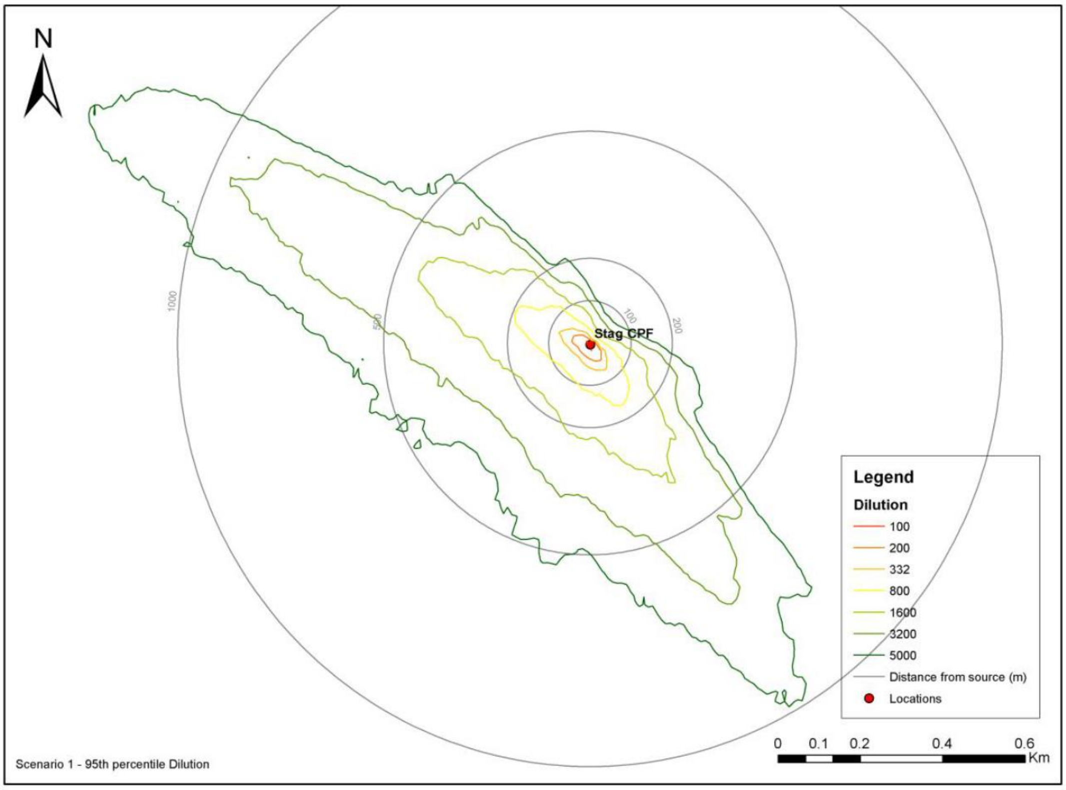
Table 7-9: Concentrations of PW constituents in the marine environment at dilutions given

Discharge component	Oil (ppm)	Chemical oxygen demand (ppm)
Initial concentration in discharge	9	368
Concentration in receiving waters	0	0
Concentration at 50x dilution	0.18	7.4
Concentration at 100x dilution	0.09	3.7
Concentration at 200x dilution	0.05	1.8
Concentration at 400x dilution	0.02	0.9

Figure 7-6 shows the average and 95th percentile dilution contours for produced water discharged from the CPF. The discharge moves mainly with the tidal axis along ESE and WNW directions. The 95th percentile dilution reaches the 99% species protection dilution requirement (1:332) at a distance of 70 m from the CPF discharge point.

Simulation of the sedimentation of fine particles released with the produced water indicated that there would be broad dispersal at low concentrations (<0.001 $g/m^2/d$ as a maximum) surrounding a localised area of higher deposition aligned with the tidal axis in the receiving environment (**Figure** 7-7).

Average daily deposition rates are the most appropriate estimators for evaluating annual deposition rates because they are calculated for the widest range of conditions and therefore incorporate variability in rates due to changes in environmental conditions. Average daily deposition rates only account for input estimates however and do not include removal due to resuspension, or for mixing and dilution with ambient sediments, and therefore they are overly conservative as an estimate to net deposition to the marine environment.



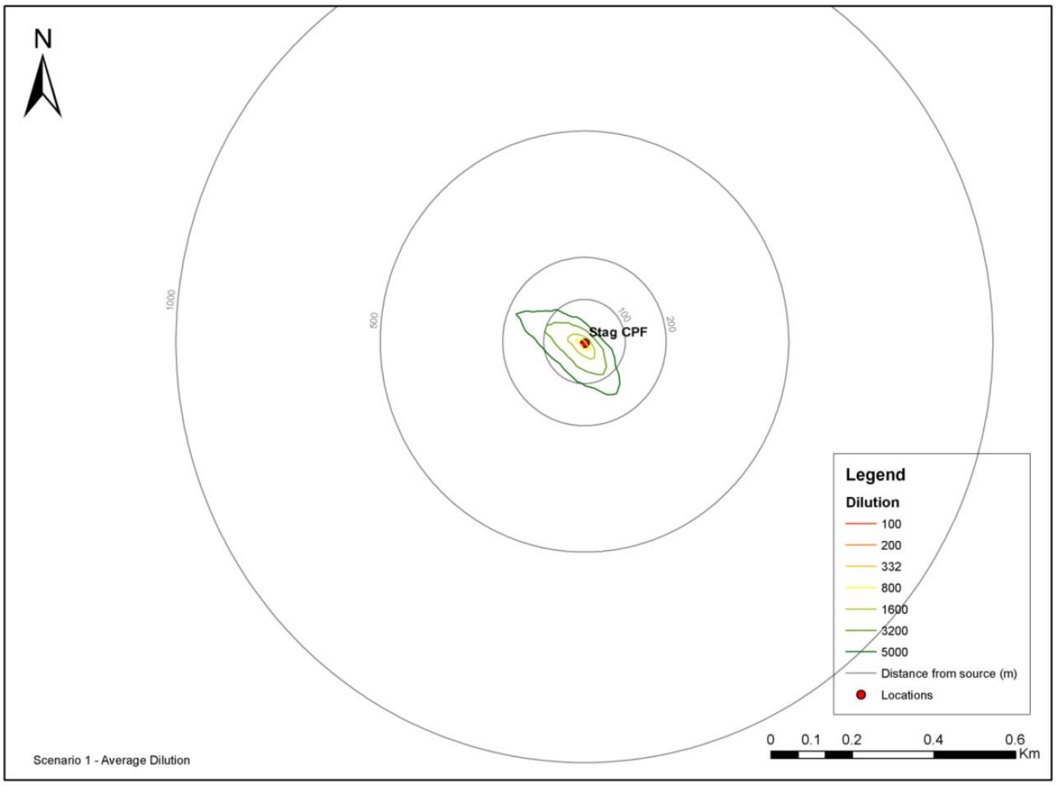
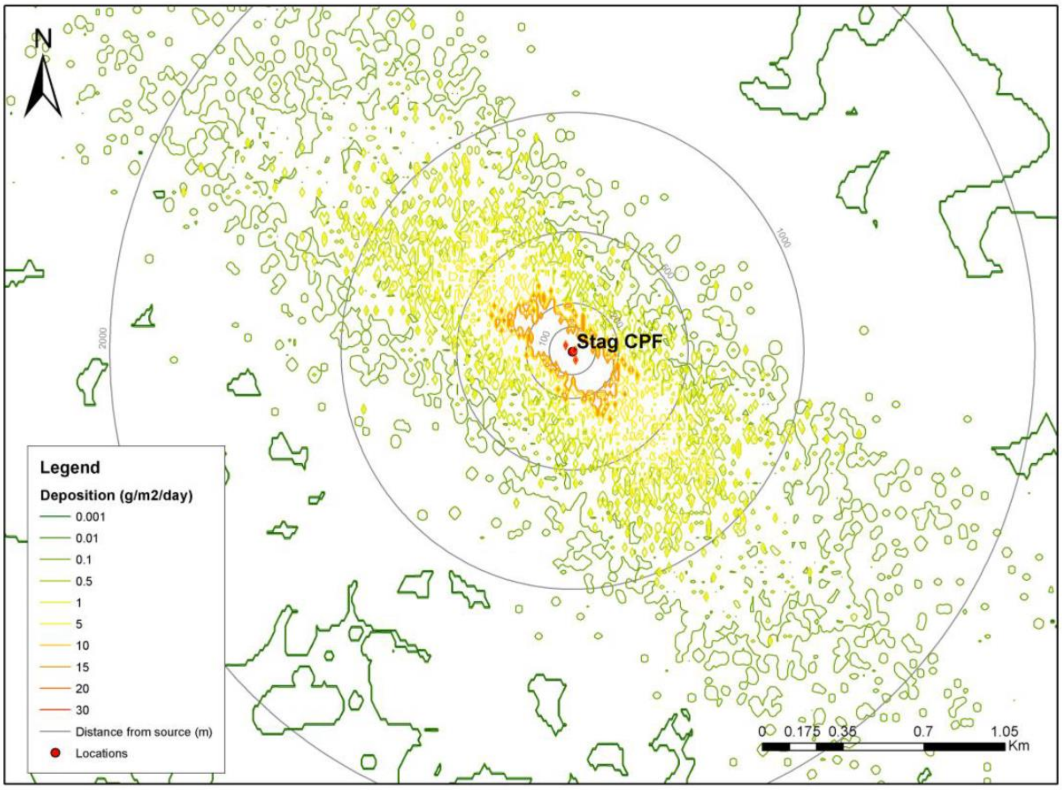


Figure 7-6: Contours of 95th percentile (top) and average (bottom) dilution for produced water discharged from the CPF



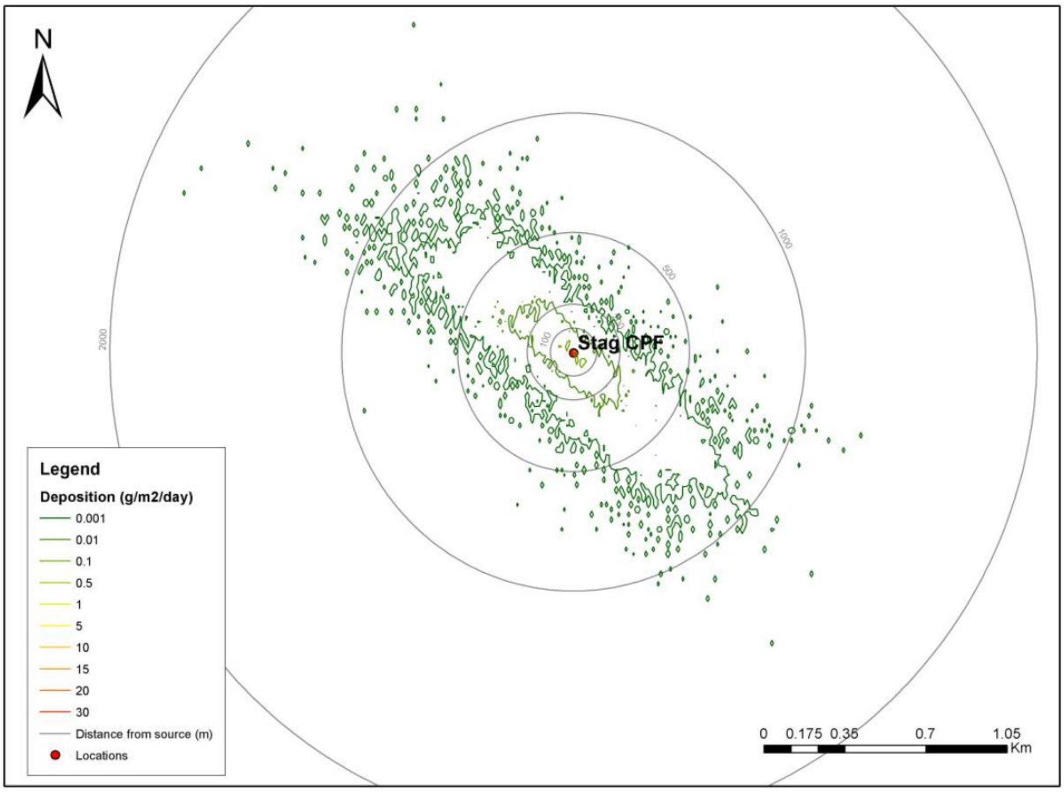


Figure 7-7: Contours of the maximum daily (top) and average daily (bottom) sedimentation rate ($g/m^2/d$) due to produced water discharged from the CPF

The estimated daily deposition rates were highly skewed with average daily rates exceeding 0.01 g/m^2 (or 3.56 g/m^2/y) for an area extending approximately 250 m from the CPF discharge point along the tidal axis and 100 m across this axis. Average daily rates were calculated at up to 0.1 g/m^2 (35.6 g/m^2/y) as small patches that might occur within 100 m of the CPF discharge point along the tidal axis.

The sediment loadings predicted are extremely light: 3.5 g of sediment is approximately three teaspoons of fine particulate material distributed across a one square metre area per year. This degree of loading will be extremely difficult to detect in the open marine environment particularly when accounting for open environment fate processes such as resuspension and redistribution.

Area of Impact

Using the 95th percentile water column far field mixing results for the 1:332 dilution contour and the 0.01 g/m^2/d sedimentation contour, modelling indicates that the predicted area of impact for produced water discharge is an area up to 70 m radius from the discharge point in surface waters and up to 250 m at sea bed from the CPF discharge point.

In applying the discharge modelling results presented above, marine water quality and sediment quality perturbations due to produced water discharge are not predicted beyond 250 m distance of the CPF discharge point.

Verification of Modelling

Field validation of hydrodynamic predictions and water and sediment quality sampling were undertaken by a third-party marine consultancy in 2014 (Oceanica, 2015). The study aimed to validate the area of impact as predicted by the modelling and included evaluating current predictions, dilution fields and sedimentation footprints, as these form the basis of the defined area of impact. The in-field monitoring occurred between the 2nd and 5th of November 2014. At the time of sampling, the produced water discharges at the CPF were as shown in **Figure** 7-8. As indicated by **Figure** 7-8, the produced water discharges from the CPF at the time of in field monitoring fell within a period of routine discharge operations.

The study undertaken by Oceanica (2015) included the following activities:

- Currents were measured in the field using drogues to evaluate the accuracy of the predictions obtained from the hydrodynamic model and used as the basis for produced water dispersion modelling;
- Water sampling was undertaken to determine the concentration of contaminants at distances away from the discharge location, including within, at the edge and beyond the predicted area of impact. This activity underpinned the assessment of whether contaminants associated with the produced water discharge were at or below predicted concentrations and if ANZECC/ ARMCANZ (2018) 95% species protection trigger values for water quality were met at the edge of the area of impact; and
- Sediment sampling was undertaken to determine the concentration of contaminants at distances away from the discharge location, including within, at the edge and beyond the predicted area of impact.

Figure 7-9 shows the monitoring locations used during the in-field monitoring campaign.

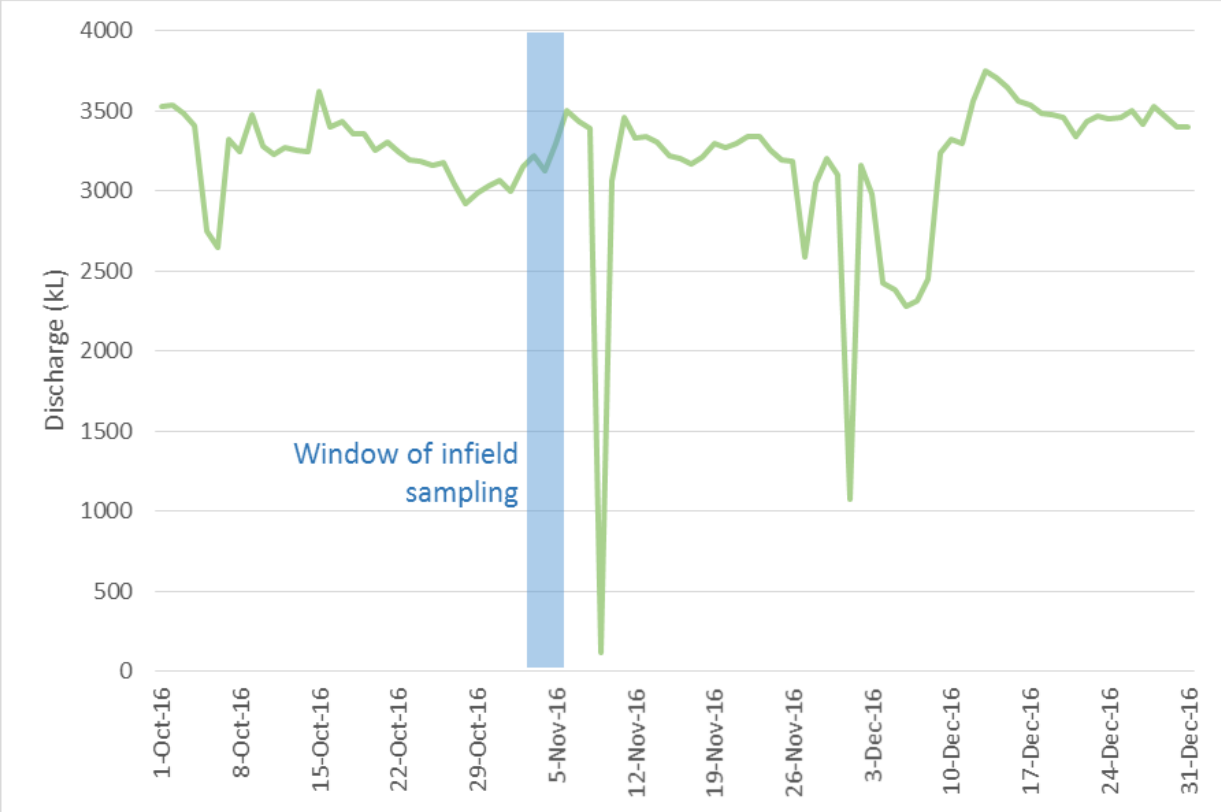


Figure 7-8: Produced water discharge rates from the Stag CPF during infield monitoring (highlighted blue) in relation to daily discharge rates over Q4 2016

Oceanica (2015) summarised the study findings as follows:

At a distance of ≥ 50 m from the discharge point, the produced water plume could not be differentiated from background based on temperature/ salinity/ dissolved oxygen/ pH characteristics. All water quality analytes were below their respective ANZECC/ARMCANZ guidelines (where applicable). Slightly elevated ammonia, total phosphorus, barium and iron concentrations near the discharge point on Vector 1 [one of four transect monitoring lines] *compared to the opposite and perpendicular vectors provided confidence that the sampling captured the produced water plume. The influence of the produced water on nutrient and trace metal levels within the water column was generally limited to ≤200 m from the discharge and did not exceed ANZECC/ARMCANZ triggers. Concentrations of all hydrocarbons (TPHs, BTEX, PAHs) were below the laboratory limits of reporting. Considering that these compounds could not be detected in the receiving waters suggests that they pose little risk to the environment. A dilution of 280- to 350-fold at 50–70 m from the discharge was estimated from barium levels, which is similar to the predicted 332-fold dilution by the modelling.*

The sediments were all of similar grain size and dominated by sand sized particles. Shells and other biota were present in the majority of samples. There was little variation in the sediment particle size distribution along the vector. Concentrations of all contaminants in sediments were below their respective ANZECC/ARMCANZ ISQG-Low and -High levels (where applicable). Zinc concentrations were elevated in the vicinity of the CPF, decreasing to background levels by 250 m from the CPF similar to previous monitoring undertaken in 2000 (IRC 2001). Lead and barium concentration results were similar to those reported in 2000; however, the copper and chromium results were slightly lower than those measured in 2000.

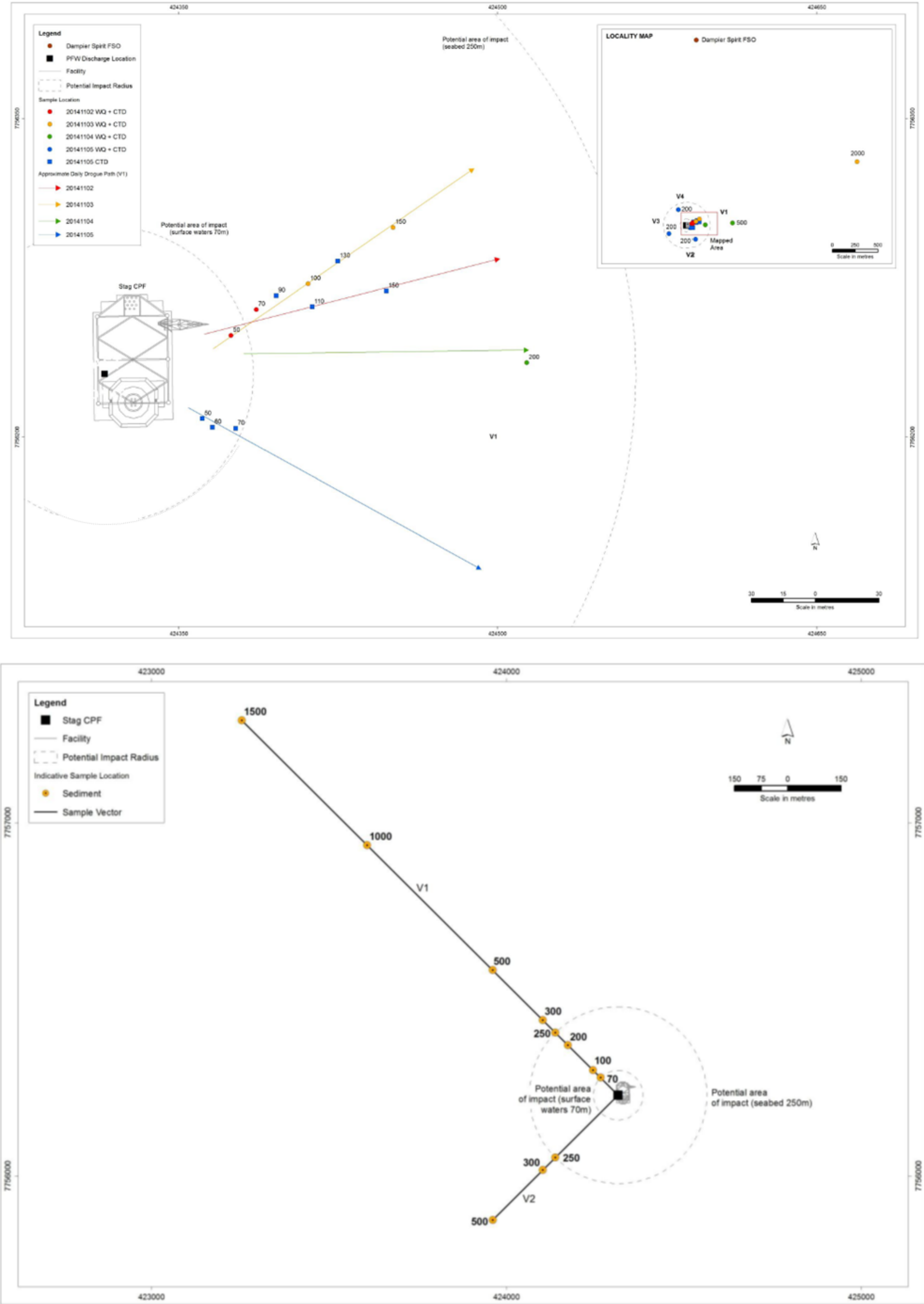


Figure 7-9: Location of in-field monitoring locations for water quality monitoring (top) and sediment quality monitoring (bottom)

The organic content of the sediments were low and at least one order of magnitude lower than recorded in 2000. All hydrocarbon concentrations were below their limits of reporting, suggesting that there has been no hydrocarbon contamination in these sediments resulting from activities associated with the CPF. This is consistent with the previous sediment quality monitoring at the Stag Oilfield in 2000 (IRC 2001).'

The study, commissioned by Quadrant Energy, was undertaken to verify the hydrodynamic model used to predict the environmental footprint for produced water discharge. While extensive data was collected during this study, particularly around local water and sediment quality, further information particularly relating to the hydrodynamics of the local receiving environment will provide further certainty as to the accuracy of the environmental footprint of the produced water discharge stream.

Therefore, to augment the study undertaken by Oceanica, Jadestone will undertake a tracer dye experiment to provide further verification of the model, and of the predicted environmental footprint for soluble and particulate components of the produced water discharge stream (i.e. water column and seabed areas of impact).

In normal operation, suspended solids in the separators are carried by process water through four hydrocyclones that remove solids greater than 20 µm from the water stream to the solids handling system for further processing. As a result, the produced water discharge stream does not contain particulates greater than 20 µm in size.

Microscopic particles less than 0.5 mm or 500 µm, and colloidal particles, do not sink and are freely suspended (Bochdansky et al., 2010). As such, particulates within the produced water discharge stream will remain suspended, their fate a function of metabolic process rather than being deposited in a benthic environment.

With this in mind, the application of a tracer dye to the produced water discharge is appropriate for evaluating both soluble and particulate components of the discharge stream within the receiving environment. Measurement of the plume's behaviour and composition using tracer dye will then allow the dispersion function, driven largely by local currents used in the predictive model, to be used to verify the accuracy of the model's predicted areas of impact. By having the plume coloured, it gives confidence that the water being collected and measured is actually the produced water plume.

The commitment to undertake a tracer dye experiment of the produced water discharge can be found in the environmental performance table for produced water provided in **Section 7.4.3**.

7.4.2 Impacts

Beyond temporary perturbation to water quality, no environmental impacts due to the discharge of produced water are expected.

Provided below is an overview of the risks and potential impacts associated with discharge of produced water to the marine environment.

Produced water constituents

Potential impacts to sensitive receptors from discharged produced water may be attributable to dissolved hydrocarbons and suspended oil droplets, naturally occurring radioactive materials (NORMs), dissolved metals and nutrients as well as low residual concentrations of a small number of process chemicals such as corrosion and scale inhibitors and biocides. Hydrocarbons however are considered the constituent of most concern to marine fauna, particularly polycyclic aromatic hydrocarbons (PAHs).

<u>Hydrocarbons</u>: hydrocarbon exposure may lead to mortality in marine organisms as well as sub-lethal chronic (long exposure) effects such as decreased genetic diversity in communities, decreased growth and fecundity, lower reproductive success, respiratory problems, behavioural and physiological

problems, decreased developmental success and endocrine disruption (Neff *et al*., 2011a). It is generally agreed that within produced water the components of greatest threat to the environment are the more persistent hydrocarbons, primarily PAHs (Neff *et al*., 2011a), which can bioaccumulate within marine organisms (i.e. increase in tissue of marine organisms over time; see *Bioaccumulation* below).

Metals**:** as with hydrocarbons, dissolved metals may create impacts to marine organisms if present at high enough concentrations. Some metals also have the potential to bioaccumulate within marine organisms. ANZECC/ARMCANZ (2018) guidelines suggest the heavy metals mercury, selenium and cadmium have the greatest potential for bioaccumulation and secondary poisoning, although bioaccumulation may occur for a range of metals.

Metal bioaccumulation is a complex process and depends upon the concentration and bioavailability of metals and physiology of individual species and can vary greatly among species in the same environment (Luoma and Rainbow, 2005).

Heavy metals in produced water undergo a series of chemical reactions once they enter seawater and ultimately precipitate out as metal hydroxides or sulphides. Metals present in marine sediments as hydroxides or sulphides are not generally available for biological uptake.

Nutrients: elevated nutrient levels can lead to increased bacterial and phytoplankton production (e.g. phytoplankton blooms). In nutrient poor waters such as those in offshore marine environments, introduction of dissolved nutrients such as ammonia and nitrate to surface waters where high light levels are available will lead to rapid uptake by phytoplankton with associated increased biomass. Increased biomass will be a highly localised feature (within tens of metres) associated with the availability of dissolved nutrients.

NORMs: the environmental risk around radioisotopes in produced water is due to ionising radiation (alpha, beta and gamma radiation). Within produced water the radioisotopes of primary concern are ^{226}Ra and ^{228}Ra, which are more likely to be dissolved within produced water than other NORMs, and which have the relatively longest half-lives of 1,601 and 5.7 years, respectively (i.e. they show greatest persistence in the marine environment).

The principal radionuclide of concern is ^{226}Ra for which studies into health and ecological impact have been carried out (OGP, 2005). A foodweb study by Brookhaven National Laboratory in the Gulf of Mexico concluded that there would be no detectable impacts on fish, molluscs and crustaceans and the environmental risk of discharge within Gulf of Mexico is small (OGP, 2005). The MARINA II study conducted in the North Sea determined that the offshore oil and gas industry was the largest contributor of alpha radiation emitters in the North Sea but that the discharges were of insignificant risk to the health of marine life or humans (OGP, 2005).

Impact mechanisms

Bioaccumulation

Chronic exposure to a contaminant can lead to bioaccumulation of the contaminant within marine organisms over time (accumulation of chemicals from the water or from food sources into tissues over time). ANZECC/ARMCANZ (2018) guidelines provide an indication of chemicals for which possible bioaccumulation and secondary poisoning effects should be considered. These include PAHs and the heavy metals mercury, selenium and cadmium.

Uptake of PAHs can occur in all marine organisms to varying levels; however, there is a wide range in tissue concentrations from variable environmental concentrations, level and time of exposure, and species ability to metabolise these compounds (Meandor *et al*., 1995). Since the elimination of PAHs is generally very efficient in fish and other vertebrates, bioaccumulation of PAH within these taxa do not generally reflect their level of exposure (van der Oost *et al*., 2003). Instead bioaccumulation of PAH has been mainly recorded within invertebrates which are less efficient at metabolising PAH.

Hydrocarbon taint

Elevated hydrocarbon levels in fish flesh have the potential to impact humans if affected fish species are targeted by fisheries. When present in foods, petroleum hydrocarbons stimulate an olfactory response in humans that causes a tainting of flavour or taste. Connell and Miller (1981) compiled a summary of studies listing the threshold concentrations at which tainting occurred for hydrocarbons. The results contained in their review indicate that tainting of fish occurs when fish are exposed to ambient concentrations of 4–300 ppm (mg/L) of hydrocarbons in the water, for durations of 24 hours or more, with response to phenols and naphthenic acids being the strongest.

Accumulation of contaminants in sediments

While the produced water plumes from Stag CPF primarily influence the quality of localised surface waters, there is the potential for particles within the plume, which may comprise metal oxides and low solubility hydrocarbon droplets (such as higher molecular weight PAHs), to drop out of the plume in the far-field mixing zone (Neff *et al*., 2011a). These components of the produced water therefore have the potential to accumulate in sediments.

Results of the model field validation study indicate produced water constituents were not above background concentrations in marine sediments beyond 250 m of the discharge point.

Biomagnification

Biomagnification occurs when concentrations in the tissues of one organism exceed those in its food or in an adjacent trophic level (Reinfelder *et al*., 1998). Biomagnification of PAHs is possible in invertebrate food webs (Jorgensen, 2010), although unlikely to occur within food chains comprising marine vertebrates (e.g. fish, marine reptiles and mammals and seabirds).

In a field study, PAHs in lower order consumers (molluscs) were shown to be higher than in higher order consumers (fish and decapod crustaceans) indicating biomagnification of PAH was unlikely to be occurring (Takeuchi *et al*., 2009). Organisms at higher trophic levels tend to show increased ability to metabolise PAHs indicating that biomagnification of PAH up the food chain is unlikely to occur (Takeuchi *et al*., 2009).

In terms of metals, biomagnification of inorganic mercury (as methyl-mercury) in aquatic food webs has been observed in a number of studies with highest concentrations in the long-lived high order consumers (Cabanna and Rasmussen, 1994, Bowles *et al*., 2001, Power *et al*., 2002). However, for other metals biomagnification into higher trophic levels is not believed to occur (Fisher and Reinfelder, 1995, Miramand *et al*., 1998, Gray 2002). Instead concentration within a trophic level is mainly determined by the feeding strategy of the particular species at that trophic level (Rainbow, 2002).

Potential impacts to sensitive receptors

Pelagic environment

WET testing of Stag produced water has been carried out on six test species (including marine algae and invertebrate test species; refer **Table** 7-6). The WET testing captured potential additive effects of constituents of the produced water. The WET testing determined that after sufficient dilution (assessed as 332:1 dilution) no observable effect (NOEC) to marine species will occur; the spatial scale of the area of impact is described in **Section 7.4.1.4** and it accommodates this dilution for no ecological effect. Further to this, the dilution factor and area of impact required to achieve this level of dilution have been confirmed as being achieved in the marine environment through a field validation study (Oceanica, 2015).

NORMs within Stag produced water have been measured at 8.94 Bq/L which is at the lower range of levels recorded in produced water samples worldwide (Neff *et al.*, 2011a). Given that studies from regions of very active oil and gas regions have not concluded significant environmental impacts from NORMs it is not predicted that NORMs in Stag produced water will lead to significant environmental impacts.

<u>Plankton</u>

Components of the plankton that could be impacted by produced water include micro-invertebrates; eggs; larvae of invertebrates; and fish. Acute effects include lysis of single-celled organisms and narcosis of motile invertebrates leading to impaired swimming ability.

The predicted small scale of the area of impact suggests that exposure impacts (sub-lethal or lethal) from produced water are likely to be insignificant at population or ecosystem scales. There are no nearby hard coral areas that would suggest that impacts from produced water on hard coral eggs and larvae would occur during coral spawning season (peaking in March/April).

Nutrients (N and P) discharged within produced water have the potential to increase the biomass of phytoplankton and bacteria within local waters. The field validation study of the produced water area of impact at the Stag Facility (Oceanica, 2015) found slightly elevated ammonia and total phosphorus near the CPF discharge point. The influence of produced water on nutrient levels within the water column was generally limited to ≤ 200 m from the discharge and did not exceed ANZECC/ ARMCANZ triggers.

<u>Invertebrates</u>

In addition to invertebrates within the plankton assemblage, larger pelagic invertebrates (e.g. jellyfish, squid, salps) will be present around the Stag Facility. Based on WET testing of Stag produced water, impacts could occur to these invertebrates within the area of impact.

Macro-invertebrates present in surface waters are expected to be mobile and while they may be exposed to produced water and may experience sub-lethal effects such as impaired mobility, these effects will be short-term and will recover rapidly once outside the area of impact of the produced water discharge (approximately 50 to 70 m away from the discharge point).

Bioaccumulation of hydrocarbons (e.g. PAHs) and metals is most likely to occur in sessile invertebrates attached to the CPF sub-structure close to the discharge location. These fauna are repeatedly dosed with produced water and thus experience prolonged (chronic) exposure. This is likely to be due to either uptake of dissolved constituents (e.g. volatile, low molecular weight hydrocarbons such as BTEX hydrocarbons) across cellular structures or ingestion (filter feeding) of higher molecular weight hydrocarbons (e.g. PAHs) or precipitated metals which may be bound to organic particulate matter. This impact would be highly localised and particular to organisms attached to the CPF sub-structure within the produced water discharge plume.

<u>Fish</u>

Effects may be experienced by pelagic fish within the produced water area of impact. Pelagic fish are commonly associated with offshore structures and therefore higher abundances are likely to occur around the CPF than in surrounding open waters, especially given the surrounding habitat of flat sediments in depths >50 m.

Impacts to pelagic fish are likely to be caused by exposure to dissolved hydrocarbons (e.g. BTEX hydrocarbons) or metals across gill structures, although impacts could also occur through ingestion of hydrocarbon droplets. PAHs are the hydrocarbon of most concern in terms of long-term exposure to produced water. While PAH concentrations may be elevated in fishes attracted to the CPF the elimination of PAHs is generally very efficient in fish and other vertebrates and bioaccumulation of PAH within these taxa do not generally reflect their level of exposure (van der Oost *et al.*, 2003).

The infield model validation monitoring study (Oceanica, 2015) found that concentrations of all hydrocarbons (TPHs, BTEX, PAHs) measured in marine waters were below the laboratory limits of reporting. Authors of the monitoring report (Oceanica, 2015) concluded that, considering that these compounds could not be detected in the receiving waters suggests that they pose little risk to the environment.

EPBC species

With regards to impacts to MNES, a conservative 1 km search radius from the Stag Facility (double that of the 500 m restricted zone of the Facility) was used to conduct the EPBC MNES search to cover the risk of produced water discharges (**Appendix C**). For noting, the 1 km radius EPBC MNES search area used is well beyond the 70 m radial distance from the Facility for mixing of produced water discharge in the water column, and the 250 m radial area over which fine particulate material may settle to seabed.

The search found 17 listed/ threatened species and 23 migratory species or species habitat that may occur within the area. Of note was the overlap with Biologically Important Areas (BIAs) for four EPBC listed species: the humpback whale, blue pygmy whale, wedge tailed shearwater and Flatback turtle (**Figure** 7-10). The Whale Shark BIA was approximately 9 km from the 1km search area boundary (**Figure** 7-11).

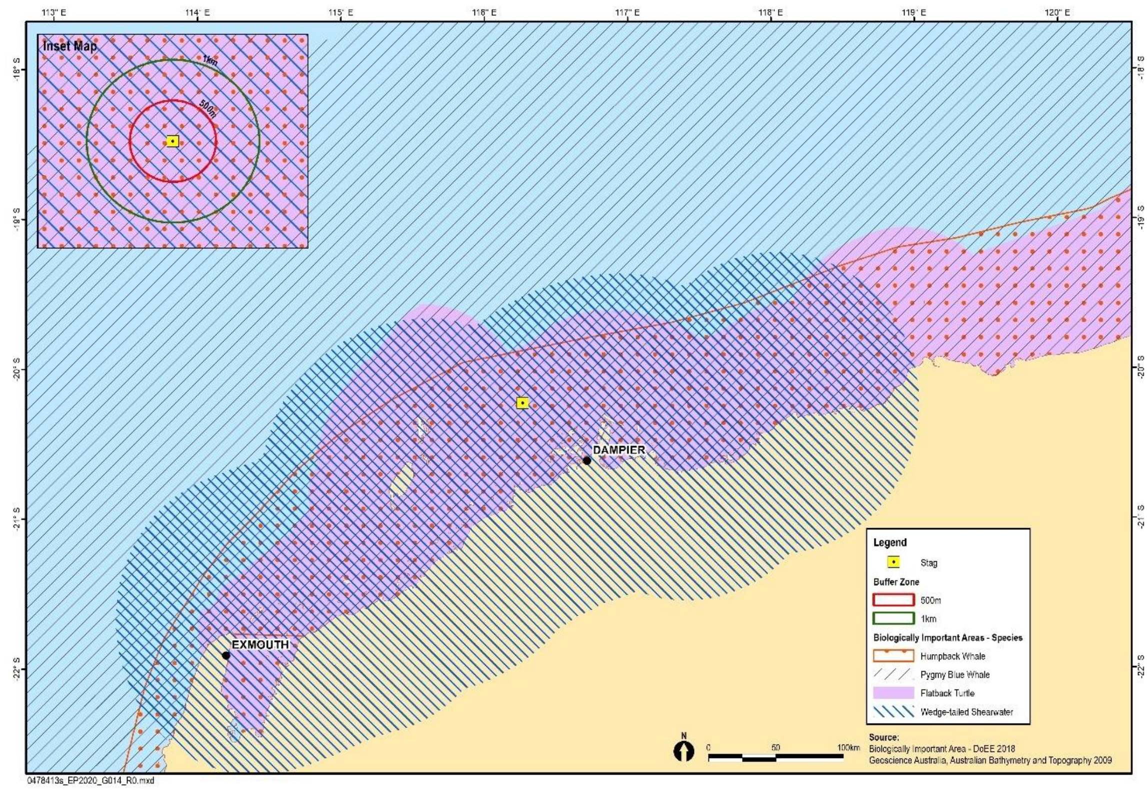


Figure 7-10 Stag Facility with 500m and 1 km radial areas used for EPBC search, showing EPBC species BIA

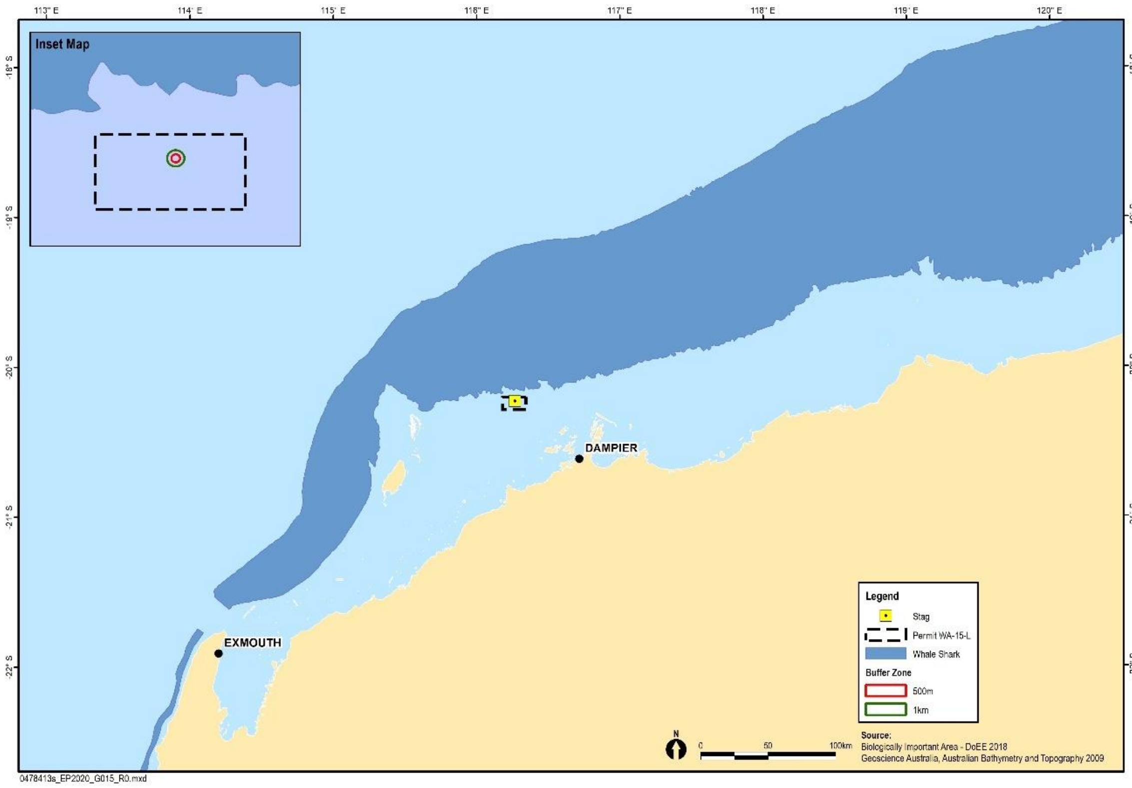


Figure 7-11 Whale Shark BIA adjacent to Stag Facility and permit area

Based on the marine monitoring that has been conducted (Oceanica, 2015) it was concluded that there will not be acute or chronic impacts to marine reptiles, marine mammals or seabirds due to produced water discharged from the Stag CPF. It is noted that the area does overlap with the humpback whale and blue whale migration corridor, shearwater foraging, and the flatback turtle interesting areas which may result in a higher number of these species around the Stag Facility.

The Flatback BIA (inter-nesting areas) overlaps the EPBC MNES search area, and although there may be transient individuals (**Section 5.6.3**) most females inter-nest close to their nesting beaches, typically in shallow (0–10 m) nearshore waters of their nesting beach (Chevron 2008) – unlike the depth of the operational area. The Stag Facility is in 49 m depth, and the nearest significant nesting beaches are 32 km away at Dampier Archipelago.

The bioaccumulation/ biomagnification risk to marine turtles or the impact pathway is through the food chain. However as described above, the BIA area for flatbacks overlapping the Operational Area (and area affected by produced water) is thought to be for inter-nesting. The study by Sperling et al. (2010) concluded that flatback turtles do not feed during the inter-nesting period which greatly reduces the risk of bioaccumulation/ biomagnification. However, if individuals were likely to use this area as foraging grounds, outside of nesting season it would represent an insignificant percentage of all available nesting grounds and not significantly effect individuals or population.

'Management of oil spills and operational discharges' is identified as an action in the Turtle Recovery Plan (DoEE 2017). However, the total size of the BIA for Pilbara flatbacks is 35,758,776 km^2. The areas that may potentially be affected by produced water discharges (water quality a 70 m radial extent largely limited to the top 1 m of water column) represents less than 0.01% of the total area.

Furthermore, the produced water Management Framework (refer **Section 7.4.3**) which involves continual measurements and ongoing monitoring of produced water will ensure there will be no increase in the current or predicted levels of contaminants and risks to flatback turtles remain low.

Blue whale

The area where blue whales are known to be distributed which is part of the species BIA also overlaps the operational area (refer **Figure** 5-7). Although little is known about their precise migration routes blue whale migration is thought to follow deep oceanic routes (DSEWPaC, 2012d). The blue whale is rarely present in large numbers outside recognised aggregation areas and is unlikely large numbers would be found around the Stag Facility and be exposed to produced water discharges. There is no Conservation advice for blue whale, but the species information (SPRAT Blue Whale, DEE 2017as) does not identify water quality as a potential threat, and no management actions will be compromised due to the release of produced water.

Wedge tailed shear water

The wedge tailed shearwater breeds on the east and west coasts of Australia on offshore islands. The species is common in the Indian Ocean. The species BIA (foraging areas) overlaps the Stag Facility and produced water discharge area (**Table** 5-6). However, when foraging at sea the birds are often alone or in small groups and are unlikely to be impacted by change in water quality associated with the produced water discharge plume in the surface metre of the water column. Additionally, like with the turtles BIA, the proportion of foraging area likely to be impacted by produced water discharges (a 70 m radial extent from the discharge point in the top 1 m) is minimal.

The whale shark BIA is approximately 9 km from the Operational Area (**Figure** 7-11). As such it is reasonable to expect individuals to pass through the area. Whale sharks spend the majority of their time in deeper waters, and would avoid the surface produced water plume, however it may have a small indirect effect on plankton which is a food source for whale sharks (Meekan 2008). The predicted small scale of the area of impact however suggests that exposure impacts (sub-lethal or lethal) from produced water is not likely to significantly impact whale shark food sources (as described above in impacts to fish).

The Conservation advice for the whale shark identifies habitat disruption from the resource sector as a minor threat to the species (SPRAT Whale shark, DEE 2017as). However as described above the release of produced water 9 km from the nearest point of the whale shark BIA is not likely to have any impact on the species or habitat used by the species.

Pipefish and seahorse

Although the PMST report for the 1km buffer around the facility found a number of sygnathid 'species or species habitats may occur in the area' – there is no records of them actually occurring. Knowledge about the distribution, abundance and ecology of both syngnathids and solenostomids is limited (DSEWPaC 2012). Almost all syngnathids live in nearshore and inner shelf habitats, usually in shallow, coastal waters, among seagrasses, mangroves, coral reefs, macroalgae-dominated reefs, and sand or rubble habitats (Dawson 1985; Lourie et al. 1999, Lourie et al. 2004; Vincent 1996). In tropical areas species are primarily found among coral reefs (Foster & Vincent 2004; Scales 2010). Given the substrate observed in the produced water EMBA was predominately soft sediments it is considered unlikely for any of these species to be observed in the area.

As described in **Section 7.4.2** contaminant levels from produced water discharge are not considered at a level that would impact on marine organisms such as syngnathids. This is supported by (DSEWPaC 2012) which lists oil pollution from rigs as 'of least concern' to the species.

Fisheries

No fishing is permitted within the 500m restricted zone around the CPF, third-party tanker and other subsea infrastructure. Given that the area of impact for produced water discharge lies within this restricted zone, and recent sediment and water quality surveys (Oceanica 2015) have found that concentrations of hydrocarbons (including PAHs) and mercury were below analytical detection limits, no impact to fish targeted by nearby fisheries is predicted.

Furthermore, for the actively fished commercial fisheries in the area, the approved fishing area is extensive the purposes of flexibility and boundary simplicity, rather than being a true representation of where catch and effort is actually undertaken. Although the habitat within the operational area may represent suitable habitat for some of the commercial species (Table 5.16), in reality fishing effort for these species will be focussed on areas of most suitable habitat and away from constraints such as infrastructure. Although some of the larger fish species may be transient through the operational area and then travel significant distances to active fishing grounds, this was not considered a significant risk.

In summary:

- The Oceanica report found contaminant levels from produced water as not likely to have significant impact on fauna;
- The 70 m of sediment that may have low levels of contamination are not significant feeding grounds for the fish species and represent less than 0.1% of the total fishing boundary; and
- The probability of capture after being in the location is low.

Furthermore, the Produced Water Monitoring Framework (**Section 7.4.3**) which involves continual measurements and ongoing monitoring of produced water will ensure there will be no increase in the current or predicted levels of contaminants and risk of bioaccumulation.

Benthic environment

A water and sediment sampling study undertaken by IRCE (2001) at sites located between 50 and 200 m from the Stag CPF did not detect measurable levels of total petroleum hydrocarbons (TPH), at a 0.1 ppm (mg/L) detection limit, indicating that there had not been significant accumulation of hydrocarbons in sediments as a result of hydrocarbons dropping out of the produced water discharge plume (IRCE, 2001). These results included PAHs which are believed to be the constituent of most concern in discharge produced water due to their persistence in the environment and toxicity (Neff *et al*., 2011). The IRCE (2001) study determined that concentrations of chromium, copper, lead and zinc were slightly elevated within 50 m of the Stag CPF but below trigger levels defined in ANZECC/ ARMCANZ (2018) interim sediment quality guidelines (IRCE, 2001).

The infield validation study completed by Oceanica (2015) determined that concentrations of all contaminants measured in sediments were below their respective ANZECC/ARMCANZ ISQG-Low and -High levels (where applicable). Zinc concentrations were elevated in the vicinity of the CPF, decreasing to background levels by 250 m from the CPF, similar to previous monitoring undertaken in 2000 (IRCE 2001). Lead and barium concentration results were similar to those reported in 2000; however, the copper and chromium results were slightly lower than those measured in 2000.

Oceanica (2015) also found that the organic content of sediments sampled were low and at least one order of magnitude lower than concentrations recorded in 2000 by IRCE. All hydrocarbon concentrations were below their limits of reporting, suggesting that there has been no hydrocarbon contamination in these sediments resulting from activities associated with the CPF. This is consistent with the previous sediment quality monitoring at the Stag Oilfield in 2000 (IRCE 2001).

Invertebrates

Benthic invertebrates include infauna within sediments such as polychaetes and other worms, molluscs and crustaceans while sessile and mobile epifauna may include crustaceans, cnidarians, molluscs associated with sediments and the Stag CPF structure (e.g. mobile and sessile epifauna and infauna).

Studies into the infauna, metal concentration and hydrocarbon concentration in the vicinity of the Stag platform suggests highly variable infauna abundance and composition amongst sites, with increased lancelet abundance within 200 m suggesting some level of change to infauna from human activity, interpreted to be most likely from drilling activity (IRCE, 2001). However, IRCE (2001) noted that natural changes to infauna community as a whole is likely to be on a larger scale than anthropogenic changes related to activities at the Facility.

NORMs within Stag produced water have been measured at 8.94 Bq/L which is at the lower range of levels recorded from samples worldwide (Neff *et al*., 2011a). On the NWS, a review of produced water impacts and relevant studies by Fandry *et al*. (2006) indicated only one study into NORMs at the Cossack-Pioneer offshore facility. This study found produced water discharge was not causing any build-up of radionuclides in sediments around the facility (Colman and West, 2000, cited within Fandry *et al*., 2006). Impacts due to NORMs on benthic invertebrates are not expected.

<u>Fish</u>

Benthic (demersal) fish associated with benthic habitats (i.e. sediments and the lower Stag CPF structure) are less likely to be exposed to dissolved hydrocarbons given that initial discharge modelling of the Stag CPF produced water plume indicates that the plume initially disperses within surface waters. Impacts to benthic fishes may be more due to ingestion of hydrocarbon droplets or precipitated metals on and above sediments although sediment sampling of hydrocarbons below the CPF has not detected the presence of hydrocarbons (IRCE, 2001; Oceanica, 2015).

7.4.3 Environmental Performance

Aspect		Discharge of produced water (EPH-5)					
Performance outcome		Produced water discharges achieve the national marine water quality guidelines for protection of 99% of species, and the sediment quality ISQG-low values, as defined by ANZECC/ ARMCANZ (2018) at the boundary of the area of impact					
		Planned operations		Contingency operations		Adaptive Management	
ID	Management Control	Performance standard	Measurement criteria	Performance standard	Measurement criteria	Performance standard	Measurement criteria
	Discharge						
016	Daily discharge of PW is monitored and recorded	Daily discharge rate from the CPF does not exceed 3,816 kL per day @ 15 mg/L oil in water	Daily report shows the volume of produced water discharged from the CPF did not exceed 3,816 kL and did not record an oil in water concentration greater than 15 mg/L	If the total daily discharge is approaching the volume of 3,816 kL, calculate the total oil load that has been discharged for the day (i.e. [OIW] x volume discharged) and ensure the total load does not exceed 57 kg oil/d [2]	Daily report shows a total oil load does not exceed 57 kg	If an increase in the total allowable daily discharge load is required, undertake management of change to determine whether there are changes to the environmental risks and impacts (as per **Section 4**) as provided for in the EP. If new or significant increases to risks and impacts are expected, revise EP and submit to NOPSEMA for acceptance.	Completed Management of Change process
	Measurement						
017	PW discharge managed and monitored	Inline analyser continuously measures oil in	CCR shows alarm was recorded if	Manual sample of produced water stream collected and	Compare manual sample results with inline analyser	N/A	N/A

[2] The rationale of calculating a discharged daily load of oil recognises multiple components of a discharge contribute to pollution of the environment – as well as the volume it is also the quality of the discharge that needs to be considered when evaluating environmental performance.

Aspect		Discharge of produced water (EPH-5)					
Performance outcome		Produced water discharges achieve the national marine water quality guidelines for protection of 99% of species, and the sediment quality ISQG-low values, as defined by ANZECC/ ARMCANZ (2018) at the boundary of the area of impact					
		Planned operations		Contingency operations		Adaptive Management	
ID	Management Control	Performance standard	Measurement criteria	Performance standard	Measurement criteria	Performance standard	Measurement criteria
	according to Measurement, Management and Reporting of Produced Water (GA-19-PR-P-00006)	water concentrations of produced water stream	the [OIW] >15 mg/L	oil in water concentration measured	measurement to confirm high concentration		
018				Discharge diverted inboard if [OIW] >30 mg/L within 10 minutes of the exceedance being identified	Once manual sampling results show [OIW] <30 mg/L discharge can recommence	N/A	N/A
019				If slops tanks on the CPF (and any other storage options) are at full capacity and PW remains off spec (i.e. above 30 mg/L OIW) production will cease	Daily reports show OIW results, slops storage volumes and time of shut in	N/A	N/A
020				If inline analyser is not operational, manual sampling to be done at least three times during day shift and three times during night shift	If manual sample results show a concentration above 15 mg/L increase manual monitoring frequency to every two hours	N/A	N/A

Aspect		Discharge of produced water (EPH-5)					
Performance outcome		**Produced water discharges achieve the national marine water quality guidelines for protection of 99% of species, and the sediment quality ISQG-low values, as defined by ANZECC/ ARMCANZ (2018) at the boundary of the area of impact**					
		Planned operations		**Contingency operations**		**Adaptive Management**	
ID	**Management Control**	**Performance standard**	**Measurement criteria**	**Performance standard**	**Measurement criteria**	**Performance standard**	**Measurement criteria**
021	PW discharge managed and monitored according to Measurement, Management and Reporting of Produced Water (GA-19-PR-P-00006)	Manual analysis of [OIW] in two manually collected produced water samples per day	[OIW] not to exceed 15 mg/L in a manual produced water sample	If a manual sample has an [OIW] >15mg/L, increase manual sampling frequency to every two hours	Once two consecutive manual samples show [OIW]s <15mg/L reduce sampling frequency to twice per day	N/A	N/A
022		[OIW]s in manual sample and inline analyser measurement at same time are compared within one hour of manual sampling results being available	Measured concentrations of the inline analyser are not to be more than 5 mg/L higher or more than 2 mg/L lower than the manual lab sample	If greater than +5 mg/L or -2 mg/L in concentrations difference is recorded, clean inline analyser	Post-clean measurement shows inline analyser successfully measuring [OIW]s		N/A
	Monitoring						
023	Bassnet work instruction details characterisation requirements of PW discharge	Biannual characterisation of contaminants (inc. NORMs) in produced water	Check contaminant concentrations are acceptable by applying a 1:332 dilution rate to measured concentrations to ensure	If contaminant concentration/s will not be sufficiently diluted to required background levels undertake WET testing of effluent stream	WET testing results show a 1:332 dilution requirement of discharge stream is still achievable	If WET testing results show the produced water discharge stream(s) can no longer meet the 1:332 dilution requirements, undertake management of change to determine whether there are changes to the environmental risks and impacts (as per **Section 4**) as provided	Completed Management of Change process

Aspect		Discharge of produced water (EPH-5)					
Performance outcome		Produced water discharges achieve the national marine water quality guidelines for protection of 99% of species, and the sediment quality ISQG-low values, as defined by ANZECC/ ARMCANZ (2018) at the boundary of the area of impact					
		Planned operations		Contingency operations		Adaptive Management	
ID	Management Control	Performance standard	Measurement criteria	Performance standard	Measurement criteria	Performance standard	Measurement criteria
			contaminant concentrations are back to background (99% ANZECC/ ARMCANZ 2000 trigger values) by the edge of the predicted mixing zone.[3]			for in the EP. If new or significant increases to risks and impacts are expected, revise EP and submit to NOPSEMA for acceptance.	
024		Whole effluent toxicity testing[4] every two years of produced water discharge with the first test to occur within 6 months of	WET testing results do not exceed 2008 results used to determine the mixing zone boundary (i.e. 1:332 dilution of	If WET testing results exceed 2008 test results, re-run mixing zone modelling to determine if the extent of the mixing	Modelling results show no change in areal extent of the produced water discharge plume	If the mixing zone area is predicted to increase in area based on new WET test results, undertake management of change to determine whether there are changes to the environmental risks and impacts (as per **Section 4**) as provided	Completed Management of Change process

[3] The work instruction applies to all measured contaminants. A listing of the contaminants measured is provided in **Appendix F**. The contaminant characterisation suite of analytes used to evaluate toxicity as a complement to ecotoxicity testing methods has been developed from guidance provided by the scientific literature, most notably Neff et al. (2011a)

[4] For noting, requirements for all WET testing referenced within this EP must include the following: testing will be undertaken by a NATA accredited laboratory; testing will follow protocols as recommended by ANZECC/ ARMCANZ (2000) including five locally relevant test species from four different taxonomic groups; the inclusion of chronic as well as acute tests to allow sub-lethal effects to be assessed; the differences in treatment concentrations should be limited to a factor of not more than 3.2 (OECD 1996); a coefficient of variation among control replicates be used to make sure the variability around the mean is acceptable to ensure the statistical analyses then conducted on the data is reliable.

Aspect		Discharge of produced water (EPH-5)					
Performance outcome		Produced water discharges achieve the national marine water quality guidelines for protection of 99% of species, and the sediment quality ISQG-low values, as defined by ANZECC/ ARMCANZ (2018) at the boundary of the area of impact					
		Planned operations		Contingency operations		Adaptive Management	
ID	Management Control	Performance standard	Measurement criteria	Performance standard	Measurement criteria	Performance standard	Measurement criteria
		acceptance of this EP	effluent required to meet mixing zone boundary concentrations)	zone increases in area[5]		for in the EP. If new or significant increases to risks and impacts are expected, revise EP and submit to NOPSEMA for acceptance.	
025		Annual Microtox® testing of produced water discharge	Microtox® test results show that the mean light output of the highest PW test concentration is not less than 80% of the mean light output of the reference water, and the two means are not statistically different from	If Microtox® test results show an unacceptable level of toxicity, commence full species suite WET testing	WET testing results do not exceed 2008 results and show the 1:332 dilution rate is met	If WET testing results exceed 2008 test results, re-run mixing zone modelling to determine if the extent of the mixing zone increases in area	Modelling results show no change in areal extent of the produced water discharge plume.

[5] The rate of discharge directly affects the nearfield mixing zone, with higher volumes achieving higher initial mixing rates (i.e. smaller footprint here). To a point, changed flows may offset an increased toxicity measurement. The size and boundary conditions of the initial mixing zone in turn affect the farfield mixing zone wherein the spatial extent over which a dilution rate is to be achieved is determined. Therefore discharge rates experienced at the time of re-test will also be applied to the re-model which may in turn affect the size of the environmental footprint.

Aspect		Discharge of produced water (EPH-5)					
Performance outcome		Produced water discharges achieve the national marine water quality guidelines for protection of 99% of species, and the sediment quality ISQG-low values, as defined by ANZECC/ ARMCANZ (2018) at the boundary of the area of impact					
		Planned operations		Contingency operations		Adaptive Management	
ID	Management Control	Performance standard	Measurement criteria	Performance standard	Measurement criteria	Performance standard	Measurement criteria
			each other (t-test, $p \leq 0.05$)				
026		Tracer dye verification of the modelled produced water discharge, including particle size distribution analysis of discharge streams, to be completed within 6 months of EP acceptance as per the Tracer Dye Experiment for Monitoring Produced Water (GF-70-PR-H-00002)	Tracer dye monitoring of produced water discharge streams confirms modelling predictions of the discharge footprint for soluble and particulate components of the discharge stream	If tracer dye monitoring of produced water discharge stream(s) does not verify assumptions of input data used in modelling, undertake infield water and sediment quality monitoring to confirm discharge footprint as per the Marine Monitoring Program for Produced Water (GF-70-PR-H-00001)[6]	Check water quality and sediment quality concentrations meet the water quality 99% trigger values and sediment quality ISQG-high trigger values (ANZECC/ ARMCANZ 2018) by the edge of the predicted mixing zones.[7]	If the measured discharge footprint is greater than the footprint presented in the EP, undertake management of change to determine if there are changes to the environmental risks and impacts (as per **Section 4**) as provided for in the EP. If new or significant increases to risks and impacts are expected, revise EP and submit to NOPSEMA for acceptance.	Completed Management of Change process

[6] For noting, while the ANZECC/ARMCANZ (2018) ISQG-low values have been referenced here, Jadestone will apply the values as provided by Sediment quality assessment: a practical guide (2016) by Simpson and Batley, along with future updates as relevant, when assessing data pertaining to marine sediment quality.

[7] The work instruction applies to all measured contaminants. A listing of the contaminants measured is provided in **Appendix F**. The contaminant characterisation suite of analytes used to evaluate toxicity as a complement to ecotoxicity testing methods has been developed from guidance provided by the scientific literature, most notably Neff et al. (2011a).

Aspect		Discharge of produced water (EPH-5)					
Performance outcome		Produced water discharges achieve the national marine water quality guidelines for protection of 99% of species, and the sediment quality ISQG-low values, as defined by ANZECC/ ARMCANZ (2018) at the boundary of the area of impact					
		Planned operations		Contingency operations		Adaptive Management	
ID	Management Control	Performance standard	Measurement criteria	Performance standard	Measurement criteria	Performance standard	Measurement criteria
	Maintenance						
027	Inline Analyser Operator Manual details maintenance requirements	Inline OIW analyser maintained in accordance with operator manual every 3 months	Completed maintenance records	If inline analyser not operational, increase manual sampling frequency to 6 times per day	Repair/ independent calibration report shows the inline analyser is functional	N/A	N/A
028	CPF laboratory spectrophoto-meter calibrated as per Preparation of OIW Standards and Calibration of Spectrophotometer (GA-19-PR-P-00027)	CPF laboratory spectrophoto-meter calibrated weekly with oil in water standards set	Completed calibration records	If calibration unsuccessful, raise work order for repair/ independent calibration	Repair/ independent calibration report shows the spectrophotometer is functional	N/A	N/A
029	Spectrophot-ometer Operator Manual details calibration requirements	Laboratory spectrophotometer calibrated by Stag Chemist biannually as recommended by the manufacturer to	Spectrophot-ometer successfully calibrated (i.e. reads OIW concentration as per calibration standards)	If calibration unsuccessful, raise work order for repair/ independent calibration	Repair/ independent calibration report shows the spectrophotometer is functional	N/A	N/A

Aspect		Discharge of produced water (EPH-5)					
Performance outcome		Produced water discharges achieve the national marine water quality guidelines for protection of 99% of species, and the sediment quality ISQG-low values, as defined by ANZECC/ ARMCANZ (2018) at the boundary of the area of impact					
		Planned operations		Contingency operations		Adaptive Management	
ID	Management Control	Performance standard	Measurement criteria	Performance standard	Measurement criteria	Performance standard	Measurement criteria
		ensure it maintains accurate results					
	Production & processing						
030	Chemical Selection and Approval Procedure details requirements of risk assessment for production chemicals	Production chemicals and their application is to be assessed and approved for use before application using Chemical Selection and Approval Procedure	Approval record completed prior to use	None – production chemicals and their application must be approved for use prior to application. If a chemical is assessed as unacceptable, an alternative chemical must be found suitable for the proposed application.	Approval record completed prior to use	N/A	N/A
031		Production chemicals to be added to the system at a dosage rate as prescribed in the chemical approval request	Daily monitoring of chemicals in production system show dosage rates are as per approved rate	None – production chemicals and their application must be approved for use prior to application.	Approval record completed prior to use	N/A	N/A
032	Chemical – Testing, Frequency, Reporting (GA-19-PR-P-00001)	Chemical usage volumes within acceptable rates as per procedure	Stag CPF Monthly Laboratory Report	None – production chemicals and their dosage rate must be	Approval record completed prior to use	N/A	N/A

Aspect		Discharge of produced water (EPH-5)					
Performance outcome		Produced water discharges achieve the national marine water quality guidelines for protection of 99% of species, and the sediment quality ISQG-low values, as defined by ANZECC/ ARMCANZ (2018) at the boundary of the area of impact					
		Planned operations		Contingency operations		Adaptive Management	
ID	Management Control	Performance standard	Measurement criteria	Performance standard	Measurement criteria	Performance standard	Measurement criteria
	procedure details the monitoring and reporting requirements of production chemical			approved for use prior to application.			
033	Change management process details the requirement for risk and impact assessment prior to change to operation	Production fluids to be processed as per the activity description in the EP	Daily reporting shows production is as per planned activity	N/A	N/A	If a new reservoir section is to be added to the production stream, the impact assessment process for produced water discharges from the CPF must be repeated	Repeat of impact assessment process of new produced water stream to follow Figure 7-15 in Section 7.4. Assessment does not find changes to contaminant loads are predicted, and the mixing zone for produced water discharge from the CPF does not change
034						If a change to the production processing equipment occurs, the impact assessment process for produced water discharges must be repeated	

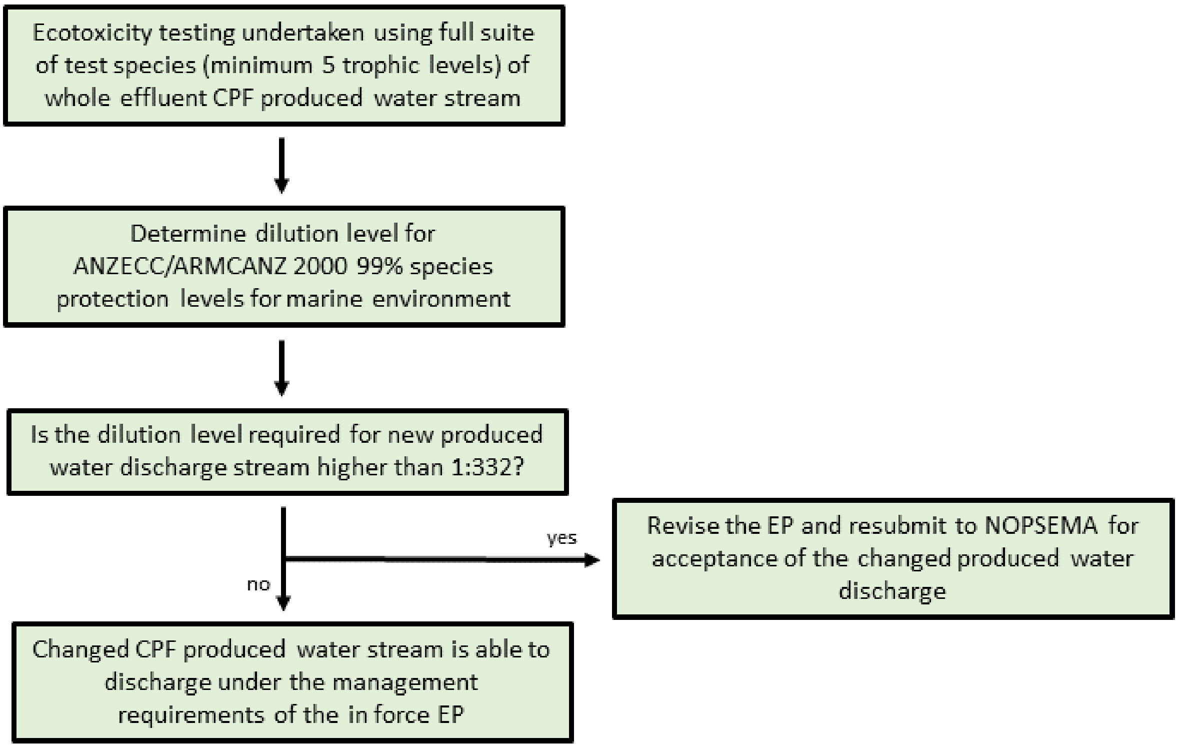


Figure 7-12: Impact assessment process for produced water discharges

7.4.4 ALARP Assessment

On the basis of the impact and risk assessment completed, Jadestone considers the control measures described above are appropriate to manage produced water discharges from the CPF. The residual risk ranking for this potential impact is considered Low, and therefore ALARP has been demonstrated. Further controls considered but rejected are detailed below.

Rejected control	Hierarchy	Practicable	Cost effective	Justification
Reinjection of produced water to the reservoir	Eliminate	No	No	The original Stag project design called for sea water injection into the reservoir to maintain reservoir pressure and to force water to pass through the pores in the reservoir to sweep the oil to the production wells. It was designed such that any produced water (formation and reproduced sea water) would be processed and discharged overboard. In 2008, a Compact Gas Floatation Unit (CGFU) and two new pumps were installed to allow the disposal of produced water with a high oil-in-water content back to the Stag Reservoir. This system allowed approximately 635 m^3/d to be injected back to the reservoir. This was initially moderately successful, however, in March 2009, the disposal well 18H was found to be in communication with

				the production wells and the practice of disposing of produced water down-hole ceased. Produced water was not deemed viable as an injection fluid as it is recognised in the industry that reinjection of produced water in reservoirs such as Stag needs to be conducted at fracturing pressure to overcome the plugging of pores by contaminants in the produced water. This fracturing creates channels from the injectors towards the producers that would allow the injection water to bypass the oil contained in the reservoir matrix and result in poor sweep and oil recovery. Therefore, PW reinjection is not a feasible option given the state of the reservoir.
Contain all PW and transfer to shore for onshore treatment and disposal	Eliminate	No	No	3,816kl per day, would require multiple trips. Containment would require storage on tanker for approx. 2 weeks, mooring system would be required and an offtake tanker. Increases risk of vessel collision incident with increased frequency of vessel trips. SIMOPS additional vessel in field, additional costs for treatment and disposal onshore
N/a	Substitute	N/a	N/a	No substitute for the discharge of produced water to the marine environment could be identified.
Process polishing	Engineering	No	No	In terms of reducing the OIW content of produced water, improvements to the current production process have reduced the OIW content of Stag CPF produced water to an average of 9.5 mg/L averaged over a 24 hour period. Other options for reducing OIW content further than current practices would include retrofitting the facilities with further processing equipment. Retrofitting additional produced water processing equipment on the CPF would require additional deck space which is limited. Reducing the OIW content of the produced water would require a sizeable storage vessel in order to facilitate the increased produced water residence time required to reduce OIW content further. Additional purchase and modification of equipment would negatively affect the commercial viability of the Facility and given that it is operating in an environment of low sensitivity (in terms of habitats and species) retrofitting is not considered a practicable option with respect to the environmental benefit it might provide.

Modification to discharge infrastructure	Engineering	No	No	Modelling to evaluate the possible modification of discharge infrastructure such that the produced water stream is discharged to the marine environment with a diffuser at the end of the discharge line has been prepared by APASA (2014). The fitting of a diffuser is intended to improve the initial dilution rate of the effluent stream in the near field mixing zone. Modelling of current discharge arrangements in which the produced water stream is released from an open hole pipe above sea level found a dilution rate of approximately 8 to 20 times within the near field mixing zone; variation in dilution rates was attributable to fluctuations expected in current speeds of the receiving environment. Modelling of the discharge infrastructure with a diffuser in place found that initial dilution rates were reduced compared to current discharge dilution rates to between 1.5 and 13.4 times, the variation again due to current speeds. Similarly, the scenario of a diffuser being fitted along with mixing the produced water stream 50:50 with seawater achieved a dilution rate of 6.7 to 26.1 times, however the horizontal distance travelled in the near field mixing zone increased from 1 to 7.7 m predicted with the current discharge infrastructure, to 1.6 to 18.8 m with a diffuser and pre-mixing with ambient seawater. These modelling results indicate that the current discharge infrastructure is effective at achieving initial dilution of the effluent stream within a reasonable horizontal distance of the marine environment entry point that is cost effective in terms of installation, management and repair requirements. Given the nature of the effluent being fresh, heated and containing oil (which has a specific gravity less than water) the rise through the water column within the initial mixing zone gives an excellent dilution rate which would not be improved upon enough to justify the expense (~100K) of diffuser installation.
Discharge of PW subsea	Engineering	No	No	The discharge outlet currently sits 0.5m above mean sea level, as a result the discharge point is both in and out of the water. The hydrostatic head that would need to be counted for a subsea discharge pipe would require additional pumps (increasing deck space usage), power requirements and result in additional air emissions for little environmental benefit as evidenced by the numerical modelling.
Storage and disposal onshore	Isolation	No	No	This disposal option is not deemed practicable as approximately 2,800 kL of produced water is generated each day. At these volumes, the CPF does not have the capacity to store the produced water with the current slops tanks providing for up to one hour of produced water containment only at normal production levels. Notwithstanding the lack of capacity for the CPF to store the volumes of produced water, the size and frequency of vessels removing produced water from the CPF would make the operation impractical. For example, it is estimated that it would take within 30 days to load a

				vessel with produced water which would then need to unload on a regular basis at a suitable port facility on the mainland. The costs and logistics make this grossly disproportionate to the production rates and economics of the Facility while introducing additional environmental risks associated with the transfer, transport and disposal of produced water.
N/a	Administrat-ive	N/a	N/a	The primary means of reducing the risk of environmental impacts from the composition of these chemicals is through the implementation of Jadestone's Operations Chemical Selection Evaluation and Approval Procedure (JS-70-PR-I-00033) which promotes the use of environmentally low risk chemicals based on ecotoxicity data and information gathered from ChemAlert. Production chemicals are required to be added to the production process to ensure the process is operating efficiently.
N/a	Administrat-ive	N/a	N/a	The quantity of chemicals used in the production process, and therefore the residual concentration discharged within produced water, is reduced to as low as practicable through routine sampling and assessment from various points in the production process. Concentrations of these chemicals have optimal levels; dosages need to be maintained above certain levels to meet the production requirements but excessive levels are reduced to reduce costs and the potential for environmental impacts from discharge of produced water.
Automatic closure of discharge	Engineering	<u>No</u>	<u>No</u>	<u>CPF</u> The manumatic procedural controlled design of intent of diverting off-spec PW has been in place since the original design of the CPF and has proven to work, where on immediate detection of higher than normal OIW, off-spec water is manually routed to the slops tank. The slops tanks are sized at 400 bbl, which has a very limited capacity of approximately 30 minutes of production; once this capacity is reached, diversion is then by either sent to the third-party tanker or production is restricted to allow troubleshooting. To change to an automatic system would involve the installation of a number of new valves, modification to the control system, adding further slop tank capacity or automatic protection to shut down the plant on high volume levels in the slops tanks which actually take us to the condition of the PW upsets, which are at their highest when starting the platform back up from a shutdown. Auto closure of discharge would lead to a greater likelihood of PW upsets. It would additionally remove the tried and tested process of having an operator being dispatched to the slops tank to monitor the upset.

On the basis of the impact and risk assessment completed, Jadestone considers the control measures described above are appropriate to manage produced water discharges from the CPF. Therefore, the residual risk ranking for this potential impact is considered Low, and ALARP has been demonstrated.	
Eliminate	Reinjection of produced water to the reservoir The original Stag project design called for sea water injection into the reservoir to maintain reservoir pressure and to force water to pass through the pores in the reservoir to sweep the oil to the production wells. It was designed such that any produced water (formation and reproduced sea water) would be processed and discharged overboard. In 2008, a Compact Gas Floatation Unit (CGFU) and two new pumps were installed to allow the disposal of produced water with a high oil-in-water content back to the Stag Reservoir. This system allowed approximately 635 m^3/d to be injected back to the reservoir. This was initially moderately successful, however, in March 2009, the disposal well 18H was found to be in communication with the production wells and the practice of disposing of produced water down-hole ceased. Produced water was not deemed viable as an injection fluid as it is recognised in the industry that reinjection of produced water in reservoirs such as Stag needs to be conducted at fracturing pressure to overcome the plugging of pores by contaminants in the produced water. This fracturing creates channels from the injectors towards the producers that would allow the injection water to bypass the oil contained in the reservoir matrix and result in poor sweep and oil recovery.
Substitute	No substitute for the discharge of produced water to the marine environment could be identified.
Engineering	Process polishing In terms of reducing the OIW content of produced water, improvements to the current production process have reduced the OIW content of Stag CPF produced water to an average of 9.5 mg/L averaged over a 24 hour period. Other options for reducing OIW content further than current practices would include retrofitting the facilities with further processing equipment. Retrofitting additional produced water processing equipment on the CPF would require additional deck space which is limited. Reducing the OIW content of the produced water would require a sizeable storage vessel in order to facilitate the increased produced water residence time required to reduce OIW content further. Additional purchase and modification of equipment would negatively affect the commercial viability of the Facility and given that it is operating in an environment of low sensitivity (in terms of habitats and species) retrofitting is not considered a practicable option with respect to the environmental benefit it might provide. Modification to discharge infrastructure Modelling to evaluate the possible modification of discharge infrastructure such that the produced water stream is discharged to the marine environment with a diffuser at the end of the discharge line has been prepared by APASA (2014). The fitting of a diffuser is intended to improve the initial dilution rate of the effluent stream in the near field mixing zone. Modelling of current discharge arrangements in which the produced water stream is released from an open hole pipe above sea level found a dilution rate of approximately 8 to 20 times within the near field mixing zone; variation in dilution rates was attributable to fluctuations expected in current speeds of the receiving environment. Modelling of the discharge infrastructure with a diffuser in place found that initial dilution rates were reduced compared to current discharge dilution rates to between 1.5 and 13.4 times, the variation again due to current speeds. Similarly, the scenario of a diffuser being fitted along with mixing the produced water stream 50:50 with seawater achieved a dilution rate of 6.7 to 26.1 times, however the horizontal distance travelled in the near field mixing zone increased from 1 to 7.7 m predicted with the current discharge infrastructure, to 1.6 to 18.8 m with a diffuser and pre-mixing with ambient seawater.

	These modelling results indicate that the current discharge infrastructure is effective at achieving initial dilution of the effluent stream within a reasonable horizontal distance of the marine environment entry point that is cost effective in terms of installation, management and repair requirements. Automatic closure of discharge The manumatic procedural controlled design of intent of diverting off-spec PW has been in place since the original design of the CPF and has proven to work, where on immediate detection of higher than normal OIW, off-spec water is manually routed to the slops tank. The slops tanks are sized at 400 bbl, which has a very limited capacity of approximately 30 minutes of production; once this capacity is reached, diversion is then by either sent to the third-party tanker or production is restricted to allow troubleshooting. To change to an automatic system would involve the installation of a number of new valves, modification to the control system, adding further slop tank capacity or automatic protection to shut down the plant on high volume levels in the slops tanks which actually take us to the condition of the PW upsets, which are at their highest when starting the platform back up from a shutdown. It would additionally remove the tried and tested process of having an operator being dispatched to the slops tank to monitor the upset.
Isolation	Storage and disposal onshore This disposal option is not deemed practicable as approximately 2,800 kL of produced water is generated each day. At these volumes, the CPF does not have the capacity to store the produced water with the current slops tanks providing for up to one hour of produced water containment only at normal production levels. Notwithstanding the lack of capacity for the CPF to store the volumes of produced water, the size and frequency of vessels removing produced water from the CPF would make the operation impractical. For example, it is estimated that it would take within 30 days to load a vessel with produced water which would then need to unload on a regular basis at a suitable port facility on the mainland. The costs and logistics make this grossly disproportionate to the production rates and economics of the Facility while introducing additional environmental risks associated with the transfer, transport and disposal of produced water. Note that any produced water on the tanker will be stored and disposed of at the cargo receiving facility, and therefore will not be discharged in the operational area.
Administrat-ive	Chemical selection Production chemicals are required to be added to the production process to ensure the process is operating efficiently. The primary means of reducing the risk of environmental impacts from the composition of these chemicals is through the implementation of Jadestone's Operations Chemical Selection Evaluation and Approval Procedure (JS-70-PR-I-00033) which promotes the use of environmentally low risk chemicals based on ecotoxicity data and information gathered from ChemAlert. Chemical usage The quantity of chemicals used in the production process, and therefore the residual concentration discharged within produced water, is reduced to as low as practicable through routine sampling and assessment from various points in the production process. Concentrations of these chemicals have optimal levels; dosages need to be maintained above certain levels to meet the production requirements but excessive levels are reduced to reduce costs and the potential for environmental impacts from discharge of produced water.

7.4.5 Acceptability Assessment

The potential impacts of produced water discharges are considered 'Broadly Acceptable' in accordance with the Environment Regulations, based on the acceptability assessment provided in the table below. In particular, the acceptability assessment provided below presents the risks, acceptable level of impact and an assessment of impact for each of the following environmental values:

- Water;
- Sediment;
- Fauna and habitat;
- Commercial fishing; and
- Principles of ecologically sustainable development.

For each environmental value, a Summary of the acceptable level of impact is provided at the end of each sub-section within the table.

Impact aspect	Acceptable level of impact	Assessment
Water		
Consideration: the key contaminants of concern in produced water are hydrocarbons, naturally occurring radioactive materials (NORMs), dissolved metals and nutrients. These contaminants may be associated with the water fraction, and/ or the particulate fraction, of the discharge stream.		
Hydrocarbons are considered the constituent of most concern to marine fauna within produced water, particularly polycyclic aromatic hydrocarbons (PAHs). Hydrocarbon exposure may lead to mortality in marine organisms as well as sub-lethal chronic (long exposure) effects such as decreased genetic diversity in communities, decreased growth and fecundity, lower reproductive success, respiratory problems, behavioural and physiological problems, decreased developmental success and endocrine disruption (Neff *et al*., 2011a).	Water quality concentrations for hydrocarbons, metals and nutrients meet the 99% species protection guidelines for contaminants (ANZECC/ARMCANZ 2018) after accounting for the 1:332 required dilution rate. For noting, the 99% species	Components of the plankton that could be impacted by produced water include micro-invertebrates; eggs; larvae of invertebrates; and fish. In addition to invertebrates within the plankton assemblage, larger pelagic invertebrates (e.g. jellyfish, squid, salps) will be present around the Stag Facility. The attached assemblages have an increased frequency and duration of exposure to the discharge stream given their fixed placement in the receiving environment. For motile species within the open water plankton assemblage, the exposure is limited in frequency (perhaps one-off events with the exception of motile species that may return to the artificial structure of the CPF and become exposed again), and duration given they are not held at one point in the environment.

Impact aspect	Acceptable level of impact	Assessment
Dissolved metals may create impacts to marine organisms if present at high enough concentrations and some metals have the potential to bioaccumulate, in particular mercury, selenium and cadmium (ANZECC/ ARMCANZ (2000)).	protection limits provide for the management of bioaccumulation/ biomagnification processes.	Pathways of exposure to the contaminants within the produced water stream include uptake of dissolved constituents (e.g. volatile, low molecular weight hydrocarbons such as BTEX hydrocarbons) across cellular structures, ingestion (filter feeding) of higher molecular weight hydrocarbons (e.g. PAHs associated with suspended oil droplets) or precipitated metals which may be bound to organic particulate matter that is small enough to remain buoyant (i.e. <63 µm in size). Impacts include acute effects at high concentrations such as lysis of single-celled organisms and narcosis of motile invertebrates leading to impaired swimming ability. Bioaccumulation of hydrocarbons (e.g. PAHs) and metals (in particular, Hg, Se and Cd) is most likely to occur in sessile invertebrates attached to the CPF sub-structure close to the discharge location experiencing repeated exposure. Included in this assemblage are macroalgae and macroinvertebrates (e.g. tunicates, soft coral, molluscs), as well as small fish with high site fidelity. The area of impact for the water column environment is predicted to be small scale (up to 70 m from the CPF before reaching 99% species protection concentrations) and is therefore unlikely to be significant at population or ecosystem scales for the organisms exposed to the discharge stream.
Elevated nutrient levels can lead to increased bacterial and phytoplankton production (e.g. phytoplankton blooms). In nutrient poor waters such as those in offshore marine environments, introduction of dissolved nutrients such as ammonia and nitrate to surface waters where high light levels are available will lead to rapid uptake by phytoplankton with associated increased biomass.		Increased water column biomass will be a highly localised feature (within tens of metres) associated with the availability of dissolved nutrients. The field validation study of the produced water area of impact at the Stag Facility (Oceanica, 2015) found slightly elevated ammonia and total phosphorus near the CPF discharge point. The influence of produced water on nutrient levels within the water column was generally limited to ≤ 200 m from the discharge and did not exceed ANZECC/ARMCANZ (2000) 99% species protection concentrations.
Within produced water the radioisotopes of primary concern are ^{226}Ra and ^{228}Ra, which are more likely to be dissolved within produced water than other NORMs, and which have the relatively longest half-lives of 1,601 and 5.7 years, respectively (i.e.	NORMs concentrations in water meet the 0.1Bq/L recreation guidelines (ANZECC/ ARMCANZ 2018) for gross alpha and gross beta	The environmental risk around radioisotopes in produced water is due to ionising radiation (alpha, beta and gamma radiation). Ionising radiation is high in energy and can break chemical bonds of exposed atoms. In some cases, in which the ionising energy is high enough, the nucleus of an atom may be damaged or destroyed, and in the circumstance of an organism's cell being exposed, the DNA may be damaged leading to mutations (Gordon, 1957).

Impact aspect	Acceptable level of impact	Assessment
they show greatest persistence in the marine environment).	concentrations after accounting for the 1:332 dilution rate.	Within produced water the radioisotopes of primary concern are ^{226}Ra and ^{228}Ra, which are more likely to be dissolved within produced water than other NORMs, and which have the relatively longest half-lives of 1,601 and 5.7 years, respectively (i.e. they show greatest persistence in the marine environment) (OGP, 2005). A food web study by Brookhaven National Laboratory in the Gulf of Mexico concluded that there would be no detectable impacts on fish, molluscs and crustaceans and the environmental risk of discharge within Gulf of Mexico is small (OGP, 2005). The MARINA II study conducted in the North Sea determined that the offshore oil and gas industry was the largest contributor of alpha radiation emitters in the North Sea but that the discharges were of insignificant risk to the health of marine life or humans (OGP, 2005). Jadestone completed water quality analysis of NORMs in produced water samples that had been filtered (soluble concentration only) and unfiltered (soluble and particulate concentrations) for gross alpha and gross beta levels of activity to evaluate water quality for radioactivity against the ANZECC/ARMCANZ (2000) recommended guidelines for recreation (0.1 Bq/L for gross alpha, and gross beta activity levels). Results showed results for soluble/total gross alpha activity levels to be 2.04/2.51 Bq/L, respectively, and for gross beta activity to be 2.29/4.15 Bq/L in neat (undiluted) produced water samples. In understanding that the particulate component of the produced water stream can be considered in the context of the 1:332 dilution factor, the application of this dilution factor shows that the radiation activity levels within produced water discharged from Stag to meet the ANZECC/ ARMCANZ (2000) recommended guideline (0.1 Bq/L) to be met by the boundary of the area of impact (0.006–0.125 Bq/L).
Summary: monitoring and measurement of the produced water discharge demonstrates that the marine water quality trigger values recommended by ANZECC/ARMCANZ (2000) for the protection of 99% species are met when taking into account a 1:332 dilution, as required by the Area of Impact showing that the discharge has an acceptable level of impact on water quality of the receiving environment.		
Sediments		
Consideration: while the produced water plume from Stag CPF primarily influences the quality of localised surface waters, there is the potential for particles within the plume, which may comprise metal oxides and low solubility hydrocarbon droplets (such as higher molecular weight PAHs), to drop out of the plume in the far-field mixing zone and accumulate in the sediments, or remain suspended and disperse into the larger environment on a regional scale (Neff *et al.*, 2011a).		

Impact aspect	Acceptable level of impact	Assessment
Dilution and chemical processes rapidly reduce the concentration of inorganic elements within the produced water stream when entering the sea (Bakke et al., 2013). Redox-sensitive species are likely to become insoluble, binding to other soluble ions or particles and precipitate upon discharge. Such processes affecting the solubility of contaminants may also influence the behaviour of metals, for example through co-precipitation with other complexes that have formed through changed physio-chemical qualities of the discharge as it moves through the production and discharge stages. Metals present in the marine environment as hydroxides or sulphides for example are not generally available for biological uptake. The study by Azectus-Scott et al. (2007) indicated three different fate pathways for inorganic elements: components that 1) stayed in solution would dilute along with the produced water plume in the receiving environment, 2) oxidise/ precipitate to form insoluble inorganic compounds that would sink, 3) associate with oil droplets that are lighter than seawater and rise to the surface.	Sediment quality concentrations meet the ISQG-high species protection guidelines for contaminants where available, as recommended by ANZECC/ ARMCANZ (2018).	For the purpose of estimating sedimentation rates, the average concentration of suspended solids (106.7 mg/L) was applied to the fate modelling undertaken for the produced water stream. Of this mass, the following particle size distribution was applied in the far field fate modelling of particles assumed in the produced water stream at Stag, in the absence of PSD data:

Class	Particle size (mm)	Settling velocity (cm/s)	12 ¼ " hole section % passing
Coarse sand	1	12.730	23.3
	0.5	7.500	4.0
Medium sand	0.45	6.600	2.1
	0.4	6.000	2.4
	0.35	5.000	2.8
	0.3	4.000	5.6
	0.25	3.100	6.7
Fine sand	0.2	2.300	8.9
	0.15	1.600	5.6
	0.1	0.800	4.2
	0.063	0.340	2.3
Total sands			**67.9**
Coarse silts	0.05	0.220	2.2
	0.04	0.150	1.6
	0.035	0.110	1.6
	0.03	0.080	2.2
	0.026	0.060	2.1
Medium silts	0.02	0.038	2.0
	0.016	0.026	20.4
Total silts			**32.1**

Impact aspect	Acceptable level of impact	Assessment
		The particle size distribution was biased towards coarser sizes ('sands'), which are commonly silica based particles with little binding opportunity for speciated contaminants, however which yield higher deposition rates. The finer particle sizes, the 'silts', while a smaller proportion of the particle size distribution range by mass, contain particles that are more likely to be charged (e.g. oil droplets with attached material, clay particles) and are more likely to contain the majority of contaminants. It is this dichotomy of particle size, likelihood of deposition, and contaminant-containing fraction that allows the impact assessment to interpret the estimated deposition rate in the far field associated with produced water discharges. The sediment loadings predicted by the model around the CPF were extremely light: 3.5 g of particulate material is approximately 3 teaspoons distributed across a one square metre area per year. When also considering that perhaps only 30% of this amount is the proportion with highest contamination potential, and that saltation (the 'jumping' of particles representing resuspension processes in the marine environment due to current movement), the threat to sediment quality due to particle loading from the produced water discharge stream is extremely low and would be very difficult to observe through sediment quality monitoring designed to measure contaminant concentrations. A water and sediment sampling study undertaken by IRCE (2001) at sites located between 50 and 200 m from the Stag CPF did not detect measurable levels of total petroleum hydrocarbons (TPH), at a 0.1 ppm (mg/L) detection limit, indicating that there had not been significant accumulation of hydrocarbons in sediments as a result of hydrocarbons dropping out of the produced water discharge plume (IRCE, 2001). These results included PAHs which are believed to be the constituent of most concern in discharged produced water due to their persistence in the environment and toxicity (Neff *et al*., 2011). The IRCE (2001) study determined that concentrations of chromium, copper, lead and zinc were slightly elevated within 50 m of the Stag CPF but below trigger levels defined in ANZECC/ ARMCANZ (2000) interim sediment quality guidelines (IRCE, 2001). The infield validation study completed by Oceanica (2015) determined that concentrations of all contaminants measured in sediments were below their respective ANZECC/ARMCANZ ISQG-Low and -High levels (where applicable). Zinc concentrations were elevated in the vicinity of the CPF, decreasing to background levels by 250 m from the CPF, similar to previous monitoring undertaken in 2000 (IRCE 2001). Lead and barium concentration results

Impact aspect	Acceptable level of impact	Assessment
		were similar to those reported in 2000; however, the copper and chromium results were slightly lower than those measured in 2000. Oceanica (2015) also found that the organic content of sediments sampled were low and at least one order of magnitude lower than concentrations recorded in 2000 by IRCE. All hydrocarbon concentrations were below their limits of reporting, suggesting that there has been no hydrocarbon contamination in these sediments resulting from activities associated with the CPF. This is consistent with the previous sediment quality monitoring at the Stag Oilfield in 2000 (IRCE 2001). As explained, the Stag CPF has hydrocyclones that remove particles from the fluid production stream. They are designed to remove particles sized 20 µm and larger from the fluid stream. As such, particulate material suspended within the produced water stream will comprise particle sizes <20 µm. Given that microscopic particles less than 0.5 mm or 500 µm, and colloidal particles, do not sink and are freely suspended (Bochdansky et al., 2010), particulates in the produced water discharge will remain suspended. As a result, contamination of the local benthic environments due to particulates in produced water discharged and accumulating in sediments is not considered a risk at Stag.
Summary: monitoring and measurement of the produced water discharge demonstrates that sediment water quality trigger ISQG-high values recommended by ANZECC/ARMCANZ (2000) have been met, and contamination of the benthic environment is not predicted within the Area of Impact, showing that the discharge has an acceptable level of impact on sediment quality of the receiving environment.		
Fauna and habitat values (incl. recovery plans and conservation advices)		
Consideration: the Area of Impact for the discharge of the produced water at the Stag Facility coincides with habitats that support fauna with conservation status, or the fauna directly.		
The facility and produced water discharge environment overlaps with the humpback whale and blue whale migration corridor, shearwater foraging, and the flatback turtle internesting areas which may result in a higher number of these species around the Stag Facility.	Produced water discharges do not contravene management objectives of fauna and habitat values as identified in bioregional plans, including recovery	The Flatback BIA (inter-nesting areas) although there may be transient individuals most females inter-nest close to their nesting beaches, typically in shallow (0–10 m) nearshore waters of their nesting beach (Chevron 2008) – unlike the depth of the operational area. The Stag Facility is in 49 m depth, and the nearest significant nesting beaches are 32 km away at Dampier Archipelago. The bioaccumulation/ biomagnification risk to marine turtles or the impact pathway is through the food chain. However, the BIA area overlapping the discharge area for inter-nesting. Sperling et al. (2010) concluded that flatback turtles do not feed

Impact aspect	**Acceptable level of impact**	**Assessment**
The Marine Turtle Recovery Plan identifies that the Operational Area is within the Flatback Turtle habitat that is critical to survival. The areas that may be affected by produced water discharges (a 70 m radial extent largely limited to the top 1 m of water column) represents less than 0.01% of the total area. Therefore, this does not represent a threat against the long-term and interim recovery objectives listed for the area identified as habitat critical to survival under the Marine Turtle Recovery Plan.	plans and conservation advices	during inter-nesting which greatly reduces the risk of bioaccumulation/ biomagnification. However, if individuals were likely to use this area as foraging grounds, outside of nesting season it would represent an insignificant percentage of all available nesting grounds and not significantly affect individuals or population. 'Management of oil spills and operational discharges' is identified as an action in the Marine Turtle Recovery Plan (DoEE 2017). The total size of the BIA for Pilbara flatbacks is 35,758,776 km^2. The areas that may be affected by produced water discharges (a 70m radial extent largely limited to the top 1 m of water column) represents less than 0.01% of the total area. Therefore, this does not represent a threat against the long-term and interim recovery objectives listed for the area identified as habitat critical to survival under the Marine Turtle Recovery Plan. Blue whale the area where blue whales are known to be distributed which is part of the species BIA overlaps the discharge area. Although little is known about their migration routes blue whale migration is thought to follow deep oceanic routes (DSEWPaC, 2012d). The blue whale is rarely present in large numbers outside recognised aggregation areas and it is unlikely large numbers would be found around the Stag Facility and exposed to produced water discharges. There is no Conservation advice for blue whale, but the species information (SPRAT Blue Whale, DEE 2017as) does not identify water quality as a potential threat, and no management actions will be compromised due to the release of produced water. Wedge tailed shear water the wedge tailed shearwater breeds on the east and west coasts of Australia on offshore islands. The species is common in the Indian Ocean. The species BIA (foraging areas) overlaps the Stag Facility and produced water discharge area. When foraging at sea the birds are often alone or in small groups and are unlikely to be impacted by change in water quality associated with the produced water discharge plume in the surface metre of the water column. Additionally, like with the turtles BIA, the proportion of foraging area likely to be impacted by produced water discharges (a 70 m radial extent from the discharge point) is minimal. The whale shark BIA is approximately 9 km from the Operational Area and individuals are known to pass through the area. Whale sharks spend the majority of their time in deeper waters, and avoid the surface produced water plume; however, the discharge may have a small indirect effect on plankton which is a food source for whale sharks (Meekan 2008). The predicted small scale of the area of impact however suggests that exposure impacts

Impact aspect	Acceptable level of impact	Assessment
		(sub-lethal or lethal) from produced water is not likely to significantly impact whale shark food sources. The Conservation advice for the whale shark identifies habitat disruption from the resource sector as a minor threat to the species (SPRAT Whale shark, DEE 2017as). However as described above the release of produced water 9 km from the nearest point of the whale shark BIA is not likely to have any impact on the species or habitat used by the species. Pipefish and seahorse Although the PMST report for the 1km buffer around the facility found a number of sygnathid 'species or species habitats may occur in the area' – there is no records of them actually occurring. Knowledge about the distribution, abundance and ecology of both syngnathids and solenostomids is limited (DSEWPaC 2012). Almost all syngnathids live in nearshore and inner shelf habitats, usually in shallow, coastal waters, among seagrasses, mangroves, coral reefs, macroalgae-dominated reefs, and sand or rubble habitats (Dawson 1985; Lourie et al. 1999, Lourie et al. 2004; Vincent 1996). In tropical areas species are primarily found among coral reefs (Foster & Vincent 2004; Scales 2010). Given the substrate observed in the produced water EMBA is predominately soft sediments it is considered unlikely for any of these species to be observed in the area. Contaminant levels from produced water discharges are not considered at a level that would impact on marine organisms such as syngnathids. This is supported by DSEWPaC (2012) which lists oil pollution from rigs as 'of least concern' to the species.
Summary: evaluation of the Area of Impact and quality considerations of the produced water discharge did not identify that either conservation objectives are compromised by the discharge stream, or threaten the fauna of interest, showing that the discharge is acceptable to conservation objectives relevant to the area.		
Commercial fishing values		
Consideration: the Area of Impact for the discharge of the produced water at the Stag Facility coincides with habitats that support commercial fishing interests.		
Elevated hydrocarbon levels in fish flesh have the potential to impact humans if affected fish species are targeted by fisheries. When present in foods, petroleum hydrocarbons stimulate an olfactory response in humans that causes a tainting of flavour or taste.	Water quality concentrations for hydrocarbons meet the 99% species protection guidelines for contaminants (ANZECC/	Effects may be experienced by pelagic fish within the produced water area of impact. Pelagic fish are commonly associated with offshore structures and therefore higher abundances are likely to occur around the CPF than in surrounding open water. Impacts to pelagic fish are likely to be caused by exposure to dissolved hydrocarbons (e.g. BTEX hydrocarbons) or metals across gill structures, although impacts could also occur through ingestion of hydrocarbon droplets. PAHs are the hydrocarbon of most concern in

Impact aspect	Acceptable level of impact	Assessment
Connell and Miller (1981) compiled a summary of studies listing the threshold concentrations at which tainting occurred for hydrocarbons. The results contained in their review indicate that tainting of fish occurs when fish are exposed to ambient concentrations of 4–300 ppm (mg/L) of hydrocarbons in the water, for durations of 24 hours or more, with response to phenols and naphthenic acids being the strongest.	ARMCANZ 2018) after accounting for the 1:332 required dilution rate.	terms of long-term exposure to produced water. While PAH concentrations may be elevated in fishes attracted to the CPF the elimination of PAHs is generally very efficient in fish and other vertebrates and bioaccumulation of PAH within these taxa do not generally reflect their level of exposure (van der Oost *et al*., 2003). The infield model validation monitoring study (Oceanica, 2015) found that concentrations of all hydrocarbons (TPHs, BTEX, PAHs) measured in marine waters were below the laboratory limits of reporting. Authors of the monitoring report (Oceanica, 2015) concluded that, considering that these compounds could not be detected in the receiving waters suggests that they pose little risk to the environment. No fishing is permitted within the 500 m restricted zone around the CPF and other subsea infrastructure. Given that the area of impact for produced water discharge lies within this restricted zone, and recent sediment and water quality surveys (Oceanica 2015) have found that concentrations of hydrocarbons (including PAHs) and mercury were below analytical detection limits, no impact to fish targeted by nearby fisheries is predicted. Furthermore, for the actively fished commercial fisheries in the area, the approved fishing area is extensive the purposes of flexibility and boundary simplicity, rather than being a true representation of where catch and effort is actually undertaken. Although the habitat within the operational area may represent suitable habitat for some of the commercial species, in reality fishing effort for these species will be focussed on areas of most suitable habitat and away from constraints such as infrastructure. Although some of the larger fish species may be transient through the operational area and then travel significant distances to active fishing grounds, this is was not considered a significant risk.
Summary: evaluation of the Area of Impact and quality considerations of the produced water discharge did not identify that commercial fishing activities are or will be compromised by the discharge stream, or threaten target species, showing that the discharge is acceptable to conservation objectives relevant to the area.		
Ecologically sustainable development		
Consideration: Jadestone must ensure that discharge of produced water at the Stag Facility does not contravene or perform in conflict with the intent of the principles of Ecologically Sustainable Development.		

Impact aspect	Acceptable level of impact	Assessment
a) decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations	The activity does not contravene or perform in conflict with the intent of the principles of Ecologically Sustainable Development.	The Jadestone risk assessment process and the Jadestone business management system both include long-term and short-term economic, environmental, social and equitable considerations when assessing exploration and development activities. The residual consequence ranking for discharge of produced water to the environment from the Stag facility was assessed as a category 1, 'slight effect; recovery in days to weeks; injury to organism' (refer **Table 7-1**).
(b) if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation		No threats of serious or irreversible environmental damage were identified in the impact assessment process for the discharge of produced water to the environment at the Stag facility. Scientific knowledge is available and supports this: produced water has been researched for over 20 years and is well documented in the scientific literature.
(c) the principle of inter-generational equity--that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations		As assessed above in the impact pathway overviews, no medium to long term effects are predicted or expected from the discharge of produced water from the Stag facility that will have inter-generational equity considerations.
(d) the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making		No impacts are expected or predicted that will threaten or contravene conservation values for those species that do or may occur in the discharge footprint. The deliberation on this matter is documented above in this table under ***Fauna and habitat values (incl. recovery plans and conservation advices)***
(e) improved valuation, pricing and incentive mechanisms should be promoted		Technical risk assessments for new or changes to activities within Jadestone consider safety, the environment and the economics of the activity prior to approval and implementation. By taking multiple lines of risk into account when planning and implementing activities, Jadestone includes the consideration of improved value, pricing and incentive mechanisms for itself, as well as other beneficiaries.
Summary: evaluation of the Area of Impact and quality considerations of produced water did not identify that discharge from Stag will contravene or perform in conflict with the intent of the principles of Ecologically Sustainable Development, showing that the discharge is acceptable in this regard.		

7.5 Discharge of Liquid Wastes

7.5.1 Description of Hazard

Aspect	Planned discharge of liquid wastes includes sewage, deck drainage and bilge water, cooling water and desalination brine. A summary of each waste type is provided below. A summary of chemicals used in operations that influence the quality of overboard liquid waste discharges is provided in **Table** 7-10. Sewage All sewage (including grey water) generated onboard the CPF is discharged through an inline macerator to comminute solids to a diameter of less than 25 mm. The discharge estimates are based on the known number of personnel on the Facility discharging an estimated 100 l/person/d. The CPF personnel on board (POB) levels are 20–24 during normal production operations although during platform maintenance, upgrade works, or well workovers the manning level of the platform can increase to the maximum of 58 POB. This loading includes sewage as well as grey water from laundry, showers and wash basins. Bleach is used as a disinfectant for the sewage discharge rather than chlorine or chloride tablets. Sewage treatment and disposal on support vessels is consistent with Marine Orders (Part 96), MARPOL Annex IV, Navigation Act 2012 and Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (Part IIIB). Deck drainage and bilge water The CPF has a drainage system that delivers drainage water, collected from rainwater and deck wash, work areas and machinery spaces to a slops storage tank. Deck drainage may contain minor quantities of oil, grease and detergents from machinery, fresh or waste oil drums and residual cleaning agents if present on the decks. Fluids collected in the slops storage tank are processed through the Second Stage of the Production Separation system and treated to < 30 mg/l OIW prior to discharge. Only drainage from the helicopter landing deck drains directly overboard. Dirty water on support vessels, including deck drainage and wastewater generated in machinery spaces, is directed to the slop tanks. No oily water will be discharged from the support vessels while moored to the CALM buoy. Cooling water Seawater is used as a heat exchange medium for the cooling of the three onboard power generators. The cooling water is drawn through a segregated cooling system and is therefore not contaminated by engine oils or other liquid discharges from the process. Average discharge rates are up to 108 m^3/h for each of the generators. Discharge water is approximately 3°C above ambient marine waters and is discharged at hull level. Seawater is drawn from the ocean and flows counter current through closed-circuit heat exchangers, transferring heat to the seawater. It is then discharged to the ocean via the seawater cooling caisson (i.e. a once-through system) as hot water of varying temperatures dependent upon the generators' workload. This water is drawn through a segregated piping system and is therefore not contaminated by engine oils or other liquid discharges from the process. Discharge is ~3°C above ambient waters and is from hull level which allows air cooling. Biocides are not added to the CPF cooling water system. An industrial grade saltwater chlorinator is used to produce chlorinated water to dose the respective caisson and pumps utilising sea water to prevent the accumulation of marine growth throughout the system. Seawater is used as a heat exchange medium for the cooling of vessel engines and machinery on support vessels. Desalination brine The freshwater system is designed to produce, store and distribute fresh and potable water throughout the CPF. During normal operations, fresh and potable water is produced via a desalination process and results in a brine discharge of ~850 m^3/d approximately 10% higher salinity than the intake seawater, an increase in temperature (between 27–39°C) and low concentrations of anti-scale

	chemicals. The seawater feed is taken from the main generator seawater cooling return line and further heated as required by steam supplied from the boiler. Potable water may also be delivered by supply vessel during extended maintenance periods. A unique hose connection is provided to prevent cross contamination by inadvertent transfer of diesel from the supply vessel. Storage is provided in a single Potable Water Tank, T960, of 215 m^3 capacity located within the west side of the hull structure. The tank is fitted with high and low level alarms, and trips.

Table 7-10: Chemicals Present in Operational Discharges

Chemical/ application	Injection point	[ ][1]	Risk ranking
Fire fighting foam	Fire pumps	~0.34 µg/L	Low
Hypochlorite	Potable water	~0.1 µg/L	Low
Scale inhibitor	Water maker	~0.06 µg/L	Low
Detergent	Used on deck	~0.79 µg/L	Low

[1] Determined from average chemical usage rates and average operational discharge rates

7.5.2 Impacts

Sewage

The routine discharge of sewage is likely to result in localised increases in nutrient concentrations, levels of phytoplankton and bacterial activity, and biological oxygen demand (BOD).

In terms of BOD, the open water conditions and swift currents of the receiving environment will dilute the discharge and prevent environmentally significant reductions of oxygen levels in the water column (Somerville et al., 1987, cited in Swan et al., 1994).

Sewage discharge has the potential to contribute to the organic content of sediments under the CPF. However, sediment monitoring conducted in 2000 by IRCE (2001) did not detect elevated organic content under the CPF in comparison to locations further away. It is likely that the highly dispersive marine environment and high water column productivity are preventing long term accumulation of organics under the Stag CPF.

Some fish and oceanic seabirds may be attracted to the Stag CPF and vessels by the discharge of sewage. This attraction may be either direct, in response to increased food availability, or secondary, as a result of prey species being attracted to the area. However, given the small quantities and intermittent nature of disposal, any attraction is likely to be minor and is not expected to result in adverse impacts at an ecosystem or population level.

While marine mammals and reptiles may transit through the area there are no feeding, breeding or other aggregation areas nearby. The localised extent of any increases in BOD, nutrients, bacteria or phytoplankton and short visit times of these fauna suggest that any impacts from discharged sewage are unlikely.

Deck drainage and bilge water

If not properly managed, the discharge of oily water has the potential to create an oil sheen on surface waters and a temporary highly localised decline in water quality and toxic effects to marine fauna. Toxicity to marine organisms would be from trace amounts of dissolved hydrocarbons in the oily water drainage after treatment. Given that oil and grease residues in oily water drainage will be in low concentrations, the potential for impact is low and would be further reduced due to the strong tidal movements experienced in the region and the naturally turbid environment.

Dispersion and biodegradation of potentially contaminated oily water drainage is expected to be rapid and highly localised resulting in no long-term or adverse effects on water quality or marine ecology.

Cooling water

The potential impacts arising from discharge of cooling water include:

- Thermal impacts to marine organisms; and
- Decline in water quality associated with lowered dissolved oxygen concentrations as a result of elevated water temperature.

When discharged to the sea surface, cooling water will initially be exposed to the atmosphere and subsequently air cooled. Upon reaching sea surface cooling water will then be subjected to turbulent mixing and some transfer of heat to surrounding waters. The plume will disperse mainly within surface waters being thermally buoyant, primarily in the direction of prevailing tidal currents (northwest–southeast).

The natural range in sea surface temperature at the Stag facilities location is between a low monthly average of 24^{o}C (winter and spring) and high of 27^{o}C (summer) (APASA, 2013). Assuming that a localised area around discharge locations was raised by 2^{o}C (as modelled at the Van Gogh field) a range of 26 to 29^{o}C may be experienced.

Organisms utilising surface waters including plankton, fish, marine turtles, marine mammals and seabirds. Fish and plankton are likely to be at greatest risk from cooling water discharge impacts since they are most likely to be attracted to the discharge location (fish) or entrained within the discharge plume (plankton). Fish and plankton are also relatively small, cold blooded organisms that may experience increased body temperature and altered physiological processes (e.g. increased respiration rate and oxygen demand). However, given that the area of raised water temperature will be highly localised and within the range of temperature on the North-West Shelf significant impacts on a larger ecosystem or population level to fish or plankton are not expected to occur.

Desalination brine

The potential impacts of desalination brine discharge on the environment include:

- Alteration of physiological processes of exposed biota; and
- Reduced water quality.

On discharge to the sea, desalination brine will sink and disperse in the currents. Given that discharged brine will have a salinity of ~10% greater than ambient seawater the largest increase of salinity experienced would be approximately 10% in the immediate vicinity of the discharge point. Most marine species are able to tolerate short-term fluctuations in the order of 20–30% (Walker and McComb, 1990), and it is expected that exposed organisms such as plankton, pelagic invertebrates and fish would be able to tolerate short-term exposure to the slight (maximum 10%) increase in salinity caused by the discharged brine. For large marine species that may temporarily use surface waters such as marine turtles, mammals and seabirds, the effect of a slight increase in salinity is expected to be negligible.

Cumulative impact assessment

Routine discharges of these liquid waste streams may cause a localised reduction in water quality, including a temporary increase in nutrient concentrations, temperature and salinity.

On entering the marine environment, sewage and cooling water from the CPF and support vessels will be subject to rapid dilution and dispersion by the prevailing currents and waves. Like produced water discharge (refer **Section 7.4**), sewage and cooling water being fresh and thermally buoyant waste water streams will disperse in surface waters primarily in the direction of prevailing tidal currents along a northwest-southeast axis.

Monthly discharges of sewage from the CPF are orders of magnitude less than monthly produced water discharge volumes and thus will be a much lower contributor of nutrients. A study into produced water discharge on water column productivity at the Harriet Alpha platform indicated only a localised effect on water column productivity despite elevated nutrients in produced water (Furnas and Mitchell, 1998). It is therefore expected that nutrient impacts from Stag CPF and support vessels sewage disposal will have very localised effects on water column productivity (e.g. bacteria and phytoplankton).

Modelling of cooling water discharges from *Ningaloo Vision* FPSO at the Van Gogh field on the North-West Shelf was conducted by APASA (2010). Modelling results for the combined discharge source (~7,000 m^3/h) indicated that within 50 m from the FPSO a sea temperature increase of 2°C is predicted to occur less than 25% of the time. The scale of impacts from the Stag facilities cooling water discharges are likely to be smaller than this given that the combined volume discharge is approximately an order of magnitude lower (1,000 m^3/h) than the volume modelled for the Van Gogh field FPSO, with the discharge coming from the CPF.

Woodside undertook brine wastewater discharge modelling (vertical, horizontal and temperature) for their Torosa South-1 appraisal well drilled near Scott Reef (Woodside, 2008). Modelling indicates that a 100:1 dilution of the discharge stream occurs within approximately 50 m of the discharge point under any condition (Woodside, 2008). Given that the marine environment is highly dispersive at the Stag location, a similarly localised mixing zone is expected to occur at the Stag location.

With high rates of initial mixing in the Stag field area, dilution to background conditions is expected to occur in the immediate vicinity of the discharge streams. As a result, short-term impacts to the environment and associated sensitivities due to discharge of liquid wastes are expected.

7.5.3 Environmental Performance

Hazard		Discharge of liquid wastes (EPH-6)		
Performance outcome		**No unplanned discharges of liquid wastes within the Operational Area** **Emissions and discharges of liquid waste to sea are in accordance with legislative requirements**		
ID	**Management controls**	**Performance standard**	**Measurement criteria**	**Responsibility**
	Sewage			
035	Sewage Treatment Plant operated in line with MARPOL requirements (vessels >400T)	Current International Sewage Pollution Prevention Certificate for STP (or equivalent) on vessels which confirms that required measures to reduce impacts from sewage disposal are in place	Valid ISPP Certificate	Operations Manager
036	Maintenance of sewage system: CPF	Sewage system maintained in accordance with the CMMS.	CMMS data indicates maintenance completed as scheduled. 14 day check on sewage treatment plant	Maintenance Technician
	Deck drainage and bilge water			
037	Oily water filtering and monitoring equipment fitted and maintained	If required under MARPOL Annex I, support vessels have oily water filtering and monitoring equipment that is compliant (e.g. discharges oily water with OIW <15 mg/L) and surveyed/ maintained as per MARPOL Annex I and an IOPP certificate	Maintenance records or a pre-mobilisation inspection report (e.g. OCIMF OVID, IMCA CMID, ISM inspection)	Logistics Lead
038		A continuous OIW monitor is in place and functioning on the CPF such that an alarm sounds in the CPF central control room if [OIW] is >30 mg/L	Central control room alarm log shows no alarm has been recorded due to [OIW] >30 mg/L Audit as per Bassnet	Stag OIM
039		Bilge water is transferred to slops tank	Bilge water transfer records	Stag OIM
	Cooling water			
040	Water cooled equipment is certified and maintained	Water cooled equipment/ machinery and heat exchangers on the CPF maintained in accordance with the CMMS	Bassnet shows maintenance has been satisfactorily completed as scheduled	Stag OIM

Hazard		Discharge of liquid wastes (EPH-6)		
Performance outcome		**No unplanned discharges of liquid wastes within the Operational Area** **Emissions and discharges of liquid waste to sea are in accordance with legislative requirements**		
ID	**Management controls**	**Performance standard**	**Measurement criteria**	**Responsibility**
	Desalination brine			
041	Potable water systems maintained	CPF potable water system maintained in accordance with the CMMS	Bassnet/CMMS shows when maintenance has been satisfactorily completed.	Stag OIM
042	Production chemicals selected for discharge in accordance with Chemical Selection Evaluation and Approval Procedure (JS-70-PR-I-00033)	Chemicals used are Gold/Silver/D or E rated through OCNS, or PLONOR substances listed by OSPAR, or have a complete risk assessment so that only environmentally acceptable products are used	Completed chemical risk assessment forms for new chemicals	Stag OIM

7.5.4 ALARP Assessment

On the basis of the impact and risk assessment completed, Jadestone considers the control measures described above are appropriate to manage liquid waste discharges from the CPF and support/ supply vessels. The residual risk ranking for this potential impact is considered Low, and therefore ALARP has been demonstrated, no further controls are required. Additional controls considered but rejected are detailed below.

Rejected control	Hierarchy	Practicable	Cost effective	Justification
All wastes stored onboard CPF and tanker and transferred to shore for onshore treatment and disposal	Eliminate	No	No	Costs associated with complete re-engineering such that wastes contained onboard and disposed of onshore, onshore treatment and disposal costs and increase in fuel consumption due to multiple vessel transfers would be disproportionate to the environmental benefit gained given the rapid dilution in offshore water/ atmosphere and low potential impact from discharges/ emissions. In addition, transfers increase the risks of spills/ leaks and safety risks to personnel during transfer operations.
Reduce toxicity of discharges	Substitute	No	No	Chemicals selected for discharge in accordance with the procedure to ensure that there is a low potential impact. Further substitution of all chemicals to the lowest potential impact only (e.g. only PLONOR) is not practicable as chemicals are required for the activity. Little benefit determined given lack of sensitive receptors in area.
Re-engineer equipment to retain wastes onboard	Engineering	No	No	Costs associated with complete re-engineering such that wastes contained onboard and disposed of onshore would be disproportionate to the environmental benefit gained. There is not enough space on board the facility or vessels to have storage tanks for all the waste produced prior to transferring to a vessel for onshore treatment and disposal. Substantial additional costs for re-engineering is grossly disproportionate to the benefit gained.
N/a	Isolation	N/a	N/a	The Activity is located at distance from sensitive receptors and the coastline and no significant impacts on receptors are predicted.
N/a	Administrative	N/a	N/a	Maintenance management system implemented, compliance with relevant and appropriate MARPOL requirements and certified equipment ensure discharges meet regulatory requirements.

7.5.5 Acceptability Assessment

The potential impacts of liquid waste discharges are considered 'Broadly Acceptable' in accordance with the Environment Regulations, based on the acceptability criteria outlined below. The control measures proposed are consistent with relevant legislation, standards and codes.	
Policy compliance	Jadestone's HSE Policy objectives are met.
Management system compliance	**Section 9** demonstrates that Jadestone's HSE Management System is capable of meeting environmental management requirements for this activity.
Social acceptability	Stakeholder consultation has been undertaken (see **Section 6**), and no stakeholder concerns have been raised with regard to impacts from liquid waste discharges on sensitive receptors.
Laws and standards	Liquid waste discharges are compliant with MARPOL and AMSA Marine Orders.
Industry best practice	The APPEA Code of Environmental Practice (CoEP) (2008) objectives are met with regard to offshore production operations.
Environmental context	While there are liquid waste discharges to sea surface immediately around the Stag facility, the impact and risk assessment process indicates that discharges will not result in significant effects to marine fauna. The potential impact is considered acceptable after consideration of: - Potential impact pathways - Preservation of critical habitats - Assessment of key threats as described in species and Area Management /Recovery plans - Consideration of North-West Bioregional Plan; and Principles of ecologically sustainable development ESD
ALARP	The residual risk has been demonstrated to be ALARP.

7.6 Interaction with Other Users

7.6.1 Description of Hazard

Aspect	The presence of the 500 m radius Restricted Zone (the Operational Area) and 3 nm Cautionary Zone creates a localised disturbance for other users of the area including commercial and recreational fishers, and shipping traffic.

7.6.2 Impacts

Presence of the Stag Facility and the associated restricted and cautionary zones result in the preclusion of other users including commercial and recreational fishers, and commercial shipping traffic, to use the area for their purposes.

While commercial and recreational fishing is permitted to occur in the vicinity of the Operational Area (refer to **Section 5.9.1** for information on State and Commonwealth fisheries permitted to operate in the vicinity of the Operational Area), the placement of the 500 m restricted zone means relevant commercial and recreational fishers are unable to work the area of the restricted zone.

Despite the imposition to commercial and recreational fishers due to the restricted zone, commercial and recreational fishing effort is not anticipated within the Operational Area as the area does not represent important habitat for targeted species, such as natural seabed features (e.g. rocky outcrops or coral reef).

Consequently, waters associated with the Stag Facility do not support significant fishing activity and therefore impact to fishers is predicted to be minimal. Any impacts to commercial or recreational fishing would not be expected to have a significant effect on the catches or income of fishers. No feedback during consultation of relevant persons, including commercial fishers, was received indicating that impact to commercial fishers has or will result from operation of the Stag Facility.

The presence of the Stag CPF 500 m restricted zone, 3 nm cautionary zone, and the movement of support vessels, present obstacles for shipping traffic in the region and are potential navigational hazards and a collision risk. The Stag Facility is located 4 km northwest of the nearest designated shipping route and so it is not anticipated there will be high commercial shipping traffic in the immediate area (refer to **Section 5.9.4** for details on commercial shipping, including designated shipping routes, and **Figure 5-12**) (AMSA, 2012). Any detour by shipping traffic that may occur is considered negligible in comparison to the area available for vessels to navigate through.

7.6.3 Environmental Performance

Aspect		Interaction with other users (EPH-7)		
Performance outcome		**Recreational and commercial fishers, and shipping traffic, are aware of the Stag Facility Operational Area and associated activities**		
ID	**Management controls**	**Performance standards**	**Measurement criteria**	**Responsibility**
043	Stag facility maintains navigational and communication equipment in accordance with legislative requirement	The Stag facility and CALM buoy are chartered on Australian Hydrographic Service (AHS) nautical charts with gazetted PSZ	Annual audit confirms accuracy of AHS charts and Stag location	Stag OIM
044		AIS system on CPF	PMS records show evidence of navigation and communication equipment maintenance	Maintenance Supervisor
045		Continuously manned CPF CCR	CCR log documents continuous manning	Stag OIM
046		Periodic navigation light checks and servicing for CPF recorded in CMMS	CMMS records show evidence of navigation lighting maintenance	Maintenance Supervisor
047		Marine Navigation lights on the CPF shall be provided to ensure at least one light is visible upon approaching the structure from any direction	CMMS records show evidence of navigation equipment presence and maintenance	Maintenance Supervisor
048		A Marine VHF Radio is located and functioning in the CPF radio room and central control room (CCR)	Bassnet and assurance through daily use	Maintenance Supervisor
049	Jadestone Energy Stakeholder Engagement Plan (JS-70-STD-I-00001) details consultation requirements to ensure other marine users are aware of the activity	Consultation undertaken with relevant stakeholders as **Section 6**	Stakeholder communication records	Country Manager

7.6.4 ALARP Assessment

On the basis of the impact and risk assessment completed, Jadestone considers the control measures described above are appropriate to reduce as far as practicable the imposition due to the physical presence of the Stag facility to activities undertaken by relevant persons in the area. The residual risk ranking for this potential impact is considered Low, and therefore ALARP has been demonstrated, no further controls are required. Additional controls considered but rejected are detailed below.

Rejected control	Hierarchy	Practicable	Cost effective	Justification
Removal of facility and vessels	Eliminate	No	No	To not be physically present is not an option for the Stag facility operations. Operation of the facility would not be possible without the replenishment of supplies required for safe operations.
Store oil on CPF to remove requirement for third-party tanker and thereby reduce exclusion area to that around the CPF only	Substitute	No	No	While creating the ability to store oil on the CPF would reduce the spatial footprint of the Operational Area, the costs associated with the modifications required would be disproportionate to the benefit that would be received by other users of the area. Reducing the area of the safety restricted zone would result in minimal environmental gain, while potentially increasing the risk of vessel collision.
Re-engineer to remove requirement for topsides altogether	Engineering	No	No	Costs associated with complete re-engineering of the facility such that the need for topsides infrastructure was not required would be grossly disproportionate to the benefit that would be received by other users of the area.
N/a	Isolation	N/a	N/a	Stag operations is located outside of shipping fairways and is not positioned in highly prized fishing habitat.
Additional activity specific navigational or communications requirements	Administrative	No	No	The vessel navigational management and monitoring measures in place are industry standard and internationally accepted measures to minimise the potential for interference with, or collision between, vessels. Frequent and informative communication with relevant persons regarding activities associated with the Stag facility are undertaken. Additional procedures would provide no further benefit.

7.6.5 Acceptability Assessment

The potential impacts of the Stag facility and associated activities on other users are considered 'Broadly Acceptable' in accordance with the Environment Regulations, based on the acceptability criteria outlined below. The control measures proposed are consistent with relevant legislation, standards and codes.

Policy compliance	Jadestone's HSE Policy objectives are met.
Management system compliance	**Section 9** demonstrates that Jadestone's HSE Management System is capable of continuously reviewing and updating activities and practices at the Stag facility to reflect the requirements of relevant persons.
Social acceptability	Stakeholder consultation has been undertaken (see **Section 6**), and no stakeholder concerns have been raised with regards to impacts of the Stag Facility on relevant persons.
Laws and standards	The Stag facility is chartered on Australian Hydrographic Service (AHS) nautical charts, and navigation and communication equipment are in place and operable on the assets, as per AMSA's requirements.
Industry best practice	Stakeholders have been provided information on the location and operation of the facility and the infrastructure is indicated on navigational charts.
Environmental context	While the Stag facility presents a restricted zone to other users, the impact and risk assessment process indicates that the area of restriction is localised and occurs at a location that is not likely to result in significant penalties to the activities of relevant persons currently active in the area. The potential impact is considered acceptable after consideration of Principles of ecologically sustainable development (ESD).
ALARP	The residual risk has been demonstrated to be ALARP.

7.7 Interaction with Fauna

7.7.1 Description of Hazard

Aspect	Physical presence of infrastructure and the movement of vessels and helicopters.

7.7.2 Impacts

No impacts to marine fauna are expected to occur due to operation of the Stag Facility.

Potential impacts to marine fauna and avifauna may occur as a result of:

- The physical presence of the Stag Facility; or
- Vessel and helicopter movements associated with routine operations.

Potential physical and behavioural impacts may range from temporary and localised displacement to injury or mortality from vessel strike.

Impacts associated with noise are outlined in **Section 7.2.**

Physical presence

Species most susceptible to impacts from physical presence include turtles, birds, and cetaceans. Migratory species such as seabirds may experience localised and short term effects through behavioural changes; such as roosting on platforms, or changed feeding patterns in nearby waters in response to other factors such as attraction of fish to the infrastructure (Verhejen, 1985; Weise *et al*., 2001). This is predominantly attributed to the observation that structures in deeper water environments tend to aggregate marine life at all trophic levels, creating food sources and shelter for seabirds (Surman, 2002). Behavioural changes could affect the size and composition of the seabird community in the local area.

The Stag infrastructure is within an area identified as 'species core range' for humpback whales and it is possible that these and other whale species may transit the area during migration periods. Based on evidence outlined in **Section 5.6.2**, during the northern migration, individuals may be in the deeper waters while those in the southern migration tend to stay in shallower waters and so outside the Operational Area. The

Operational area is not close to any identified aggregation areas such as resting or calving locations and is within a migration corridor ~200 km wide, so is not considered a restricted corridor. It is assessed that the Stag CPF and third-party tanker do not present large obstacles that would pose an issue to individuals as they will be able to easily swim around the infrastructure with minimal deviation from migratory routes.

The Operational Area is overlapped by the flatback turtle BIAs (**Figure** 5-8) and the BIA of the whale shark is 9 km away and as such individuals may transit the area.

Slight deviations by migrating marine fauna including humpback whales, pygmy blue whales and whale sharks, to avoid the Stag Facility may be required, however this impact is considered negligible given the large navigable area available and the relatively small Operational Area. Consequently, the presence of the Stag Facility and associated vessels is unlikely to disrupt important life-cycle events of marine fauna as no aggregation areas are located in the vicinity and so impacts at an individual and population level are considered minimal.

The presence of subsea structures has the potential to provide artificial habitats for marine organisms such as fish, resulting in a local increase in biological productivity and diversity and possible alteration of predator or prey refuges and visual clues for aggregation (Galloway *et al*, 1981). However, it is likely the artificial habitat will have either negligible adverse environmental impact or a low level of positive environmental impact through an increase in species diversity or richness in the area.

Vessel/ Helicopter strike

There is significant vessel traffic transiting from ports in the North-West and so the threat of ship strikes to whales is present throughout the region. Species most susceptible to vessel strike include cetaceans, whale sharks and turtles, and this is reflected as a threat in many of the conservation advice and recovery plans for these species (refer **Table** 5-3). Other fauna such as birds, fish and sea snakes are more likely to avoid vessels operating in the area and so are considered at low risk of potential strike and will not be discussed further.

Cetaceans including humpback whales demonstrate a variety of behaviours in response to approaching vessels (attributed to vessel noise), including longer dive times and moving away from the vessel's path with increased speed (Baker and Herman, 1989; Meike *et al*., 2004). These behaviours (discussed in **Section 7.2**) may actually contribute to reducing the likelihood of a vessel strike.

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 (Laist *et al*. 2001, Jensen and Silber 2003). 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 10% at 4 knots to 80% at 15 knots. Vessels within the Operational Area will travel no faster that 5 knots, and hence the chance of a vessel-whale collision resulting in lethal outcome is reduced. The US NOAA database (Jensen and Silber, 2003) indicates there are only two known instances of collisions when the vessel was travelling at less than 6 knots and both of these were from whale watching vessels that were deliberately placed amongst whales.

Although the whale shark's skin is thicker and tougher than any other shark species, the species may be more vulnerable to boat strike as they spend a significant amount of their time close to the surface of the water (DEH 2005a). DBCA developed a code of conduct for commercial vessels engaged in whale shark watching and these measures have been used to develop minimum requirements for support and supply vessels in the Operational Area: vessels shall not approach closer than 400 m from a whale shark.

Given that marine turtles, particularly flatback turtles, who's BIA overlaps the Operational Area, are known to occur in the vicinity of the Stag Facility, there is a risk of potential vessel strike. Hazel *et al.* (2007) suggested that higher vessel speed is more likely to cause impacts particularly in shallow waters where turtles are abundant and the success of avoidance behaviour is a factor of the response time available (i.e. visual observation distance/ vessel speed). By implementing reduced vessel speeds to <5 knots in the Operational Area, the likelihood of a strike and the severity is greatly reduced.

Given the slow operating speed of support and supply vessels as well as the low likelihood of large numbers of aggregating animals being present, the potential for vessel strike to impact significantly on a cetacean, whale shark or turtle population in the Operational Area is assessed to be low.

Helicopter movements have the potential to affect birds through direct strike, however, considering the high visibility and noise levels associated with helicopter movements, birds are expected to avoid collisions with helicopters. The number of helicopter flights required is relatively low averaging two inward/ outward flights per week. Flights also occur in the daylight and not within major roosting areas, thereby reducing potential interactions and subsequent physiological impacts. Collisions are therefore considered unlikely.

7.7.3 Environmental Performance

Hazard		Interaction with fauna (EPH-8)		
Performance outcome		**No death or injury to EPBC Act listed marine fauna due to operational activities in the Operational Area**		
ID	**Management Control**	**Performance standards**	**Measurement criteria**	**Responsibility**
050	See I.D 007-008 for appropriate performance standards			
051	Vessels operate at speeds in accordance with Stag Marine Facility Operating Manual (GF-90-MN-G-00038) to reduce potential for collision with marine fauna	Vessels operating within the restricted zone must not exceed a speed of five (5) knots.	Sign off sheet completed by Vessel Master	Operations Manager
052	Competency and Training Management System [JS-60-PR-Q-00015] provides a process for ensuring that Contractors and Services Providers have the appropriate level of HSE capability	Online induction includes information on speed limits in the restricted zone and requirements on interacting with marine fauna	Sign off sheet completed by Vessel Master Induction Records (Vessel Contractors)	HR Manager
053	Marine fauna collisions reported to National Ship Strike Database	Any vessel collision with a whale in the operational area is submitted to the National Ship Strike Database at: https://data.marinemammals.gov.au/report/shipstrike Death or injury to EPBC Act listed marine fauna (including cetaceans or whale sharks) from vessel collision are recorded/reported to NOPSEMA and DAWE in line with regulations	Vessel collision incident report Database entry number	HSE Manager

7.7.4 ALARP Assessment

On the basis of the ERA conducted, and the use of relevant tools appropriate to the decision type, Jadestone considers the control measures described above are appropriate to manage the risk of collision between vessels and marine fauna or negative interaction with helicopters. The residual risk ranking for this potential impact is considered Low and therefore ALARP has been demonstrated. Additional controls considered but rejected are detailed below.				
Rejected control	**Hierarchy**	**Practicable**	**Cost Effective**	**Justification**
Removal of vessels and helicopter use	Eliminate	No	No	Vessel and helicopter presence is required during operational activities and there are no practicable alternatives. The potential for interaction between support and supply vessels and fauna cannot be eliminated, however the risk is extremely low given the low volume of vessel activity and speed limits.
Reduce frequency or size of support and supply vessels	Substitute	No	No	Reducing the frequency or size of support and supply vessels would introduce disproportionate operational and safety risks; for example, the vessel is required to be of sufficient size and power to enable efficient and timely supply the necessities/ services to maintain effective operation of the CPF and third-party tanker and to provide support in an emergency, e.g. man over board.
N/a	Engineering	N/a	N/a	Not relevant
Reduce or remove vessel and helicopter use during key sensitive periods	Isolation	No	No	Reducing or removing vessel and helicopter activities during known migration periods of marine fauna is not a viable option as these activities are necessary for the safe and efficient operation of the facility.
Use of Marine fauna observers on all vessels to identify fauna close to vessels	Administrative	N/a	N/a	Support and supply Vessel Masters will complete an environmental induction which includes the applicable requirements or speed limits and avoiding fauna. The introduction of a specialist marine fauna observer is unlikely to increase detection and the additional cost is considered grossly disproportionate given the low vessel speeds and low potential for impacts on marine fauna.

7.7.5 Acceptability assessment

The potential impacts of the physical presence of infrastructure and vessels are considered 'Broadly Acceptable' in accordance with the Environment Regulations, based on the acceptability criteria outlined below. The control measures proposed are consistent with relevant legislation, standards and codes.	
Policy compliance	Jadestone's HSE Policy objectives are met.
Management system compliance	**Section 9** demonstrates that Jadestone's HSE Management System is capable of meeting environmental management requirements for this activity.
Social acceptability	Stakeholder consultation has been undertaken (**Section 6**), and no stakeholder concerns have been raised with regards to impacts from vessel/ helicopter operations on sensitive receptors.

Laws and standards	Aspects of the Environment Protection and Biodiversity Conservation Regulations 2000, Division 8.1 – Interacting with Cetaceans Recovery Plan for Marine Turtles in Australia, (EA 2003) Conservation Advice for Humpback Whales (*Megaptera novaeangliae*) DoE 2015
Industry best practice	The APPEA Code of Environmental Practice (CoEP) (2008) objectives are met with regards to offshore production operations. Whale Shark Code of Conduct (DEC)
Environmental context	The Operational Area overlaps the humpback whale 'species core range', is adjacent to the whale shark BIA and overlaps the flatback turtle inter-nesting BIA. However, risk to megafauna is considered low and acceptable as vessels will travel at <5 knots; minimal vessel activity in the area, and risk of mortality from a low-speed vessel strike is low. The potential impact is considered acceptable after consideration of: - Potential impact pathways - Preservation of critical habitats - Assessment of key threats as described in species and Area Management /Recovery plans - Consideration of North-West Bioregional Plan; and Principles of ecologically sustainable development ESD
ALARP	The residual risk has been demonstrated to be ALARP.

7.8 Physical Footprint

7.8.1 Description of Hazard

Aspect	Following an integrity inspection, it may be necessary to modify the seabed in the vicinity of subsea infrastructure such as the pipeline to correct for free spans (by placing grout bags under the free span) or burial (by jetting or airlifting sediments from on top of the pipeline). As part of facility maintenance, marine growth is periodically removed either using water blasting or manual ROV, divers or bespoke automatic devices.

No other discharges to the marine environment resulting in disturbance to the seabed are expected due to IMR, corrosion control and integrity, and plant modification activities. Discharges to the environment do not occur during as a result of work over and well intervention activities as the work is carried out on wells that are accessed on the topside of the platform. Vessels used for maintenance and integrity activities in close proximity to the facility will maintain station using dynamic positioning, and will not anchor, thereby not causing impacts to the seabed.

For more information on these activities refer to **Sections 3.2.5, 3.2.6, 3.2.8** and **3.2.9**.

7.8.2 Impacts

Disturbance to marine habitats and the seabed may occur in the event subsea infrastructure needs to be modified or repaired. The physical presence of subsea infrastructure creates habitat for organisms that are attracted to and/ or attach to hard substrates.

Potential impacts from the presence of infrastructure over the life of the development are:

- Localised physical damage/ loss to soft sediment benthic habitats and associated biota under and nearby the subsea infrastructure footprint; and
- Provision of artificial habitat for benthic and pelagic organisms.

Temporary or permanent direct loss of benthic habitat and associated biota will occur under the footprint of subsea infrastructure. The Stag CPF, CALM buoy (anchors and chains) and subsea export pipeline have been in place since commissioning in 1998. In the event that the installation of additional or replacement subsea infrastructure (e.g. tie in spools) is required, this will create further disturbance to the seabed in the immediate area of existing infrastructure.

The scale of habitat loss and seabed disturbance from the physical presence of infrastructure is small in comparison to the vast size of soft substrate habitats spanning the North-west Shelf. The impacted benthic habitats and associated biota are well represented in the region and there are no known areas of sensitive habitat (e.g. corals, seagrass) within the Stag Facility area.

The operational area is within a habitat critical to survival for flatback turtles (as referred to in Table 6 of the 2017 National marine turtle recovery plan). However, the total size of the BIA for Pilbara flatbacks is 35,758,775 km^2. The areas that may potentially be affected by physical presence would represent a very small percentage of the total area.

The presence of subsea infrastructure has the potential to act as artificial habitat or hard substrate for the settlement of marine organisms that would not otherwise be successful in colonising the area. Over time the colonisation of subsea infrastructure can lead to the development of a ‘fouling’ community, which subsequently provides predator or prey refuges, foraging resources for pelagic fish species and artificial reefs potentially supporting fish aggregations (Gallaway et al., 1981).

The presence of seabed and floating structures may have a minor positive benefit with reef associated species such as cods and snappers preferring habitat of structural complexity. Similarly, near-surface infrastructure can support pelagic species that are commonly attracted to fixed and drifting surface structures in areas of open-ocean (Lindquist et al., 2005).

Impacts associated with the provision of artificial habitat from Stag infrastructure are increased biological productivity and diversity, which can result in a localised influence on marine communities. Given the small scale of the artificial habitat created, the potential impacts are expected to be highly localised.

7.8.3 Environmental Performance

Hazard		Physical presence (EPH-9)		
Performance outcome		**No unintentional disturbance to the seabed and marine environment in the Operational Area** **Seabed disturbance limited to planned activities and defined locations**		
ID	**Management Control**	**Performance standards**	**Measurement criteria**	**Responsibility**
054	Change Management Procedure (MoC) [JS-90-PR-G-00017]	Prior to commencement of integrity, maintenance or repair work on subsea infrastructure, a survey using ROV/ AUV/ diving will be undertaken which will include a visual survey of the seabed within the footprint of the work area.	Survey report	Contract Owner
055	Well control program ensures that no fluids are discharged to the marine environment	Pressure test of well control equipment ensures no leaks allowing fluids discharged to the marine environment from the workover unit	Pressure test results are undertaken prior to workover commencing and recorded in the daily report and Well Activations Notification.	Workover Supervisor
056	Decommissioning framework implemented prior to end of field life	No later than five years prior to the end of field life, Jadestone will commence decommissioning planning that details how JSE will meet the obligations under s.572 of the OPGGS Act.	Established decommissioning project by 2030	Country Manager
057	Maintenance of inactive infrastructure in accordance with the CMMS	Jadestone will maintain in good condition and repair all active and inactive subsea structures that are, and all subsea equipment and other property that is used in connection with the Stag Operations to ensure they can meet obligations under s.572 of the OPGGS Act.	Inspection records in Bassnet	Engineering & Maintenance Manager
058	Inspection of subsurface infrastructure completed in accordance with the Stag WOMP (GF-50-PLN-W-01)	Jadestone will inspect subsurface infrastructure every three years in accordance with the Stag WOMP (GF-50-PLN-W-01)	Inspection records in Bassnet	Drilling Manager

7.8.4 ALARP Assessment

On the basis of the impact and risk assessment process completed, Jadestone considers the control measures described above are appropriate to manage the impacts to seabed and benthic habitats due to the physical footprint of the operation. The residual risk ranking for this potential impact is considered Low, and therefore ALARP has been demonstrated. Additional controls considered but rejected are detailed below.

Rejected control	Hierarchy	Practicable	Cost effective	Justification
No maintenance of subsea infrastructure	Eliminate	No	No	The facility has been on location since 1998, and therefore the physical footprint is already present. However, additional disturbance due to anchoring is eliminated as dynamic positioning (DP) used by work vessels eliminates the need for anchoring, thereby reducing the risk of impacts to the seabed. Additional disturbance for stabilisation or ROV activities is unavoidable and is required to maintain the integrity of subsea infrastructure.
N/a	Substitute	N/a	N/a	The presence of the CALM buoy minimises the need for anchoring of the third-party tanker, thereby reducing the risk of impacts to the seabed due to anchoring of the third-party tanker to ALARP. No further substitutions are therefore considered.
N/a	Engineering	N/a	N/a	The marine growth prevention systems applied on near-surface submerged structures and internal seawater intake systems, and the maintenance of these systems reduces the potential for providing a significant artificial habitat and decreases the frequency of inspection activities with the consequent cleaning of biofouling communities on external in-water surfaces which may contain remnant anti-fouling paint.
N/a	Isolation	N/a	N/a	No well fluids are recovered to surface during well workover and intervention activities.
N/a	Administrative	N/a	N/a	IMR activities include visual ROV surveys of seabed habitat

7.8.5 Acceptability Assessment

The potential impacts of impacts to seabed due to physical footprint are considered 'Broadly Acceptable' in accordance with the Environment Regulations, based on the acceptability criteria outlined below. The control measures proposed are consistent with relevant legislation, standards and codes.

Policy compliance	Jadestone's HSE Policy objectives are met.
Management system compliance	**Section 9** demonstrates that Jadestone's HSE Management System is capable of meeting environmental management requirements for this activity.
Social acceptability	Stakeholder consultation has been undertaken (**Section 6**), and no stakeholder concerns have been raised with regards to impacts from physical footprint on sensitive receptors.

Laws and standards	No applicable laws or standards identified.
Industry best practice	The APPEA Code of Environmental Practice (CoEP) (2008) objectives are met with regards to offshore production operations.
Environmental context	Disturbance is localised to immediately under or near to the footprint of Stag Facility subsea infrastructure within the Operational Area. The impacted benthic habitats and associated biota are well represented in the region. The operational area is within a habitat critical to survival for flatback turtles. However, the areas that may potentially be affected by physical presence would represent a very small percentage of the total area. The potential impact is considered acceptable after consideration of: - Potential impact pathways - Preservation of critical habitats - Assessment of key threats as described in species and Area Management /Recovery plans - Consideration of North-West Bioregional Plan; and Principles of ecologically sustainable development ESD
ALARP	No applicable laws or standards identified

7.9 Spill Response Activities

7.9.1 Description of Hazard

Aspect	In the event of a hydrocarbon spill, contingency spill response activities will be undertaken to reduce the level of impact to sensitive receptors. **Section** Error! Reference source not found. outlines the spill response strategies that will be employed in the event of a hydrocarbon spill from Stag Operations. Response strategies that may be used include: • Source control; • Operational monitoring; • Surface chemical dispersants; • Containment and recovery; • Protection and deflection; • Shoreline clean-up; • Oiled wildlife response; and • Scientific monitoring. While the aim of responding is to reduce impacts from the spill, there is the potential for response activities to exacerbate or create additional impacts. Poorly selected or implemented spill response activities may therefore do more environmental harm than good.

7.9.2 Impacts

The OPEP provides detail on how response strategies will be implemented.

For noting: Forward Operating Bases will be located at Dampier/Karratha/Port Hedland to enable efficient delivery of response actions at a central location. The placement of temporary camps at remote locations is not preferred due to safety and environmental considerations; establishment of temporary camps would be in consultation with DBCA and DoT.

Light emissions

Spill response activities will use vessels, which are required at a minimum to display navigational lighting and have night safety lighting. Spill response activities will only occur in daylight hours, although as some vessels may be moored overnight there is limited potential for night light spill from vessels to impact marine and coastal fauna habitats.

Lighting may cause behavioural changes to fish, birds and marine turtles which can have a heightened consequence during sensitive life-cycle activities (refer **Section 7.1.2**), for example turtle nesting and hatching. Turtles and birds, which include threatened and migratory fauna (refer **Section 5.6**), have been identified as key fauna susceptible to lighting impacts. These species are also identified as KPIs in the protected areas within the EMBA (**Table** 5-3).

Spill response activities may occur on shorelines used by nesting turtles, including flatback, hawksbill, green and loggerhead turtles. Locations particularly important for seasonal turtle nesting include the Lowendal and Montebello Islands, Barrow Island, Dampier Archipelago and Eighty Mile Beach. The Muiron Islands and Ningaloo World Heritage area are also important for seasonal turtle nesting. Light has been identified as a key threat to turtles in the National Recovery Plan (CoA 2017), and respective species Conservation advice. Although as shoreline spill response operations will only occur in daylight hours, there will be no impact from light.

There are ten EPBC listed species whose BIA occur in the EMBA. Locations particularly important for seabirds and shorebirds include Lowendal and Montebello Islands, Dampier Archipelago, and Eighty Mile Beach. Eighty Mile Beach is a particularly important area for seasonal aggregations of migratory shorebirds and is a listed Ramsar site. Ningaloo World Heritage Area and Clerke Reef (Rowley Shoals) are also important for seabirds and shorebirds. Light emissions are not identified as a key threat to any of the EPBC threatened species (**Table** 5-3).

Lighting impacts to fauna during spill response activities are unlikely to be significant enough to cause flow on impacts to reliant industries such as tourism.

Noise

Spill response activities will involve the use of aircraft and vessels which will generate noise both offshore and in proximity to sensitive receptors in coastal areas. Spill response activities will also involve the use of equipment on coastal areas during clean-up of shorelines (e.g. pumps, generators and vehicles), and for accessing shoreline areas (e.g. vehicles).

Underwater noise from the use of vessels may impact marine fauna, such as fish, marine reptiles and marine mammals more likely causing behavioural changes which may impact key life-cycle process (e.g. spawning, breeding, calving). Underwater noise can also mask communication or echolocation used by cetaceans. Spill response activities using vessels generating noise have the potential to impact migratory marine fauna including species who have BIAs within the EMBA such as the whale sharks, humpback and blue whales. **Section 7.2.2** provides further detail on these potential impacts.

Noise and vibration from terrestrial activities on shorelines has the potential to cause behavioural disturbance to coastal fauna including protected and migratory species of shorebirds and seabirds. Noise and vibration may affect bird breeding and nesting behaviours and disrupt feeding activity. This could potentially impact reproductive success and for migratory shorebirds may negatively impact the ability to replenish energy reserves for migratory flights. However, if the shoreline is oiled, this may be beneficial by acting as a deterrent for coastal fauna and prevent oiling.

There are ten EPBC bird species whose BIA overlaps the EMBA. Locations particularly important for seabirds and shorebirds include Lowendal and Montebello Islands, Dampier Archipelago and Eighty

Mile Beach (where birds are identified as a KPI). Eighty Mile Beach and Clerke Reef are particularly important areas for seasonal aggregations of migratory shorebirds and the former is a Ramsar site.

Noise impacts to fauna during spill response activities are unlikely to be significant enough to also cause flow on impacts to reliant industries such as tourism and commercial fishing.

Atmospheric emissions

The use of fuels to power vessel engines, generators and mobile equipment used during spill response activities will result in emissions of greenhouse gases (GHG) such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), along with non-GHG such as sulphur oxides (SO_x) and nitrous oxides (NO_x). Emissions will result in localised decrease in air quality. **Section 7.3.2** provides more detail on potential impacts.

Atmospheric emissions from spill response equipment will be localised and while there is potential for fauna and flora impacts, the use of mobile equipment, vessels and vehicles is not considered to create emissions on a scale where noticeable impacts would be predicted. Emissions may occur in Protected Areas and/or areas where tourism is important however the scale of the impact relative to potential oil spill impacts is not considered great.

Operational discharges and waste

Operational discharges include those routine discharges from vessels used during spill response which may include:

- Bilge water;
- Deck drainage;
- Putrescible waste and sewage; and
- Cooling water from operation of engines.

In addition, there are specific spill response discharges and waste creation that may occur, including:

- Decanting oily water in offshore containment and recovery operations;
- Cleaning of oily equipment/vessels and vehicles;
- Flushing water for the cleaning of shoreline habitats;
- Sewage/putrescible and municipal waste at camp areas; and
- Creation, storage and transport of oily waste and contaminated organics.

Operational discharges from vessels may create a localised and temporary reduction in marine water quality. Effects include nutrient enrichment, toxicity, turbidity, temperature and salinity increases as detailed in **Section 7.4 and 7.5**. Discharges may impact a different set of receptors than previously described, given vessel use may occur in shallower coastal waters during spill response activities. Discharge could potentially occur adjacent to marine habitats such as corals, seagrass, macroalgae, however discharges will be very localised and temporary.

The decanting of oily water back into the marine environment during containment and recovery activities has the potential to impact marine organisms from the toxic effects from hydrocarbons, however, given the marine environment is already contaminated with hydrocarbons there is limited potential for an increase in impact, unless the discharge spreads the contamination to a previously uncontaminated area.

Cleaning of oil contaminated equipment, vehicles and vessels, has the potential to spread oil from contaminated areas to those areas not impacted by a spill, potentially spreading the impact area and moving oil into a more sensitive environment.

Flushing of oil from shoreline habitats is a clean-up technique designed to remove oil from the receptor that has been oiled and remobilise back into the marine environment and result in further dispersion of the oil. The process of flushing has the potential to physically damage shoreline receptors such as mangroves and rocky shoreline communities, increase levels of erosion, and create an additional, and potentially higher, level of impact than if the habitat was left to bio-remediate.

Sewage, putrescible and municipal waste will be generated from onshore activities which may include toilet and washing facilities. These wastes have the potential to attract fauna, impact habitats, flora and fauna and reduce the aesthetic value the environment areas. The creation, storage and transport of oily waste and contaminated organics has the potential to spread impacts of oil to areas, habitats and fauna not previously contaminated. The risk of sewage, putrescible and municipal waste is heighted in areas supporting shorebird population where shoreline staging areas may be deployed. Eighty Mile Beach is an area where large-scale shoreline response could occur and is a Ramsar listed site for migratory shorebirds.

Physical presence and disturbance

The movement and operation of vessels, vehicles, personnel and equipment during spill response activities has the potential to disturb the physical environment, marine/ coastal habitats and fauna, and may also impact cultural and heritage values of an area (refer **Sections 7.6.2** and **7.7.2**). The movement of vessels could introduce invasive marine species attached as biofouling or included within ballast water to nearshore areas, while vehicle and equipment movement could spread non-indigenous flora and fauna.

Oiled wildlife response activities may involve deliberate disturbance (hazing), capture, handling, cleaning, rehabilitation and release of wildlife, which could lead to additional impacts to species including EPBC listed species.

The use of vessels may disturb benthic habitats in coastal waters e.g. corals, seagrass and macroalgae, including those within protected areas. Potential impacts to habitats from shoreline/ nearshore activities includes the deployment of anchor/ chain and the grounding of vessels in shallow waters. Booms create a physical barrier on surface waters which can entangle or prevent the passing of marine fauna using surface waters. Vessel use in shallow coastal waters also increases the chance of contact or behavioural disturbance of marine megafauna including EPBC listed species such as turtles, dolphins, dugongs and seabirds. Increased vessel activity further offshore has the potential to disturb migrating humpback whales, whale sharks and blue whales in season. Locations at risk are Lowendal and Montebello Islands, Barrow Island, Dampier Archipelago and Eighty Mile Beach due to high density/ diversity of benthic habitats (e.g. corals, seagrass and/ or macroalgae) and high abundance of marine megafauna using these habitats (e.g. feeding turtles, dugongs and dolphins).

Vehicles, equipment and personnel used during shoreline response activities have the potential to damage coastal habitats such as dune vegetation, samphire and mangroves and habitats important to threatened and migratory fauna including nests of turtles and birds and bird roosting/ feeding areas. Shoreline clean-up may involve the physical removal of substrates that could cause impact to habitats and coastal hydrodynamics and alter erosion/ accretion rates. Aside from physical damage to important coastal habitat (e.g. mangroves) and turtle/ bird nesting areas, the operation of vehicles, equipment and personnel can create behavioural disturbance to coastal fauna, particularly birds, which may be present and abundant during daytime operations. As discussed with lighting and noise impacts, disturbance from shoreline operations may affect nesting and feeding behaviours, negatively influencing breeding participation/success or altering migratory behaviours. The disturbance to shorebird feeding may have implications on the replenishment of energy reserves and the timing and success of migratory flights. Although, if the shorelines are oiled, this may have a beneficial hazing effect.

Sensitive mangroves areas are a key feature of the Lowendal and Montebello Islands, Dampier Archipelago and Eighty Mile Beach, while locations particularly important for seabirds or shorebirds include Lowendal and Montebello Islands, Dampier Archipelago and Eighty Mile Beach.

Aside from disturbance to habitats and marine/coastal fauna, spill response activities may create disturbance to cultural values additional to the spill itself. Shorelines of Dampier Archipelago (Burrup Peninsula) have indigenous significance in terms of traditional use for food resources as well as containing symbolic sites and landscapes. Some shorelines of the Dampier Peninsula are subject to Native Title.

Oiled wildlife response may include the hazing, capture, handling, transportation, cleaning and release of wildlife susceptible to oiling such as birds and marine turtles. While oiled wildlife response is aimed at having a net benefit, poor response can potentially create additional stress and exacerbate impacts from oiling, interfering with key life-cycle processes, hampering recovery and in the worst instance increasing levels of mortality.

Impacts from invasive marine species released from vessel biofouling include out-competition, predation and interference with other ecosystem processes. The ability for a non-native species to establish is generally mitigated in deeper offshore waters where the depth, temperature, light availability and habitat diversity is not generally conducive to supporting reproduction and persistence of the invasive species. However, in shallow coastal areas, such as areas where vessel-based spill response activities may take place, conditions are likely to be more favourable. Impacts from invasive terrestrial species are similar in that the invasive species can out-compete local species (e.g. weeds) and interfere with ecosystem processes. Non-native species may be transported attached to equipment, vehicles and clothing. Such an introduction would be especially detrimental to wilderness areas or protected terrestrial reserves which have a relatively undisturbed flora and fauna community.

Disruption to other users of marine and coastal areas and townships

Spill response activities may involve the use of vessels, equipment and vehicles in areas used by the general public or industry. The mobilisation of spill response personnel into an affected area may also place increased demands on local accommodation and other businesses.

Shoreline response activities will restrict access and activities along affected shorelines which may include areas popular for tourism. Fisheries and aquaculture activities (e.g. pearl farming) may also be suspended in areas potentially affected by oil without necessarily being contacted by oil. Tourism and fisheries may be important economic drivers for the economies of local townships. Townships may also be impacted through the influx of spill responders using facilities for accommodation and forward operations areas which may negatively impact local businesses.

Chemical dispersant application

While the aim of chemical dispersants is to provide a net benefit to the environment, the use of dispersants has the potential to increase exposure to habitats under the sea surface, including coral, seagrass and macroalgae, and to marine fauna (particularly fish and invertebrates) by increasing entrained oil concentration. These receptors are generally located in shallow coastal areas of the mainland and offshore islands.

Increased entrained and aromatic hydrocarbon concentration can contact marine fauna, and are most likely to be encountered by plankton, benthic filter feeding invertebrates, fish and sharks. Fish and sharks include threatened/migratory species, which may ingest oil or uptake toxic compounds across gill structures. As a result of increased exposure to marine fauna and subtidal habitats, socio-economic impacts may be felt through industries such as tourism and commercial fishing.

A description of the potential impacts from entrained oil and aromatic hydrocarbons from a maximum credible worst-case spill is provided in **Section 8.5.3** and **Table** 8-13.

Quadrant provided detailed assay information of Stag crude oil to APASA to commission a report, the *Net Environmental Benefit Analysis for the Use of Dispersants* (APASA, 2012c), to assess whether the application of chemical dispersants reduced the probability of contact to shorelines. Key findings of this report include a reduction in the predicted probabilities for shoreline contact, and greater prediction times to sensitive locations following the application of chemical dispersant, particularly effective during the summer months. These key findings support the use of chemical dispersants on Stag crude as they have potential to reduce hydrocarbon contact to sensitive locations, and also increase the time of the hydrocarbon contact to shorelines, thus giving time for other response strategies to take effect and further reduce impacts.

Jadestone commissioned RPS APASA to re-analyse the outcomes of a quantitative spill risk assessment for hydrocarbon spill scenarios at Stag and conduct modelling to assess the effects of hydrocarbon dispersant application (applied as per Jadestone's proposed Chemical Dispersant Plan in Section 10 or the OPEP) for the worst-case scenario (APASA, 2017).

The modelling results suggest oil loading at the closest onshore receptors, may be reduced through the surface application of chemical dispersants particularly in the summer months. The application of chemical dispersants was predicted to result in a localised increase in the concentration of entrained oil above the impact threshold of 500 ppb, particularly at the Montebello and Lowendal Islands in summer.

During a response, the area over which entrained oil will increase will be a function of the area treated with aerial dispersants. The area treated will be a function of the height at which the dispersants were dropped as well as the volume released and the speed at which the aircraft was moving at the time of release, therefore this estimated area is very much estimated and is expected to be in the order of tens to hundreds of metres. The increase in entrained oil concentration will be short term (minutes to hours) as the floating oil moves into the water column after which dispersion of the entrained oil will see concentrations decrease.

Table 7-11 provides a summary evaluation of the selected strategies performance outcomes and controls, and the benefit that will be provided in applying this strategy.

Table 7-11: Summary evaluation of selected strategies performance outcomes and controls, and associated benefit

Performance Outcome	Control measure	Benefit	Outcome	Evaluation
Overall spill response				
Spill response has an overall net environmental benefit	Spill response activities selected on basis of a Net Environmental Benefit Analysis (NEBA) (OSRA – JS-70-PLN-I-00037)	Ensures the selection of spill response activities is having an overall net benefit to the environment	**Adopt**	Considered a standard spill response control
	Implementation of the OPEP	Ensures the selection of spill response activities are implemented to reduce the potential impact to the environment to ALARP	**Adopt**	Considered a standard spill response control
	Competency and Training Management System (JS-60-PR-Q-00015) [1]	Ensures spill response activities are undertaken by competent personnel	**Adopt**	Considered a standard control
	DoT and DBCA consulted with on shoreline operations location(s) in State waters as per **Section 6**	Prevents additional impacts to shoreline locations and fauna	**Adopt**	If a temporary camp is required, then will be determined in consultation
	Response operations conducted during daylight hours only	Reduces potential for behavioural disturbance	**Adopt**	Accepted on safety, operational effectiveness and environmental grounds.
	Waste Management Plan – Oil Spill Response (JS-70-PR-I-00037)	Prevents secondary contamination and litter	**Adopt**	Considered a standard control
Light emissions				

[1] The Competency and Training Management System outlines the framework and requirements for maintaining staff competency and training specifications for Jadestone. It provides an overview of the requirements for staff and contractors to meet their training obligations and the context within which the system operates.

Performance Outcome	Control measure	Benefit	Outcome	Evaluation
Light spill onto shorelines and coastal waters is reduced to ALARP during spill response	Response vessels stand-off at night with lighting required for safety only	Reduces potential for behavioural disturbance	**Adopt**	Accepted on safety, operational effectiveness and environmental grounds.
	Review vessel lighting to a type (colour) that will reduce impacts to fauna	Reduces potential for behavioural disturbance	**Reject**	Not required given vessel restrictions at night High cost associated with change-out of vessel lighting Time delay in spill response
	Review shoreline lighting to a type (colour) that will reduce impacts to fauna	Reduces potential for behavioural disturbance	**Reject**	Response operations conducted during daylight hours only
Noise				
Noise emissions reduced to ALARP during spill response	Support vessel and aircraft compliance with EPBC Act Regulation 8 (cetacean interactions) (Stag Marine Facility Operating Manual GF-90-MN-G-00038, Aviation Procedure JS-83-PR-G-00010)	Reduces potential for behavioural disturbance to cetaceans	**Adopt**	A standard control (regulatory requirement)
	Use of noise reduction barriers for portable equipment on shorelines	Reduces sound level	**Reject**	Sound levels from portable equipment not expected to warrant additional costs and potential delays related to applying specialised sound control barriers
Atmospheric emissions				
Spill response vessel emissions meet MARPOL requirements	If required under MARPOL, Vessels will maintain a current International Air Pollution Prevention (IAPP) Certificate.	Reduces level of air quality impacts	**Adopt** – must accept this regulatory requirement	Considered a standard control (regulatory requirement) – given low impact of atmospheric emissions further control evaluation not deemed necessary.

Performance Outcome	Control measure	Benefit	Outcome	Evaluation
Operational discharges and waste				
Impacts from spill response operational discharges are reduced to ALARP	Deck cleaning products released to sea are non- hazardous, readily biodegradable and non-bio-accumulative.	Reduces potential toxicity impacts to marine organisms	**Reject**	Vessel owners and operators are responsible for their own operational products
	Vessels meet applicable MARPOL and Marine Park sewage disposal requirements	Reduces water quality impacts in nearshore environment	**Adopt**	Considered a standard control (regulatory requirement)
	Vessel meet applicable MARPOL requirements for oily water (bilge) discharges	Reduces water quality impacts in nearshore environment	**Adopt**	Considered a standard control (regulatory requirement)
	Zero bilge discharge policy	Reduces water quality impacts anywhere from bilge water	**Reject**	Given regulatory requirements exist to protect nearshore locations, zero discharge may potentially delay or interrupt vessel mobilisation/activity for negligible benefit
	Decant oily water from offshore containment and recovery behind boom	Prevents spreading of oily water	**Adopt**	Considered a standard control
	Obtain approvals from relevant Jurisdictional Authority prior to commencing decanting operations	Prevents spreading of oily water	**Adopt**	Considered a standard control (regulatory requirement)
	Offshore Equipment washdown confined to hotzone	Prevents spreading of oily water	**Adopt**	Considered a standard control
	Use of environmentally friendly degreaser for offshore washdown	Reduces toxic impacts within water column	**Adopt**	Can be achieved with minimal cost
	Onshore equipment washdown in defined area	Prevents spreading of oily water	**Adopt**	Considered a standard control

Performance Outcome	Control measure	Benefit	Outcome	Evaluation
	Low pressure flushing of shoreline habitats using ambient temperature seawater	Reduces habitat damage, penetration of oil into sediments and erosion	**Adopt**	Considered a standard control
	Use of booms to contain shoreline flushing liquids	Reduces spread of oily water	**Adopt**	Will be accepted on a case by case basis – may be preferred if remobilisation of oil could further impact sensitive habitats. May not be applied if impacts from deploying booms exceed potential benefit
Prevention of secondary contamination of oily waste and litter during spill response	Compliance with controlled waste and disposal regulations	Prevents secondary contamination from oil waste	**Adopt**	Considered a standard control (regulatory requirement)
	Municipal waste containers present onsite	Prevents litter	**Adopt**	Considered a standard control
	Compliance with local government municipal waste requirements	Prevents incorrect disposal	**Adopt**	Considered a standard control (regulatory requirement)
Physical presence and disturbance				
Disturbance to habitats, fauna and culturally sensitive areas during spill response is reduced to ALARP	Use of shallow draft vessels for shoreline and nearshore operations	Reduce seabed and shoreline habitat disturbance	**Adopt**	Considered a standard control
	Conduct shoreline assessment	Reduce seabed and shoreline habitat disturbance	**Adopt**	Considered a standard control
	Establish demarcation zones for vessel, boom and skimmer usage	Reduce seabed and shoreline habitat disturbance	**Adopt**	Accept based on potential for spill to enter sensitive shoreline locations and can be adopted during planning with minimal cost
	Maintenance and inspection personnel assigned to boom sets	Reduce seabed and shoreline habitat disturbance	**Adopt**	Considered a standard control
	IMT assessment/selection of vehicles appropriate to shoreline conditions	Reduce coastal habitat and fauna disturbance	**Adopt**	Considered a standard control

Performance Outcome	Control measure	Benefit	Outcome	Evaluation
	Establish demarcation zones for vehicle and personnel movement considering sensitive vegetation, bird nesting/roosting areas and turtle nesting habitat	Reduce coastal habitat and fauna disturbance	**Adopt**	Considered a standard control
	Operational restriction of vehicle and personnel movement to limit erosion, compaction and disturbance to birdlife	Reduce coastal habitat erosion and compaction and disturbance to birdlife	**Adopt**	Considered a standard control
	Access plans for shoreline operations will prioritise use of existing roads and tracks	Reduce coastal habitat and fauna disturbance	**Adopt**	Considered a standard control
	Use of landing barges	Reduce coastal habitat and fauna disturbance	**Adopt**	Will be assessed as part of site evaluation
	Use of Specialist Advisor if Operational Area overlapped with potential areas of cultural and heritage significance	Reduce disturbance to cultural and heritage significant sites	**Adopt**	Specialised knowledge may be required to identify cultural and heritage significant sites
	Pre-cleaning and inspection of equipment	Prevent introduction of invasive species	**Adopt**	Minimal costs and good practice considering potential for high value nature reserves and remote areas, with relatively undisturbed environments, to be accessed
	Use airborne vehicle deployment (helicopters) where onshore access not feasible	Reduce coastal habitat and fauna disturbance	**Reject**	High costs, logistical constraints and high safety risk Landing barges will be utilised where possible
	Interstate and International vessels comply with the Marine Biosecurity Manual (JS-70-MN-G-00001)	Reduce risk for introduction of invasive marine species as part of vessel biofouling	**Adopt**	Considered a standard control

Performance Outcome	Control measure	Benefit	Outcome	Evaluation
	Locally sourced vessels comply with Vessels comply with the Marine Biosecurity Manual (JS-70-MN-G-00001)	Small reduction in IMS risk given most vessels are local and already operate in the region Greatest risk is international and interstate vessels	**Reject**	Minimal benefit in terms of risk reduction is outweighed by the delays in implementing Vessel Check over the many local vessels that would be required to mobilise rapidly.
	Ballast water management plan review requirement for interstate and international vessels (only)	Improve water quality discharge to marine environment to ALARP Reduce risk of introduced marine species	**Adopt**	Considered a standard control Vessels likely to be sourced from within WA waters
Oiled Wildlife Response				
Additional impacts from oiled wildlife response are reduced to ALARP	Implement WA Oiled Wildlife Response Plan and Regional Oiled Wildlife Response Plans	Reduce unnecessary disturbance and stress to wildlife from hazing, capture, handling, cleaning, rehabilitation, release and euthanasia	**Adopt**	Considered a standard control
Chemical dispersant application				
Additional impacts from dispersant application are reduced to ALARP	Chemical dispersant selected after having been risk assessed through Jadestone Chemical Selection, Evaluation and Approval Procedure (JS-70-PR-I-00033) The evaluation must find the chemical acceptable for use prior to application.	Reduce impacts on fauna / flora from toxicity of the dispersant	**Adopt**	A standard procedure Jadestone Chemical Selection, Evaluation and Approval Procedure (JS-70-PR-I-00033) used for chemical selection
	Field trial undertaken of dispersant efficacy	Ensures dispersants are not added for no potential benefit	**Adopt**	Considered a standard control
	Dispersant application location and volume assessment undertaken in IAP	Reduces impacts from dispersant and oil (entrained and dissolved)	**Adopt**	Considered a standard control

Performance Outcome	Control measure	Benefit	Outcome	Evaluation
		to sensitive shallow water habitats		
	Selection of correct equipment for application	Ensures correct dosage	**Adopt**	Considered a standard control
	Operational monitoring of oil and oil in water during dispersant application	Provides information to inform NEBA analysis	**Adopt**	Considered a standard control
	No dispersant application	Prevents any potential impacts from dispersant or chemically dispersed oil	**Reject**	Dispersant modelling indicates that dispersant has the potential to reduce shoreline loading and spatial extent of oil in some scenarios. Therefore, it is better to have in the toolbox and decision for application will be subject to the NEBA.
Disruption to other users of marine and coastal area and townships				
Reduce and control disruption to other users of marine and coastal areas and townships during spill response is reduced to ALARP	Stakeholder consultation (Refer **Section 6**)	Early awareness of spill response activities which reduces potential disruption	**Adopt**	Considered a standard control
	Localised Risk Management Assessment to be conducted if the response is of significant size in comparison to the size of the coastal community	Reduces potential impact due to higher utility demands causing disruptions to local community	**Adopt**	Considered a standard control

7.9.3 Environmental performance

The OPEP contains environmental performance measures for the spill responses, this table outlines the spill response preparedness measures only.

Hazard		Oil Spill Response Activities (EPH-10)		
Performance Outcome		**Spill response has an overall net environmental benefit**		
ID	**Management Controls**	**Performance Standard**	**Measurement Criteria**	**Responsibility**
	Overall spill response			
	Spill response preparedness			
059	Contracts valid and maintained in accordance with Jadestone Energy Contractor Management Framework (JS-90-PR-G-00002) to ensure access to competent personnel and appropriate equipment	Contracts in place and current with competent providers and suppliers	Contractor assessment records	Supply Chain Manager
060	AMOSC MSC/AMSA MOU valid for life of the EP	AMOSC membership allowing access to mutual aid arrangements for spill response crew and equipment via a Master Services Contract (MSC) AMSA MOU (access to NRT and resources)	Current AMOSC membership and MSC AMSA MOU valid for 5 years from 2017	Country Manager
061	Response personnel competent and trained in accordance with Jadestone Energy Incident Management Team Response Plan (JS-70-PLN-F-00008)	Assessment of response personnel as being competent and trained according to the requirements of Jadestone Energy Incident Management Team Response Plan (JS-70-PLN-F-00008)	Response personnel competency and training records	HR Manager
062	Jadestone Energy Audit Manual (JS-90-PR-G-00003) includes emergency response and spill preparedness	Audit of Jadestone's emergency response and spill preparedness requirements as scheduled	Audit schedule Audit reports	ER Lead

Hazard		Oil Spill Response Activities (EPH-10)		
Performance Outcome		**Spill response has an overall net environmental benefit**		
ID	**Management Controls**	**Performance Standard**	**Measurement Criteria**	**Responsibility**
063	OPEP maintained to ensure spill response is appropriate to nature and scale of risk	Spill response planning and preparedness aligned with nature and scale of risk	Stag OPEP	ER Lead
064	Shipboard Oil Pollution Emergency Plan valid and tested to ensure ability to respond to spills as required by MARPOL	In line with MARPOL Annex 1, vessels over 400 gross tonnage will have a current Shipboard Oil Pollution Emergency Plan (SOPEP)/ Shipboard Marine Pollution Emergency Plan (SMPEP) and International Oil Pollution Prevention (IOPP) certificate	Current SOPEP and exercise schedule	Operations Manager
065		Spill exercises are conducted in accordance with the SOPEP		
066	Personnel aware of roles and responsibilities in the event of a response in accordance with Stag Incident Response Plan (GF-00-PR-F-00041)	Instructs offshore response roles and responsibilities and training requirements.	Exercise records Training and induction records	Stag OIM
067	Labour hire contract in place for life of EP to source labour for spill response	Labour hire contract in place to provide access to personnel	Labour hire contract	HR Manager
068	Vessel availability for containment and recovery activity is monitored monthly via Jadestone's nominated vessel broker	Monitor the availability of vessels that are suitable for deployment of the Containment and Recovery strategy as defined in the OPEP	Monthly monitoring reports	Supply Chain Management
069	Maintain contract with Jadestone's Waste Management Contractor for life of the EP	Waste management contract is maintained which enables access to waste storage facilities and waste transport	Contractor assessment records	Logistics Lead

Hazard		Oil Spill Response Activities (EPH-10)		
Performance Outcome		**Spill response has an overall net environmental benefit**		
ID	**Management Controls**	**Performance Standard**	**Measurement Criteria**	**Responsibility**
070	Maintain contract with scientific monitoring service provider for life of the EP	Scientific monitoring services contract is maintained which enables access to competent personnel to undertake scientific monitoring	Contract valid and current	ER Lead
071		Scientific monitoring services provider participates in a Jadestone annual exercise for a spill response scenario	Emergency exercise evaluation report	ER Lead
072	Scientific monitoring plan reviews	12 monthly review of SMPs post OPEP exercise Six monthly external legislative review of environmental matters to ensure currency of information	Audit Manual (JS-90-PR-G-00003) Notification of membership Contract with external environmental consultancy	ER Lead
073	Maintain contract with tracker buoy provider for life of the EP	Contract is maintained which enables access to tracking buoy services	Contract valid and current	ER Lead

7.9.4 ALARP Assessment

The purpose of implementing spill response activities is to reduce the severity of impacts from an oil spill to the environment. However, if the strategies do more harm than good (i.e. they are not having a net environmental benefit) then the spill response is not ALARP. The key process in determining if the strategies employed are having a net benefit is the net environmental benefit analysis (NEBA). A NEBA is conducted for each operational period during a response to ensure the best strategies are being implemented and the ALARP principle is regularly tested (refer to the OPEP for further detail).

It is best practice to ensure all possible response strategies have been evaluated and, if there is the potential to produce a net environmental benefit, to have them in the toolbox ready for implementation if determined feasible for the scenario, (IPIECA (2016) Contingency planning for oil spill on water: Good practice guidelines for the development of an effective spill response capability).

For each of the environmental hazards associated with spill response strategies an ALARP evaluation was conducted as part of the hazard identification workshop (HAZID; refer **Appendix B**). A number of controls were identified as industry and/ or Jadestone standard controls that will be considered during a spill response while additional controls were evaluated and either accepted or rejected on the basis of the ALARP principal, i.e. a decision was based on whether the additional control would have a cost/effort disproportionate to the level of impact reduction it would provide. Results of the evaluation are shown in **Table** 7-11 and reflected in **Section 8.5.7.**

Note that some of the potential impacts to fauna from spill response activities can be beneficial in the prevention of oiling by acting as deterrents. For example, if shoreline operations are being undertaken at a turtle nesting or bird breeding site, fauna may avoid the location as disturbed by noise or people and thereby not be oiled.

7.9.5 Acceptability Assessment

The potential impacts of spill response activities are considered 'Broadly Acceptable' in accordance with the Environment Regulations, based on the acceptability criteria outlined below. The control measures proposed are consistent with relevant legislation, standards and codes.	
Policy compliance	Jadestone's HSE Policy objectives are met.
Management system compliance	**Section 9** demonstrates that Jadestone's HSE Management System is capable of continuously reviewing and updating activities and practices at the Stag facility, including spill response arrangements.
Social acceptability	Stakeholder consultation has been undertaken (see **Section 6**), including engagement with the State and National response agencies of DoT and AMSA, nearby operators, AMOSC, as well as commercial and recreational fishing industry bodies and fishers. No stakeholder concerns have been raised with regards to impacts of the spill response activities on relevant persons. During any spill response, a close working relationship with key regulatory bodies (e.g. DoT, DBCA, AMSA, DER) will occur and thus there will be ongoing consultation with relevant persons during response operations.
Laws and standards	Jadestone is obligated to respond to a hydrocarbon spill under the following legislative instruments: • OPGGS Act Section 572A-F – polluter pays for escape of petroleum • AMSA Marine Orders Part 91 • Protection of the Sea (Prevention of Pollution from Ships) Act 1983 • Protection of the Sea (Civil Liability for Bunker Oil Pollution Damage) Act 2008
Industry best practice	Response planning and preparedness undertaken in accordance with: • NatPlan (AMSA, 2020)

	• AMOSPlan (AMOSC, 2017) • NOPSEMA Guidance Notes (e.g. Oil Pollution Risk Management Information Paper Rev 2 February 2018) • DoT Offshore Petroleum Industry Guidance Note, Marine Oil Pollution: response and Consultation Arrangement July 2020 • DoT OSCP (2015) • State Hazard Plan – Maritime Environmental Emergencies (MEE), 2019) • Fingas, M.F. (2012) The Basics of Oil Spill Clean-up. CRC Press. Florida, United States of America. • ITOPF Technical Information Papers including: ○ ITOPF (2014) Technical Information Paper Dispersant Use ○ ITOPF (2020). ITOPF Members Handbook 2020/2021 ○ ITOPF (2014) Technical Information Paper Clean-up of oil from shorelines ○ ITOPF (2013). Technical Information Paper Use of Booms in oil pollution response · • IPIECA International Association of Oil and Gas Producers Good Practice Guide Series including: ○ IPIECA-IOGP. (2015) A Guide to Oiled Shoreline Clean-up Techniques: Good practice guidelines for incident management and emergency response personnel ○ IPIECA-IOGP (2015) Oil spill preparedness and response: an introduction ○ IPIECA-IOGP (2015) Contingency planning for oil spills on water Good practice guidelines for the development of an effective spill response capability • Oil Spill Response (OSRL) handbooks including: ○ Shoreline operations handbook ○ Containment and recovery handbook ○ Disperant application field guide
Environmental context	The worst-case credible spill scenario for the Stag facility operating activities is as a result of loss of crude from the underbuoy hose. The release of oil occurs over 30 minutes and the area of dispersion over which the oil travels is between Eighty Mile Beach to the north, and to Ningaloo in the south. The oil is primarily floating and sensitive receptors at risk include seabirds, shorebirds, marine fauna and coastal habitats. While some response strategies (e.g. application of chemical dispersants and booming operations) may pose additional risk to sensitive receptors, to not implement response activities would likely result in greater negative impact to the receiving environment and a longer recovery period. Response activities are undertaken in accordance with controls which reduce and/or prevent additional risks. The mutual interests of responding and protecting sensitive receptors from further impact due to response activities is managed through the use of a net environmental benefit analysis during response strategy planning in preparedness arrangements as well as during a response. The potential impact is considered acceptable after consideration of: - Potential impact pathways - Preservation of critical habitats - Assessment of key threats as described in species and Area Management /Recovery plans - Consideration of North-West Bioregional Plan; and - Principles of ecologically sustainable development ESD
ALARP	The residual risk has been demonstrated to be ALARP.

8. ASSESSMENT – UNPLANNED EVENTS

This section of the EP describes the potential risks and environmental impacts from accidental events that may arise during the operation of the Stag Facility and associated mitigation and management measures that will be implemented to reduce impacts to an acceptable level.

The environmental risk assessment process identified seven accidental environmental risks. The pre-treatment and residual risk rankings are summarised in **Table 8-1** and presented in detail throughout this section.

Table 8-1: Summary of the environmental risk assessment ranking for accidental events

Hazard	Pre-treatment Ranking	Residual Ranking
1. IMS introduction	M	L
2. Non-hazardous and hazardous solid waste	M	M
3. Non-hydrocarbon hazardous liquids	M	L
4. Hydrocarbon spills	M	L
5. Unplanned release of Stag crude oil	L	L
6. Unplanned release of diesel	L	L
7. Dropped objects	L	L

The presentation of impacts and risks identified during the assessment process for hazards associated with unplanned activities is provided as follows:

- Description of the hazard;
- Impacts and risks – a discussion and assessment of the environmental impacts and risks associated with accidental events that may arise;
- Environmental performance – a description of a measurable level of performance required for the management of environmental aspects to ensure that the environmental impacts and risks will be of an acceptable level; and a statement of performance required of a control measure. This includes a description of the control measures in place to reduce the impact and control the risk; and
- Demonstration of ALARP and Acceptability – a demonstration that the environmental impacts and risks will be reduced to ALARP and will be of an acceptable level, and the rationale for these statements.

A further review of the potential unplanned impacts was undertaken in January 2021 as a result of the FSO being removed from the field. However, the risk ranking for all aspects was considered unchanged, in many cases the consequences could be assessed as lower due to the removal of some aspects (e.g. smaller hydrocarbon spill volumes); however the previous impact assessment identified the aspects as already having the lowest residual risk rankings. The only one with a medium consequence is non-hazardous and hazardous solid waste, and the types of waste are still applicable in the current operations and therefore cannot be reduced further by the removal of the FSO from the field. A record of the workshop is provided in Appendix B.

8.1 Invasive Marine Species Introduction

8.1.1 Description of Hazard

Aspect	Ballast water is taken up and discharged at the Stag location by third party vessels, these vessels may be sourced from both international or domestic locations.

8.1.2 Impacts and Risks

The introduction and establishment of invasive marine species (IMS) can result in a localised impact on native marine fauna and flora, including:

- Competition, predation or displacement of native species;
- Alteration of natural ecological processes;
- Introduction of pathogens with the potential to impact human and/or ecological health;
- Reduction and/or competition with commercial fish and aquaculture species; and
- Increased requirement for maintenance of vessels and marine infrastructure.

Potential sources for the transfer and establishment of IMS include:

- Biofouling on vessels on external surfaces and other external niches (e.g. sea chests, propulsion units, steering gear and thruster tunnels);
- Biofouling of vessels within internal system niches (e.g., strainers, seawater pipe work, anchor cable lockers);
- Biofouling on equipment that routinely becomes immersed in water (including but not limited to equipment such as conductor casing and ROVs); and
- Discharge of high risk ballast water taken up at international or domestic sources.

There are four key steps involved for a successful IMS incursion:

- Colonisation and establishment of the marine pest on a vector (e.g. vessel) in a donor region (e.g. home port);
- Survival of the organism on the vector during the voyage from the donor to the recipient region;
- Transfer from the vector to habitat in the recipient region; and
- Colonisation (e.g. reproduction or dislodgement) of the recipient region by the marine pest, followed by successful establishment of a viable new population (Commonwealth Government, 2009).

Colonisation requires there to be suitable environmental conditions for the particular species, including aspects such as water temperature, water depth, salinity, food availability and habitat type. Marine pest species also tend to be coastal species, and as such, most exotic marine pests introduced to Australian waters have distributions restricted to shallower coastal habitats.

It is unlikely that any IMS entering the Operational Area would establish on the natural benthic habitat (soft sediments at the seabed). The depth of the Operational Area (49 m), low-nutrient open ocean conditions and lack of available light at this depth provides a very different environment to that within sheltered ports and shallow coastal areas which are the typical sources of, and which have historically been colonised by IMS. Subsequently the likelihood of a potential introduction of IMS is considered low. However, there exists a risk that the field infrastructure may harbour IMS. Should such a situation exist, this would represent a subsequent risk of transfer of IMS to vessels visiting Stag, or potentially as a reservoir for spread of invasive species to Australian coastal areas via natural processes of dispersion and range expansion.

To act as a harbour for introduced marine species, a number of links in a sequential chain of successive processes would need to be properly aligned, with these summarised as follows:

- An exotic species would need to be successfully conveyed to the Stag field, such as via vessel biofouling;
- The exotic species would need to successfully transfer from its arrival vector to the field infrastructure, and establish on that new substrate; and
- The habitat conditions presented by the Stag field infrastructure and wider environment would need to be conducive to the enduring survival of that species.

It is to be remembered that not all exotic marine species present as 'invasive' or 'pest' species. To be considered as 'invasive', the introduced species must be able to survive and establish in the new location, and subsequently manifest as some form of nuisance or pest (NOPSEMA 2018). Furthermore, even if an exotic species had established on the Stag infrastructure, it would only then represent any tangible threat to Australian waters in the event that it was able to further its range, either through natural processes such as larval dispersion, or by transfer to another vector, such as by subsequent biofouling of a work vessel operating in the Stag field. Without this secondary transfer mechanism any exotic species colony which may be established at Stag would represent an isolated community of no wider significance or ecological consequence (PGM Environment, 2021).

Following their establishment, eradication of marine pest populations is often impossible, limiting management options to ongoing control or impact minimisation. For this reason, increased management requirements have been implemented by Commonwealth and State agencies via the development of Australia's National System for the Prevention and Management of Marine Pest Incursions which looks at managing biofouling and ballast water.

Ballast water

The Department of Agriculture Water and Environment (DAWE) is the lead agency for management of ballast water from vessels operating in Australian waters. DAWE introduced the Australian Ballast Water Management Requirements Version 8 (DAWE 2020) that are enforced under the *Biosecurity Act 2015*. The requirements provide guidance for vessel operators on best practice policies and apply to all vessels operating internationally and domestically in Australia.

Key points for vessels intending to discharge ballast within Australian waters, as detailed within the Australian Ballast Water Management Requirements Version 8 include:

- All vessels must carry a valid ballast water management plan;
- All vessels must carry a valid International Ballast Water Management certificate;
- Vessels with a ballast water management system (BWMS) must carry a Type Approval Certificate specific to the type of BWMS installed; and
- All vessels must maintain a complete and accurate record of all ballast water movements.

Biofouling

Under the National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (DAWR, 2009), a risk assessment approach is recommended to manage biofouling. The marine biosecurity risk arising from vessel biofouling is subject to control under the Biosecurity Act 2015, although DAWE does not impose specific vessel biofouling regulations.

The potential biofouling risk presented by vessels within the Operational Area relates to the length of time vessels are in Australian waters or operating outside Australian waters, the length of time spent at these location(s) and whether the vessels have undergone hull inspections and cleaning and the age of the antifouling coating, prior to entering Australian waters.

Any vessel or marine infrastructure destined for WA waters from interstate or overseas is also required to meet the aquatic biosecurity standards set out under the *Fisheries Resources Management Act 1994*, as administered by the DPIRD. In some circumstances, a Marine Biosecurity Inspection for the presence of known and potential IMS is required to ensure compliance with Regulation 176. No target marine species of concern to WA waters should be detected during any such inspection. In accordance with marine pest management guidelines (as enforced under the WA Fish Resources Management Act 1994; and Fish Resources Management Regulations 1995):

- Immersible equipment and the vessel hull, sea chests and other niches must be 'clean[9]' before any vessels enter WA waters and ports; and
- The suspected or confirmed presence of any marine pests or disease must be reported within 24 hours by email (biosecurity@fish.gov.au) or telephone (FishWatch tel: 1800 815 507). This includes any organism listed on the WA Prevention List of Introduced Marine Pests, and any other non-indigenous organism, that demonstrates invasive characteristics.

The risk of biofouling transfer from vessels to isolated, hard anthropogenic substrates has been assessed previously (URS 2013), with the conclusion that the likelihood of such transfer was minimal for sessile species. It was considered that any such transfer is more likely for swimming and other mobile species, such as crabs. Any inherent risk of transfer from a vessel of invasive mobile and swimming species can be minimised by managing vessel hulls to have only minimal fouling, thus denying mobile species suitable habitat for their own colonisation and sustainment.

Stag Field IMS Status

As an initial IMS risk screening and management focus measure, species listed or assessed as invasive by DAWE were considered in the context of their potential to be able to establish on the Stag infrastructure, following possible transfer to the field by ships. These candidate species were primarily drawn from those considered as presenting tangible risk via the process of development of the Australian Priority Marine Pest List (ABARES 2019). This field of candidate species was further refined, based upon work by Australian Government agencies (MPSC 2020; NIMPIS 2008; Richmond et al. 2010) by dismissing those which would require habitat conditions not available in the Stag field, with subsequent concentration upon those which could theoretically establish upon Stag and present tangible risk of further spread to Australian coastal waters.

In accordance with NOPSEMA guidance (NOPSEMA 2018), video ROV footage captured during structural assessment surveys of Stag field infrastructure in February and July 2020 was reviewed as a means of detecting any invasive species which may have established (PGM Environment, 2021). Notwithstanding the inherent limitations of in-water surveys, and the difficulties of detecting mobile species such as crabs, the review of ROV video footage did not detect any listed IMS nor indicate their likely presence (PGM Environment 2021). In general terms, the biofouling assemblage observed on the Stag field infrastructure was representative of that which would be expected of any structure immersed for an extended period in the waters in that region.

Should any IMS establish in the Stag field, other than being an isolated colony of note, they would only represent any specific biosecurity hazard to Australian waters if they were able to transfer from Stag to a nearby location of some ecological, social or economic significance and then establish in that latter location. Those locations exhibiting potential significance or vulnerability to invasion include nearby ports and conservation areas. The closest coastal areas to Stag are Dampier archipelago approximately 32km away, and the nearest marine protected areas or significant regional features are the Glomar Shoals and the Montebello Islands, which are 100km and 75 km, respectively, from Stag at their closest points. Any IMS located at Stag could only reach any of these locations following spread and dispersal by mechanisms such as currents or carriage by vessel.

[9] With 'clean' implied by DPIRD as free of listed IMS

Currents in the Stag field are semi-diurnal and predicted to have average speeds of approximately 0.25 knots up to 0.5 knots. The oscillating nature of the currents suggests that it would take somewhat in excess of three days, as a minimum, for floating larvae to reach the coastal locations in closest proximity to the Stag field, and somewhat longer to reach the closest conservation significant areas. Spread of IMS from the Stag field could also be conceivably accomplished by larval colonisation of vessels operating in the Stag field, or by mobile species swimming across to such a vessel, with subsequent vessel-mediated transfer to other locations. Although theoretically possible, such transfer has been reviewed and deemed to present a low likelihood of occurrence (URS 2013).

On the basis of the species risk evaluations and review of available video footage, it may be stated that the Stag field infrastructure, as at the time of the reviewed ROV surveys, presented no evidence of having been colonised by listed marine pest species of concern to DAWE, and with no indicators of likely presence. Accordingly, and within the limitations intrinsic to such surveys, it may be concluded that Stag infrastructure is unlikely to harbour IMS of concern and thus represents minimal risk as a haven or staging point for subsequent further spread of IMS (PGM Environment, 2021).

It is well recognised by Australian authorities that IMS can have deleterious effects upon marine areas, including conservation areas, in a number of ways such as by:

- Out competing;
- Predating upon or displacing native species;
- Altering natural ecological processes;
- Harbouring pathogens which can impact upon ecological or human health; or
- Degrading commercial fisheries and aquaculture enterprises.

Determination and description of the potential effects and consequences of IMS colonisation of conservation dependent areas in the vicinity of Stag would be species dependent and require considerable research and analysis for minimal, if any, substantive return or benefit to the tailoring of adopted management measures, and is not a standard industry practice nor one required by the responsible Commonwealth or State/Territory regulators. However, if IMS were established it may have a 'moderate' impact - Local effect; recovery in months to a year; impact to localised community.

There are increased concerns regarding fishery impacts following the introduction of IMS into Australian waters. Should IMS be introduced, they have the potential to outcompete and displace native species which may in turn affect the local marine ecosystem, and potentially fisheries operating in the area affected. However, the Operational area does not contain any known critical areas (i.e. feeding, breeding) or highly significant habitat (i.e. coral reef, seagrass) for fish. It is also unlikely that IMS will be able to establish. However, if IMS were established it may have a 'moderate' impact - Local effect; recovery in months to a year; impact to localised community.

8.1.3 Environmental Performance

Hazard		IMS Introduction (EUH-1)		
Performance objective		**No introduction of IMS**		
ID	**Management controls**	**Performance standards**	**Measurement criteria**	**Responsibility**
074	All third party tankers are cleaned prior to mobilising to the Stag field	All third party tankers undergo the following prior to disembarkation to the Stag field: - hull cleaning, - clean of the chain lockers and all open spaces on deck, - chemical flushing of inboard lines - provision of Ship Sanitation certificate Once confirmed by IMS SME as cleaned, the tanker must disembark within seven days of the cleaning activities being confirmed as completed.	IMS inspection report confirms third party tanker satisfactorily cleaned prior to disembarkation by IMS SME	Marine Superintendent
075	Vessels comply with the Biosecurity Manual JS-70-MN-G-00001*	Biofouling risk assessment to be completed prior to commencement of work within Jadestone operational areas and found to represent a low risk, or an otherwise acceptably low managed risk of potentially introducing IMS. For vessels with a biofouling risk assessment result found to not represent a low or acceptable risk, risk reduction actions must be applied prior to commencement of operation at a Jadestone site such that the subsequent risk is considered low or acceptable.	Biofouling risk assessment completed for vessel prior to commencement of work at Jadestone operated site and found to be low or acceptable risk	Operations Manager
076		For vessels designed to use ballast water, they must have: - A valid ballast water management certificate - A ballast water management plan consistent with ballast water management convention, and approved - A ballast water record book consistent with ballast water management convention.	Ballast water certificate Approved Ballast Water Management Plan Ballast Water Management Certificate Ballast Water Record Book	

* The biosecurity manual applies to all marine vessel operations in Operational Areas and has as its purpose to:

a) Describe the marine biosecurity management process for Jadestone Energy (Australia) Pty Ltd activities including vessels contracted to perform marine operations.

b) Prevent the introduction of Invasive Marine Species (IMS) into Australian Waters and the Operational Area through translocation vectors such as marine and petroleum vessels, immersible equipment and ballast water.
c) Ensure contracted vessels and vessel operators are aware of and apply the marine biosecurity requirements when chartered to execute their scope of work.
d) Ensure compliance with Commonwealth and State Australian Government legislation.
e) Detail the risk-based approach and mitigations used to reduce the risk of IMS being introduced to the operational area to As Low as Reasonably Practicable (ALARP).

8.1.4 ALARP Assessment

On the basis of the impact and risk assessment process completed, Jadestone considers the control measures described above are appropriate to manage the risk of IMS being introduced at the Stag facility. The residual risk ranking for this potential impact is considered Low, and therefore ALARP has been demonstrated. Additional controls considered but rejected are detailed below.

Rejected control	Hierarchy	Practicable	Cost effective	Justification
No routine discharge of ballast water from vessels	Eliminate	No	No	Vessel presence is required to carry out operational activities. Ballast exchange is required for safe operation of vessels and eliminating this requirement is not possible.
All vessels to be sourced from Australian waters	Eliminate	No	No	Vessel presence is required to carry out operational activities. Delays to activities caused by delays to contracting vessel(s). Minimal benefit expected given the implemented controls ensure only low IMS risk vessel are contracted.
Follow-up marine pest inspection around 75 days after arrival if the vessel is still in WA waters	Isolation	No	No	The residual risk of IMS is considered low due to inspection and cleaning controls and follow-up inspections of vessels 75 days after arrival is not considered required. In the event that any IMS entered the Operational Area the nearest habitat is the third-party tanker hull or the benthic habitat (soft sediments at the seabed). The anti-fouling coating, depth of the Operational Area (49 m), open ocean conditions and lack of available light at this depth provides a unsuitable or incompatible habitat conditions to those within the sheltered ports and shallow coastal areas which have historically been colonised by IMS.
N/a	Substitute	N/a	N/a	Wherever possible, domestic vessels will be sourced, but this may not always be feasible. However, all vessels are subject to IMS risk assessment and must manage their ballast water in accordance with regulatory requirements.
Application of new anti-foulant coating to vessels prior to contract commencement	Engineering	No	No	Substantial additional cost, potential delay to production operation. Little benefit given recent anti-fouling treatment history for vessels and requirement to complete IMS Risk assessment. Anti-fouling coating on the in-water surfaces of vessels, and the chemical dosing of seachests (marine growth prevention system) will occur. Anti-fouling coatings containing TBT are not considered an option as these biocides are prohibited for use in Australia.
Hull cleaning on every occasion	Engineering	No	No	Additional cost and potential delay to production operation, little benefit since hulls will be inspected and cleaned if required when using the IMS Vessel Check tool and

				inspected/assessed to the standard detailed in applicable DAWE biofouling guidelines (DAWR 2009) (as required).
Ballast water treatment (e.g. biocide or UV)	Engineering	No	No	Dependent upon vessel age and configuration, some may be fitted with a Ballast Water Treatment System (BWTS) able to treat ballast water to the standard required by DAWE. If a vessel is not fitted with a BWTS, then ballast water treatment is not a practicable management option, with alternatives required by DAWE as the regulatory authority.
Transfer of ballast water to separate vessel for discharge outside operational area	Isolation	No	No	Generally, intake and outlet of ballast water will occur at the 'same' location (within 1 nautical mile of the two points). Substantial additional cost would be incurred to go outside of the operational area each time. Potential activity downtime and increase in activity duration as operations would likely need to cease during ballast water transfer. Little benefit given lack of sensitive habitats (shallow water habitats etc.), and potential translocation vectors (static vessels) in operational area. Introduction of additional safety risks to personnel during vessel to vessel transfer operations
N/a	Administrative	N/a	N/a	The implementation of a Biofouling Management Plan and maintaining a Biofouling Record Book consistent with the DAWR (2009) *National Biofouling Management Guidance for the Petroleum Production and Exploration Industry*. No further administrative controls were considered.

8.1.5 Acceptability assessment

The potential impacts of IMS introduction are considered 'Broadly Acceptable' in accordance with the Environment Regulations, based on the acceptability criteria outlined below. The control measures proposed are consistent with relevant legislation, standards and codes.	
Policy compliance	Jadestone's HSE Policy objectives are met.
Management system compliance	**Section 9** demonstrates that Jadestone's HSE Management System is capable of continuously reviewing and updating activities and practices at the Stag facility to reflect the requirements of marine pest management in Australian waters.
Social acceptability	Stakeholder consultation has been undertaken (see **Section 6**), and no stakeholder concerns have been raised. Jadestone will continue to liaise with DPIRD on current requirements for the management of the risk of marine pest introduction in Western Australian waters.
Laws and standards	While no legislation directly regulates hull/ niche biofouling, vessels associated with the activity will adopt the National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (DAWR, 2009).
Industry best practice	Application of guidelines detailed in the National Biofouling Management Guidance for the Petroleum Production and Exploration Industry DAWR, (2009), and in the IMO Guidelines for

	the Control and Management of Ships' Biofouling to Minimise the Transfer of Invasive Aquatic Species.
Environmental context	It is unlikely that any IMS entering the Operational Area will establish on the natural benthic habitat (soft sediments at the seabed). The depth of the Operational Area (49 m), open ocean conditions and lack of available light at this depth provides a very different environment to that within sheltered port and shallow coastal areas which have historically been colonised by IMS. The potential impact is considered acceptable after consideration of: - Potential impact pathways - Preservation of critical habitats - Assessment of key threats as described in species and Area Management /Recovery plans - Consideration of North-West Bioregional Plan; and - Principles of ecologically sustainable development ESD
ALARP	The residual risk has been demonstrated to be ALARP.

8.2 Non-hazardous and Hazardous Solid Waste

8.2.1 Description of hazard

Aspect	Release of solid wastes may occur as a result of overfull and/or uncovered bins, incorrectly disposed items or spills during transfer of waste between the CPF/third-party tanker and support vessels. A non-hazardous release of solids to the environment has the potential to occur from the following activities: • CPF, third-party tanker or supply vessel operations; • Lifting – dropped objects (refer **Section 8.7**); • Accidental discharge of dry bulk products; and • Accidental discharge of waste. Hazardous wastes, such as chemicals and chemical containers, batteries, waste oil, produced sands, medical wastes and oily wastes, will be generated from Stag operations and disposed of onshore in accordance with a Waste Management Plan. Wetblasting, if performed, will generate a sludge waste comprising blasting medium (water or garnet if used), rust and particles of old surface coatings (e.g. paint, epoxy). Similarly, the waste product from wetblasting is disposed of onshore.

8.2.2 Impacts and Risks

Non-hazardous solid wastes such as plastics have the potential to pollute marine environments and harm fauna through entanglement or ingestion. Marine turtles and seabirds are particularly at risk from entanglement. Marine turtles may mistake plastics for food; once ingested, plastics can damage internal tissues and inhibit physiological processes, which can result in fatality. Generally, no toxic effects are expected from non-hazardous solids.

Release of hazardous solid wastes may result in the pollution of the immediate receiving environment, leading to detrimental health impacts to marine flora and fauna. Physiological damage can result through ingestion or absorption and may occur to individual fish, cetaceans, marine reptiles or seabirds. Marine fauna (including seabirds) encountered within the Operational Area are expected to be limited to small numbers of transient individuals, noting however that the area does overlap with the humpback whale and blue whale migration corridor, shearwater foraging, and the flatback turtle interesting areas which may result in a higher number of these species around the Stag Facility.

Benthic habitats have the potential to be impacted with accidental spills of solid wastes resulting in possible damage to or loss of soft sediment communities within the area affected. The potential impact may be short term to long term depending on the waste type, its degradation rate, and the amount lost to the marine environment.

In the event of a buoyant solid waste being accidentally released to the marine environment, it may create a navigational hazard.

Produced sands are generated on the Stag CPF from the Stag reservoir, consisting of fine sand and glauconite containing oil, some heavy metals and low levels of naturally occurring radioactive materials (NORMS). A third-party assessment of NORMs levels in Stag sands – *Radiation Management Plan (JS-70-PR-F-00002)* was undertaken and found that the level of NORMs within Stag sands do not put sands in the category of radioactive waste. NORMs levels in Stag sands are independently assessed annually and no samples to date have exceeded any regulatory limits for safe handling, storage or disposal. Accidental loss of containment of sand into the ocean may occur from equipment failure, incorrect handling and/or transport and overfilling of sands tanks during handling of this waste.

Supply vessels generate small quantities of similar wastes; these are managed in accordance with the vessels' own waste management plans and procedures.

8.2.3 Environmental Performance

Hazard		Non-hazardous and hazardous solid wastes (EUH-2)		
Performance objective		**No release of non-hazardous or hazardous solid wastes to the marine environment**		
ID	**Management controls**	**Performance standards**	**Measurement criteria**	**Responsibility**
077	CPF: Waste Management Plan (JS-70-PR-I-00034) implemented to ensure correct waste handling	Solid waste materials are stored in fit for purpose storage containers and/or lifting skips, labelled and equipped with lids / covers to prevent loss of material during storage and handling.	For CPF: waste register and vessel manifest	Stag OIM
078	Vessels: Waste management plan implemented to reduce the risk of waste released to sea, in accordance with Marine Orders	Hazardous solid wastes will be managed in accordance with Marine Orders – Part 94 (Marine Pollution Prevention – Packaged Harmful Substances), Navigation Act 2012 and Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (Part III) requirements, and Environmental Protection Regs (controlled waste)	Garbage Record Book shall be maintained in accordance with MARPOL 73/78 Annex V Regulation 9	Operations Manager
079	Bagging Sand Procedure (GA-19-PR-P-00007) ensures produced sand is correctly managed and disposed of onshore	Flexible IBC bags rated to a lifting weight of 2,000kg are used to bag produced sands. All bags are transported off the CPF and sands transported to shore for disposal.	Manifest details produced sand handling	Stag OIM
080		Produced Sands will be double-bagged (bulki bags).	Manifest details produced sand handling	Stag OIM
081	Personnel understand waste management requirements and undertake assessment as required by the Competency and Training Management System [JS-60-PR-Q-00015]	CPF crew and support vessel masters complete an assessment containing basic information on environmental practices	Online induction completion record	Stag OIM

8.2.4 ALARP Assessment

On the basis of the impact and risk assessment completed, Jadestone considers the control measures described above are appropriate to manage the risk of unplanned solid waste discharges from the Stag facility. The residual risk ranking for this potential impact is considered Low, and therefore ALARP has been demonstrated. Additional controls considered but rejected are detailed below.				
Rejected control	**Hierarchy**	**Practicable**	**Cost effective**	**Justification**
No use of hazardous materials or production of wastes	Eliminate	No	No	Solid wastes produced onboard are disposed of onshore and are not discharged to the marine environment, therefore there is no planned impact to the marine environment. Complete elimination of waste is not feasible; therefore, the risk of unplanned releases remains
Substitute any hazardous chemical use with non-hazardous chemical use	Substitute	No	No	Where appropriate selection of chemicals or materials to achieve low or no environmental effect is made. Some hazardous waste is unavoidable from the use of batteries, lights etc and produced sand, therefore there are limited opportunities for substitution.
N/a	Engineering	N/a	N/a	All waste bins have lids and wastes are segregated at the time of disposal. No other engineering controls were considered.
N/a	Isolation	N/a	N/a	The Activity is located at distance from sensitive receptors and the coastline.
N/a	Administrative	N/a	N/a	Maintenance management system implemented, compliance with relevant and appropriate MARPOL and legislative requirements, certified equipment. No further controls were identified.

8.2.5 Acceptability Assessment

The potential impacts of unplanned non-hazardous and hazardous solid waste accidental releases to the marine environment are considered 'Broadly Acceptable' in accordance with the Environment Regulations, based on the acceptability criteria outlined below. The control measures proposed are consistent with relevant legislation, standards and codes.	
Policy compliance	Jadestone's HSE Policy objectives are met.
Management system compliance	**Section 9** demonstrates that Jadestone's HSE Management System is capable of continuously reviewing and updating activities and practices at the Stag facility to reflect the requirements of the Waste Avoidance and Resource Recovery Act and Controlled Waste Regulations.
Social acceptability	Stakeholder consultation has been undertaken (see **Section 6**), and no stakeholder concerns have been raised with regards to waste management practices at the Stag facility.
Laws and standards	Requirements of the Waste Avoidance and Resource Recovery Act and Controlled Waste Regulations have been adopted.
Industry best practice	The APPEA Code of Environmental Practice (CoEP) (2008) objectives are met with regards to offshore production operations.

Environmental context	Benthic habitats have the potential to be impacted with solid wastes resulting in potential loss of soft sediment communities and harm to marine fauna. The potential impact may be short term to long term depending on the waste type and its degradation rate. If impacted, benthic habitats and associated biota are well represented in the region The potential scale of environmental harm from accidentally discharged solid waste is small in comparison to the vast size of soft substrata habitats spanning the North-west Shelf. The operational area is overlapped by 4 species BIA. However, the areas that may potentially be affected by accidentally discharged solid waste would represent a very small percentage of the total area. The potential impact is considered acceptable after consideration of: - Potential impact pathways - Preservation of critical habitats - Assessment of key threats as described in species and Area Management /Recovery plans - Consideration of North-West Bioregional Plan; and - Principles of ecologically sustainable development ESD
ALARP	The residual risk has been demonstrated to be ALARP.

8.3 Non-hydrocarbon Hazardous Liquids

8.3.1 Description of Hazard

Aspect	A non-hydrocarbon liquid, in particular chemicals, may be released to the environment. The expected spill amounts are small, with the largest instantaneous volume being 1,000 L (the full contents of an IBC instantaneously released to the marine environment).

There may be accidental releases/ discharges to the marine environment of a variety of potentially hazardous materials and chemicals (liquid) which are stored and utilised or produced at the CPF and/ or vessels during operations. These include:

- Bulk process chemicals including biocide, corrosion inhibitor, scale inhibitor and emulsion breakers. Chemical spills to the marine environment have the potential to occur should non-routine incidents occur during chemical transfer, handling, storage or use and in the event of equipment failure or upset conditions from topsides or subsea infrastructure;
- Cleaning products, solvents and paints on support/ supply vessels;
- Loss of chemicals from chemical injection lines during well intervention/ water injection well set-up and workover activities (for example, during run and pull of ESPs);
- Other non-process chemicals such as fluorescein dye, paints and thinners, laboratory chemicals and cleaning agents. As for bulk process chemicals, spills of non-process chemicals may occur from incidents with storage, handling and transport. However, these are likely to be either of very minor quantity (usually less than 50 L);
- Water foaming agents used in fire fighting (aqueous film forming foams (AFFF)) may enter the sea; and
- Accidental release of liquid hazardous materials as a result of dropped objects during bulk material transfer to the CPF/ third-party tanker.

A number of chemicals are used on the Stag CPF during the production process and within water injection and ancillary equipment. These chemicals are used to:

- Aid oil and water separation from the collected well fluids;
- Treat produced water for the removal of hydrocarbons;

- Control corrosion and scale;
- Prevent the growth of marine organisms within the equipment;
- Treat seawater prior to injection into the Stag reservoir;
- Treat potable water;
- Aid in leaks detection in pipelines and hoses; and
- Assist analytical determinations in the CPF laboratory.

For instance, scale and corrosion inhibitors are injected downhole in the wells to protect the well tubing and internal process piping integrity. Sea water is injected into the reservoir to maintain downhole pressures in the reservoir. This seawater is de-aerated (with oxygen scavenger) prior to pumping through the five dedicated wells back into the reservoir. Biocide is added to pipework and slops tanks to minimise the formation of sulphur reducing bacteria (SRB). Other water clarifiers and emulsion breakers are used in the produced water treatment circuit for the removal of oil. Similarly, a range of chemicals are added to the Reverse Osmosis Unit (RO) to assist with drinking water treatment.

Fluorescein dye sticks can be added to water when used for pressure testing pipelines and hoses, to assist in leak detection. Typically, Fluorescein Dye Sticks (Champion Product No. 1323) are utilised and these have a Gold OCNS ranking.

The production chemicals are soluble in produced water and oil to varying extents and the dissolved fractions are ultimately either retained within the crude oil or discharged with the produced water. For example, chemicals such as the demulsifiers are very hydrophobic (octanol/water partition coefficient >4 considered very hydrophobic) and stay within the oil fraction, whereas chemicals such as the biocides are very hydrophilic (octanol/water partition coefficient <1 considered hydrophilic) and stay within the produced water fraction.

The various process chemicals and their application and injection points, as well as their discharge points, are detailed in **Table** 8-2.

8.3.2 Impacts and Risks

The impacts associated with the accidental discharge of liquid hazardous materials is related to the nature of the material spilled, the volume and its behaviour in the marine environment (sink/ float/ disperse etc.).

Chemicals, for example solvents and detergents, are typically stored in small containers of 5–25 L capacity and used in areas that are bunded. Leaks and spills of non-hydrocarbon liquids are contained within the immediate storage/ use area or on board. Small spills cleaned up using spill kits as per general housekeeping requirements, or the Shipboard Oil Pollution Emergency Plan (SOPEP) (or equivalent for vessels <400 DWT). Non-hydrocarbon liquids may also enter the marine environment during transfer operations (offloading or backloading) – for example, a dropped object event. The maximum possible volume that may enter the marine environment is 1,000 L, this volume would be contained within an IBC which is assumed to be damaged during the lifting/ drop event such that the full volume is instantaneously released.

If hazardous materials are accidentally lost overboard, potential impacts will include a temporary and highly localised decline in water quality with limited potential for toxicity to marine fauna due to the temporary exposure and low toxicity resulting from the rapid dilution in the marine environment. It is noted that the area does overlap with the humpback whale and blue whale migration corridor, shearwater foraging, and the flatback turtle interesting areas which may result in a higher number of these species around the Stag Facility. However, potential impacts are likely to be limited to the immediate vicinity and unlikely to affect overall population viability. In the event of a spill from Stag Facilities to the marine environment the hazardous materials would be subjected to rapid dispersion and dilution by the open ocean water conditions and prevailing currents.

Further impacts associated with the release of hydrocarbons are discussed in **Sections 8.4.2.1** and **8.6**.

Table 8-2: Process and ancillary chemicals

Chemical Tag	Chemical/ Usage	Injection Point	Disposal Point	Risk Ranking or Ecotox Information
Acetone	Acetone/ glass cleaning	Laboratory	Atmosphere/ overboard	Soluble and readily biodegradable, miscible with water (SG: 0.791); low environmental risk.
Sodium metabisulphite	Preservative for RO membranes	RO Unit	Overboard	Not discharged to marine environment; low environmental risk.
AFFF	Firefighting foam	Fire pumps	Overboard/ drains	Soluble with water (SG: 1.01). No ecotoxicity data available. However only a small quantity is used and largely diluted upon release to marine environment. Low environmental risk.
BPA4972	Antifoulant/ hypochlorite	Potable water	Overboard	Soluble in water (SG:1.2). LC50 (Rainbow trout) = 1.9 mg/L/96hrs; LC50 (Daphnia magna) = 1.6 mg/L/48hrs; LC50 (Bluegill sunfish) = 5.3 mg/L/96hrs. Assessed using 1.6 mg/l = 1.92ppm. Low environmental risk.
Citric acid	Descaler	RO Unit	Overboard	Not discharged to marine environment. Low environmental risk.
CRW 24006	Corrosion inhibitor	Process	Overboard	Toxic to aquatic organisms (R51/R53) may cause long term adverse effects in the aquatic environment. Soluble in water Sg = 1. Low environmental risk.
CRW 24408	Neutralising amine	Boiler	Overboard	Soluble in water. SG = 0.975. Low environmental risk.
DMO86539	Forward emulsion breaker	Process	Export	Gold OCNS CHARM. Toxic to aquatic organisms (R51/R53) may cause long term adverse effects in the aquatic environment. Insoluble in water. SG = 1.015. Low environmental risk.
Fluorescein dye sticks	Leak detection	Pipeline, hoses	Overboard	Gold OCNS CHARM. Low environmental risk.
Grime buster	Detergent	Decks	Overboard	Limited ecotoxicity data was available when preparing the MSDS, ensure appropriate measures are taken to prevent this product from entering the marine environment. Soluble in water. SG = 1.1. Low environmental risk.
Isopropanol	Isopropanol/ glass cleaning	Laboratory	Atmosphere/ overboard	E OCNS non-CHARM-able. Low environmental risk.
Kerosene	Base sediment and water readings	Laboratory	Atmosphere	Not discharged to marine environment. Low environmental risk.
Nalco 8338	Corrosion inhibitor	Process	Overboard	The ingredient sodium tolytriazole at 1-5% in the product is slightly toxic to fish and algae; however, with only ultra-trace volumes for discharge, the ingredient will be diluted and considered a very low risk. The remaining ingredients in the product are either PLONOR or

Chemical Tag	Chemical/ Usage	Injection Point	Disposal Point	Risk Ranking or Ecotox Information
				non-hazardous so this product is not considered hazardous and no risk to the receiving marine environment.
Oceanic HW	Hydraulic fluid	W/H hydraulic	Export	Not discharged to marine environment and remains in export line with crude oil. Low environmental risk.
OSW 24514	Oxygen scavenger	Water injection	Reservoir formation	Not discharged to marine environment and remains in export line with crude oil. Low environmental risk.
OSW 24909	Oxygen scavenger	Boiler	Overboard	Only a small quantity of 10 L is used on average per month. The concentration in the PW is ~0.1 µg/L. Ecotoxicity data are only available for freshwater species. Based on this data, the discharge concentration is below the lethal concentration to marine organisms. SG = 0.980. Low environmental risk.
Petrotec 3-389	Fuel biocide	Diesel biocide	Export	Not discharged to marine environment and remains in export line with crude oil. Low environmental risk.
PFR7989	Defoamer	Process	Export	Not discharged to the marine environment. Low environmental risk.
RBW24362	Reverse emulsion breaker	Process	Overboard	Recommended to flush spills to sewer but as a greatly diluted solution 'No particular hazard to the environment'. Forms an emulsion with water. SG = 1.017. Low environmental risk.
SCW24024	Scale inhibitor	Process	Overboard	Low concentration in the PW (37 µg/L) is well below the lethal concentration to marine organisms and will be largely diluted following release into the marine environment. Although this chemical is not biodegradable, it is not expected to bioaccumulate. Soluble in water. SG = 1.36. Low environmental risk.
SCW24079	Scale inhibitor	Boiler	Overboard	Very dilute concentration in the PW (0.17 µg/L) is well below the lethal concentration to marine organisms and will be largely diluted following release into the marine environment. SG = 1.154. Low environmental risk.
Toluene	Solvent/ lab analysis	Laboratory	Export	SG = 0.871. Largely exists as a vapour in the air if released to soil. Fish: Toxic 1<LC/EC/IC50<= 10mg/l. Aquatic Invertebrates: Harmful: 10<LC/EC/IC50 <= 100mg/l. Algae: Low toxicity: LC/EC/IC50 > 100mg/l. Mobility: Floats on water, highly mobile and may contaminate groundwater. Persistence/degradability: Readily Biodegradable. Oxidises by photo-chemical reactions in air. Bioaccumulation: Does not bioaccumulate significantly. Low environmental risk.
Vertrel MCA	Solvent/ lab analysis	Laboratory	Export	Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Not readily biodegradable. EC50 (72 hrs) >120 mg/l (algae). LC50 (96 hrs) 13mg/l

Chemical Tag	Chemical/ Usage	Injection Point	Disposal Point	Risk Ranking or Ecotox Information
				(fish). Soluble, SG = 1.47. As this chemical is not discharged into the marine environment, it is considered to pose little risk to the marine environment.
XC24040	Biocide (THPS)	Slops tanks/ annulus injection	Overboard	Very toxic to aquatic organisms. Soluble in water. SG = 1.137. Discharge concentration is largely diluted and not expected to cause adverse effects based on this data. Low environmental risk.
		Water injection	Reservoir formation	

8.3.3 Environmental Performance

Process chemicals are stored within bunded areas on the platform and metered to their various application points throughout the process. The bunds, in turn, drain to large capacity tanks with a design capacity exceeding the volume of the stored chemicals.

Hazard		**Non-hydrocarbon hazardous liquids (EUH-3)**		
Performance objective		**No release of environmentally hazardous chemicals to the marine environment.**		
ID	**Management controls**	**Performance standards**	**Measurement criteria**	**Responsibility**
082	Compliance with Hazardous Substances & Dangerous Goods Standards (JS-70-STD-I-00035) ensures appropriate bunding for hazardous liquids	Any hazardous liquid storage on deck must be designed and maintained to have at least one barrier (i.e. form of bunding) to contain and prevent deck spills entering the marine environment.	HSE monthly inspection	Stag OIM
N/A	Refer Section 8.6.5 for additional management controls and performance standards			
083	Compliance with Hazardous Substances & Dangerous Goods Standards (JS-70-STD-I-00035) ensures appropriate and safe chemical handling	Safety Data Sheet (SDS) available evaluation of hazard identification and chemical management	HSE Monthly inspection	Stag OIM
084		Chemicals managed in accordance with SDS in relation to safe handling and storage, spill-response and emergency procedures, and disposal considerations	HSE Monthly inspection	Stag OIM
085	If there is risk of an unplanned release greater than 80 litres, chemicals will be risk assessed in accordance with	For hazardous chemicals, the following standards apply to reduce the risk of an accidental release to sea:	HSE monthly inspection	Stag OIM

Hazard		Non-hydrocarbon hazardous liquids (EUH-3)		
Performance objective		**No release of environmentally hazardous chemicals to the marine environment.**		
ID	**Management controls**	**Performance standards**	**Measurement criteria**	**Responsibility**
	Chemical Selection, Evaluation and Approval Procedure (JS-70-PR-I-00033)	• Selected chemical substances comply with relevant regulatory requirements and approved activity environment plans; • Selected chemical substances are subject to mandatory risk review and formal approval before procurement; • Transport, storage and handling of chemicals is in accordance with relevant regulations; • Least hazardous chemicals are preferentially selected for use thereby minimising and/ or eliminating potential safety and environmental impacts; • If chemicals required are classified as hazardous and/ or dangerous goods, the control measures for safe transport, storage and handling are deemed adequate; • Selected chemical substances meet technical specifications and are fit for purpose.	Records of environmental risk assessments for chemicals for operational activities	
086	Vessel SOPEP valid and tested to ensure ability to respond to spills	Spill kits are: • Located near high risk spill areas. • Intact, clearly labelled and contain adequate quantities of absorbent materials.	Spill Exercise Reports	
087	Spill exercise conducted in accordance with Stag Incident Response Plan – Offshore component (GF-00-PR-F-00002) to ensure spill preparedness	CPF spill exercise as part of annual incident response drills.	Exercise records	Stag OIM

8.3.4 ALARP Assessment

On the basis of the impact and risk assessment process completed, Jadestone considers the control measures described above are appropriate to manage the risk of non-hydrocarbon liquid hazardous waste. The residual risk ranking for this potential impact is considered Low, and therefore ALARP has been demonstrated. Additional controls considered but rejected are detailed below.

Rejected control	Hierarchy	Practicable	Cost effective	Justification
N/a	Eliminate	N/a	N/a	Industry-standard technologies are not available to eliminate the use of chemicals or hydrocarbons on-board, therefore elimination of hazardous liquid use cannot be eliminated. Hazardous liquid waste produced or used onboard are disposed of onshore and are not discharged to the marine environment, therefore there is no planned impact to the marine environment. Complete elimination of waste is not feasible; therefore, the risk of unplanned releases remains
Substitute any hazardous liquid use with non-hazardous liquid use	Substitute	No	No	Where appropriate selection of chemicals or materials to achieve low or no environmental effect is made. Some hazardous waste is unavoidable from the use of chemicals and through the production process, therefore there are limited opportunities for substitution.
N/a	Engineering	N/a	N/a	Safeguards will be implemented as required, by the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and MARPOL Annex I, II and III. Such safeguards may include (but not limited to) inventory minimisation, designated storage and handling areas, correct stowage, accurate labelling and marking, SDS information, spill clean-up equipment and containment (e.g. bunds). No other potential controls were identified.
N/a	Isolation	N/a	N/a	
N/a	Administrative	N/a	N/a	Procedures are in place for the management of liquids to ensure technical performance is appropriately balanced with environmental performance. Procedures exist for the selection of production chemicals with low environmental risk by following Jadestone's Operations Chemical Selection Evaluation and Approval Procedure (JS-70-PR-I-00033). No additional administrative controls were identified.

8.3.5 Acceptability Assessment

The potential impacts of unplanned non-hydrocarbon liquid hazardous waste are considered 'Broadly Acceptable' in accordance with the Environment Regulations, based on the acceptability criteria outlined below. The control measures proposed are consistent with relevant legislation, standards and codes.

Policy compliance	Jadestone's HSE Policy objectives are met.
Management system compliance	**Section 9** demonstrates that Jadestone's HSE Management System is capable of meeting environmental management requirements for this activity.

Social acceptability	Stakeholder consultation has been undertaken (see **Section 6**), and no stakeholder concerns have been raised with regards to the risk of unplanned liquid waste discharges.
Laws and standards	Relevant legal and regulatory controls have been adopted
Industry best practice	The APPEA Code of Environmental Practice (CoEP) (2008) objectives are met with regards to offshore production operations.
Environmental context	While the risk of unplanned liquid waste discharges could occur from the Stag facility and have an impact on the waters immediately nearby, the impact and risk assessment process indicates that discharges will have a temporary and localised impact on marine waters and will not result in significant impact to marine fauna including those species BIA that overlap the area. The potential impact is considered acceptable after consideration of: - Potential impact pathways - Preservation of critical habitats - Assessment of key threats as described in species and Area Management /Recovery plans - Consideration of North-West Bioregional Plan; and - Principles of ecologically sustainable development ESD.
ALARP	The residual risk has been demonstrated to be ALARP.

8.4 Unplanned Release of Hydrocarbon – Scenarios

8.4.1 Maximum Credible Worst-Case Scenarios

Unplanned events may occur during the Stag operations that could result in the release of hydrocarbons to the marine environment.

The hydrocarbon spill scenarios identified during the environmental impact and risk assessment process were modelled according to the type of hydrocarbon – diesel or Stag crude oil – and the potential point of release, sea surface and subsea. The modelling considered the release of the maximum credible worst-case scenarios described (**Table** 8-3 and **Figure** 8-1) over all seasons of the year (RPS-APASA, 2020).

Table 8-3: Maximum credible worst-case oil spill scenarios for the Stag facility

Hydrocarbon	Release point	Maximum credible worst-case scenarios
Diesel	At surface	Short term (instantaneous) with total release = 250 m^3
Stag crude oil	At surface	Short-term release (30 mins) with total release volume = 17.2 m^3
	Subsea	Short-term release (30 mins) with total release volume = 86.5 m^3

To determine the maximum worst-case credible spill volumes for each identified spill scenario, Jadestone has based the volumes on the expected pumping rates and known inventories of infrastructure. They have also adopted the AMSA (2015) guideline: *Technical guideline for preparing contingency plans for marine and coastal facilities*. Jadestone considers that in adopting the AMSA guideline the estimated spill volumes are appropriately conservative given that for the scenarios presented there are multiple barriers/ controls in place; meaning the total volumes evaluated are much greater than what would be released in the event of a spill.

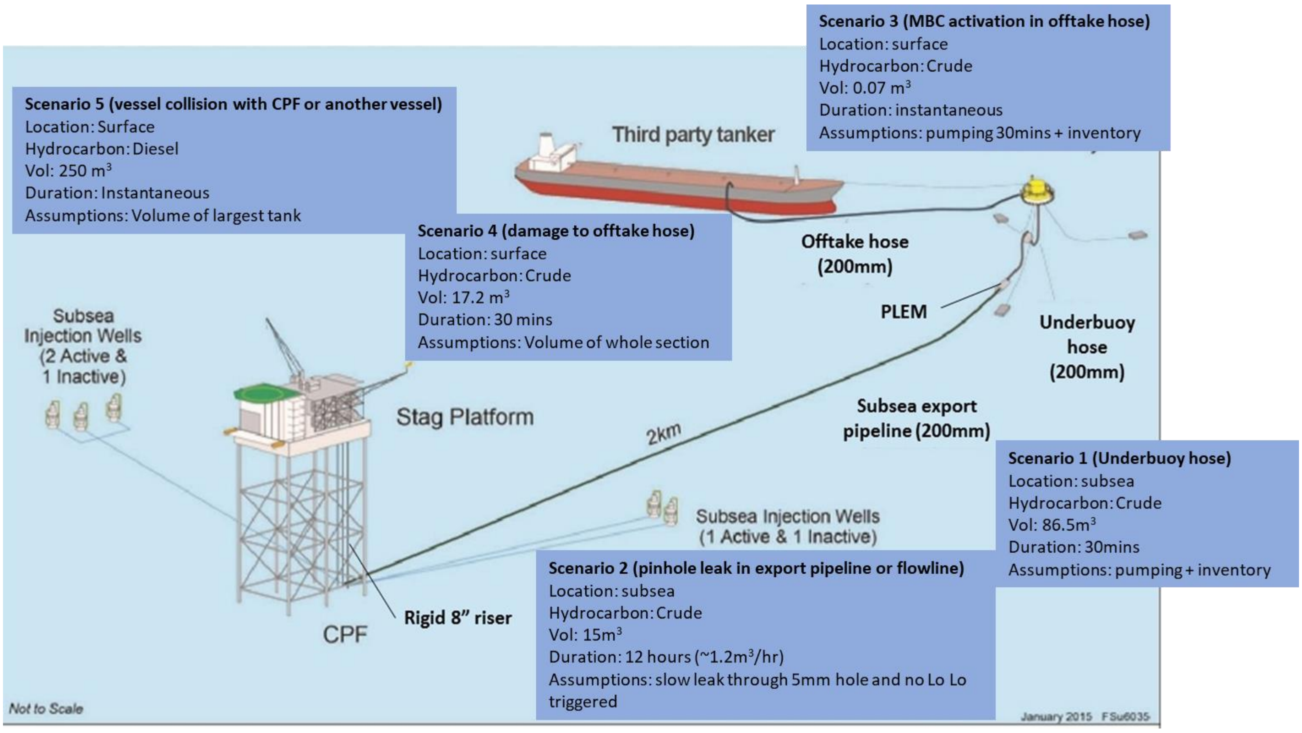


Figure 8-1: Unplanned release of hydrocarbon spill scenarios

8.4.2 Discounted Scenarios

Of the spill scenarios considered, the below were discounted as not credible:

- Release of Stag crude oil due to well blow out

As described in the Stag Well Operations Management Plan (WOMP) (GF-50-PLN-W-00001), through review of the Stag reservoir in November 2011 (Dowling and Betts, pers. comm., 2011) it was determined that the pressure in the reservoir is not sufficient to flow oil to the surface in the event of a loss of all well barriers. As the reservoir has been produced, the pressure has declined with time such that fluids (oil and produced water) will not flow to the surface unless an Electric Submersible Pump (ESP) is running in the well. In the event of a severe loss of well integrity and corresponding shutdown of the Stag artificial lift system, the reservoir pressure will be unable to support a column of well fluids to surface where seawater will effectively kill the well.

Some wells (Stag 12H and Stag 36H) have recently experienced positive surface pressures when shut in, which would indicate the wells have the capability of free-flowing limited quantities gas to surface. This is due to the wells experiencing a period of higher gas rates than previously observed. Despite the higher surface pressures, the bottom hole pressures (as measured in the wells) still preclude the ability of the wells to free flow oil and produced water to surface. To further mitigate against the potential for these wells to free-flow, downhole tubing retrievable surface controlled subsurface safety valves (TRSCSSSV) has been installed in these wells.

As such a well blow-out during production activities is not deemed a credible scenario and not considered further.

- Release of diesel/ Stag crude oil due to vessel grounding

A release of hydrocarbon due to vessel grounding and subsequent fuel tank rupture resulting from a loss of propulsion or due to navigational error resulting in a vessel running aground in shallow areas was not considered a credible scenario for the Stag operations as the facility is situated in deep water (approximately

50 m) and there are no charted reefs or islands that pose a grounding hazard. This is confirmed by seabed surveys in the operational area and surrounds.

8.4.2.1 Modelling approach

To determine the spatial extent of impacts from a potential hydrocarbon spill (surface and subsurface) and the dispersion characteristics of the oil over time, modelling was completed by Asia-Pacific Applied Sciences Association (RPS APASA, 2020). Oil spill modelling was undertaken using a three-dimensional oil spill trajectory and weathering model, SIMAP (Spill Impact Mapping and Analysis Program), which is designed to simulate the transport, spreading and weathering of specific oil types under the influence of changing meteorological and oceanographic forces.

Near-field subsea discharge modelling was undertaken using OILMAP, which predicts the droplet sizes that are generated by the turbulence of subsea discharges as well as the centreline velocity, buoyancy, width and trapping depth (if any) of the rising gas and oil plumes.

Spill modelling was performed using a number of simulated environmental conditions from all seasons thus providing a range of realistic spill trajectories from which to determine the spatial extent of potential impacts and receptors which might be affected by a spill.

A summary of the modelling method is described below.

1. **Stochastic approach**: stochastic modelling was carried out using an historic sample of wind and current data for the 'study area' that spanned ten years. For each season (March to August and September to February), a large number of replicate simulations (100) were modelled (i.e. 200 in total), each initialised at different, randomly selected points in time for that seasonal period and hence under a different time series of environmental conditions. This stochastic sampling approach provides an objective measure of the possible outcomes of a spill, because environmental conditions will be selected at a rate that is proportional to the frequency that these conditions occur over the study area. More simulations will tend to use the most commonly occurring conditions, while conditions that are more unusual will be represented less frequently.
2. **Contact thresholds**: Oil spill models are able to track hydrocarbon concentrations of surface oil, entrained oil and dissolved aromatic hydrocarbons below biologically significant impact levels. Consequently, threshold concentrations are specified for the model to control what contact is recorded for surface oil and subsurface locations (entrained oil and dissolved aromatic hydrocarbons) to ensure that recorded contacts are for biologically meaningful concentrations. Thus, it is important to describe the thresholds used as the boundary of the EMBA will be influenced by the thresholds set in the hydrocarbon spill modelling.

The determination of biologically meaningful impact thresholds is complex since the degree of impact will depend on the sensitivity of the biota contacted, the duration of the contact (exposure) and the toxicity of the hydrocarbon mixture making the contact. The toxicity of a hydrocarbon changes over time, due to weathering processes altering the composition of the hydrocarbon. To ensure conservatism in defining the EMBA boundary and the subsequent impact assessment, the threshold concentrations applied to the model are based on the most sensitive receptors that may be exposed, the longest likely exposure times and the more toxic hydrocarbons.

Impact pathways and impact threshold concentrations are detailed in **Appendix H** for floating oil, entrained oil and dissolved aromatic hydrocarbons (DAH).

3. **Data generated:** during each simulation (of which there are 100 for each season), the model recorded the location (latitude x longitude x depth) of each of the particles (representing a given mass of hydrocarbon) on or in the water column, at regular time steps.

The collective records from all simulations were then analysed by dividing the study area into a three-dimensional grid. For oil particles classified as being at the water surface, the sum of the mass in all hydrocarbon particles located within a grid cell, divided by the area of the cell provided an estimate of the concentration of oil in that grid cell, at each time step.

For entrained and dissolved hydrocarbon particles, concentrations were calculated at each time step by summing the mass of particles within a grid cell and dividing by the volume of the grid cell. The concentrations of oil calculated for each grid cell, at each time step, were then analysed to determine whether concentration estimates exceeded defined threshold concentrations. The risks were then summarised as follows:

- The probability of exposure at a location was calculated by dividing the number of spill simulations where contact occurred above a contact threshold at that location (defined as per **Figure** 8-2) by the total number of replicate spill simulations. For example, if contact occurred at the location (above a contact threshold) 50 out of 100 simulations, a probability of exposure of 50 per cent is indicated; and
- The minimum potential time to a shoreline location was calculated by the shortest time over which oil was calculated to travel from the source to the location in any of the replicate simulations.

4. **Probability contours**: the results were presented in terms of statistical probability maps based on 100 simulations, each generated under different environmental conditions. The contours of probability are not representations of a single spill event (APASA (2020).
5. **Completion of modelling**: each of the 100 simulations was run for a period of two to three weeks allowing for the fate of dispersed hydrocarbons to be evaluated. Fate assessment stops once hydrocarbon concentrations fall below the defined contact thresholds. In this manner, the full extent of the spill scenario is assessed against the specified contact thresholds.

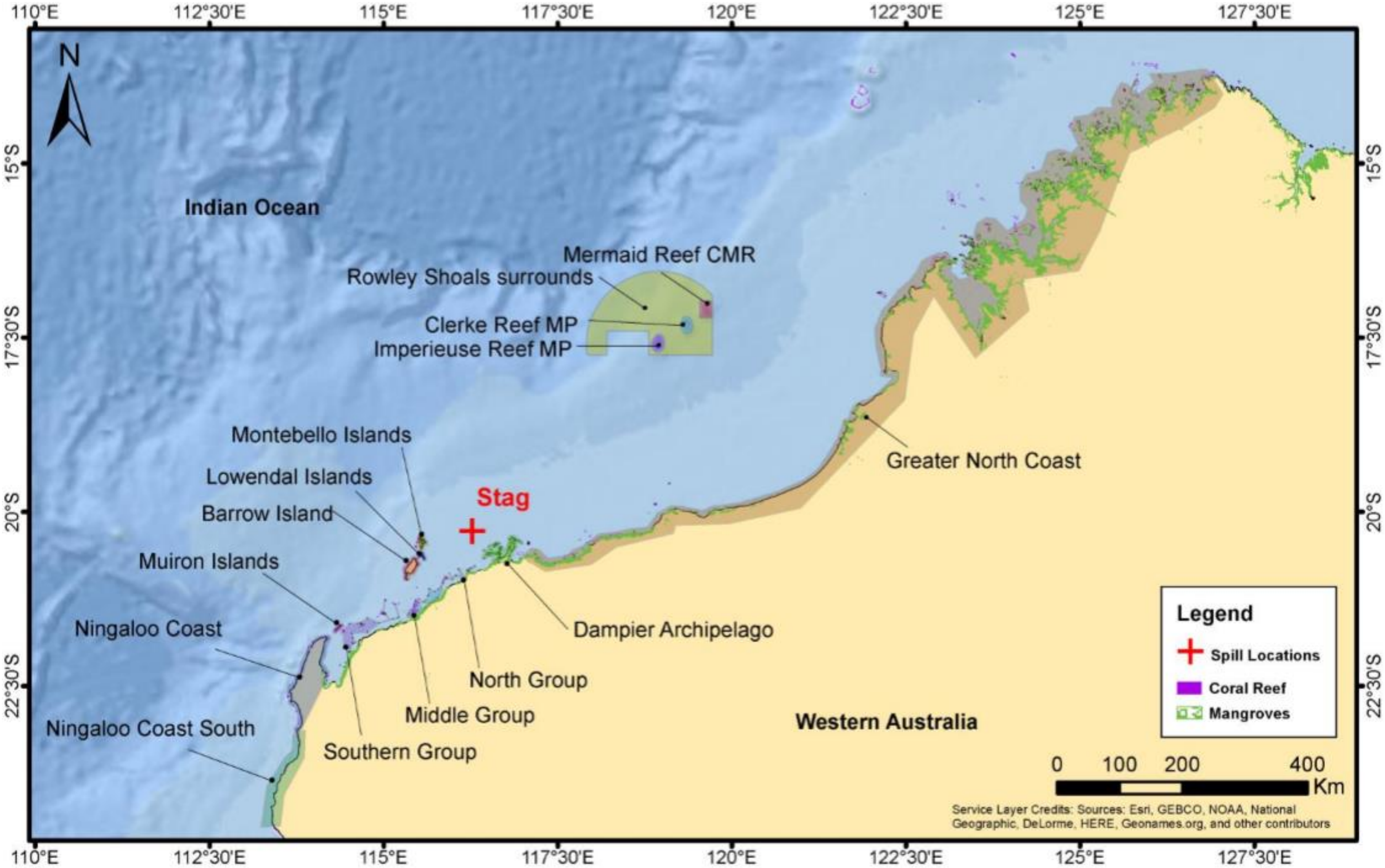


Figure 8-2: Sensitive receptor segments

Modelling Thresholds

To assess environmental effects from an unplanned hydrocarbon release, four separate hydrocarbon components that pose differing environmental risks were evaluated:

- Surface hydrocarbons – hydrocarbons that are 'on' the water surface;
- Entrained hydrocarbons – hydrocarbon that is entrained 'in' the water;
- Dissolved hydrocarbons – the dissolved component of hydrocarbon in' the water; and
- Shoreline accumulation – hydrocarbons that accumulate along shorelines.

Threshold concentrations for each of the three hydrocarbon phases were developed and applied to the modelling outputs to define the EMBA for each phase. A receptor was considered 'affected' by one of the phases as soon as the threshold for the phase at that location was exceeded (i.e. instantaneous impact approach).

The rationale for the selection of the thresholds is described in **Appendix H** and a summary of the contact thresholds applied is provided in Error! Reference source not found.. The EMBA (**Figure** 5-1) is denoted by the lowest hydrocarbon exposure thresholds to indicate all receptors that may be *contacted* by hydrocarbons of any phase from any scenario. However, for the purposes of impact assessment, higher exposure thresholds are applied, termed as 'moderate' in NOPSEMA bulletin #1, (Error! Reference source not found.) to indicate the receptors that could be *affected* (rather than just contacted) and is based on scientific knowledge to determine the potential for impact. A Risk EMBA is then drawn utilising these thresholds (Error! Reference source not found.) which lies within the overall EMBA.

Table 8-4: Summary of the contact thresholds applied in the hydrocarbon spill modelling

Floating oil (g/m^2)		Shoreline Oil		Entrained oil (ppb)		DAHs (ppb)	
1	Low (approximates range of socio-economic effects and establishes planning area for scientific monitoring)	100	Moderate (loading predicts area likely to require clean-up effort)	100	High (as appropriate given oil characteristics for informing risk evaluation)	70	Medium (approximates potential toxic effects)
10	Moderate (approximates lower limit for harmful exposures to birds and marine mammals)						

8.4.3 Spill Response Strategies

There are numerous oil spill response strategies available to be implemented in the event of a spill. These are generally based on strategies which have been implemented in the past or considered to be good industry practice.

The evaluation of the suitable response strategies was conducted based on the credible spill scenarios identified and **Table 8-8** is the outcome of the first level screening undertaken. Below are the key considerations for the evaluation:

- The properties and weathering profile of the oil;
- The philosophy of the responses, that is, what is aim of the response based on the hydrocarbon properties. In the case of Stag crude: prevention of shoreline contact and application of chemical dispersant to entrain and enhance biodegradation;
- The net environmental benefit of undertaking the response strategy;
- The nature and scale of the maximum credible worst-case scenario; and
- The potential safety and environmental aspects and impacts involved with the selected responses.

Table 8-5: Spill response strategies considered for the mitigation of contact from hydrocarbon spills

Strategy	Description	Environmental Benefits	Decision
Source control	Implementation of the third-party tanker SOPEP	Reduce the volume of oil entering the marine environment	**Adopt**
	Implementation of Emergency Pipeline Repair Plan (GF-09-PLN-L-00039	Cease loss of containment event as soon as practicable.	**Adopt**
Operational Monitoring	Surveillance actions are used to monitor and evaluate the trajectory and fate of the released hydrocarbon, to determine the effectiveness of response strategies and to identify and report on any potential/actual contacts to flora, fauna, or any other sensitive receptor that occurs. Surveillance results are used to assist in escalating or de-escalating response strategies as required.	There are various specific control measures (vessel/ aerial surveillance, tracking buoys, oil spill modelling, fluorometry) within this response strategy which may be suitable. Their use, in combination or individually, will be determined based on the spill distribution as well as other considerations such as access to locations, environmental and metocean conditions. This strategy is vital to ensure that there is sufficient information to gain situational awareness and make informed decisions on response planning, execution and termination.	**Adopt**
Surface chemical dispersion	Chemical dispersant is applied to break down the hydrocarbons and allow/enhance dispersion into the water column, thereby preventing/reducing potential shoreline contact and increasing biodegradation.	Surface chemical dispersant may be viable, either by vessel or plane. Based upon previous dispersant efficacy testing undertaken on Stag crude, there is a Window of Opportunity (WoO) up to 72 hours post spill, prior to Stag crude weathering beyond the ability of potential effective chemical dispersion, in which surface chemical dispersant could be applied (refer Section 10 of the OPEP). Chemical dispersants applied at sea surface can reduce the amount of floating oil but increase the oil concentrations in the water column, thereby increasing the risk of exposure to organisms that live in the water column (refer Section 8.5.2 and Table 8-7). Entrained oil concentrations are not constant; they are subject to frequent fluctuations due to metocean influences, mobility of receptors and the dilution of the dispersed oil by the sea. Subsequent potential contact to organisms in the water column and nearshore marine habitats is infrequent, of varying concentration, duration and consequence. Therefore, Jadestone consider that any potential shoreline loading reduction is more beneficial than the potential impact to organisms from entrained oil and this strategy is worth keeping in the toolbox as an option.	**Adopt**

Strategy	Description	Environmental Benefits	Decision
		Chemical dispersion will only be undertaken when there is a net environmental benefit. Applicability of chemical dispersant is limited to the conditions, locations and circumstances described in the OPEP.	
Physical dispersion	Physical dispersion is undertaken by running vessels through the hydrocarbon plume and using the turbulence developed by the propellers or hydro-blasting from vessel hydrants to break up the slick. Once dispersed in the water column in the form of smaller droplet sizes, biodegradation processes are enhanced.	In general, this strategy is considered an opportunistic strategy; used on targeted, small, breakaway areas, especially patches close to shorelines. Given that oil is expected to emulsify by the time it approaches shorelines, and chemical dispersant application would be preferred as a means of dispersing bulk oil; this strategy has limited effectiveness, and is not considered to be a strategy requiring further planning and associated control measures.	**Reject**
Containment and recovery	Containment and recovery of hydrocarbons can offer a preventive form of protection to sensitive receptors. Skimmers (mechanical) and booms will be used at sea. This strategy is only effective in calm conditions.	For a spill of Stag crude, this is the preferred way to remove hydrocarbons from the water surface before the risk of contacting shorelines/sensitive receptors. Containment and recovery may be applicable once evaporation of highly volatile components has occurred. Based on the Stag crude oil assay, a solidified residual is expected which can be collected using containment and recovery methods. Given that shoreline booming and shoreline clean-up are expected to be difficult across some locations within the EMBA (e.g. Dampier Archipelago and the Montebellos) this strategy is considered important to the overall spill response.	**Adopt**
Protection and deflection	Protection and deflection activities involve the use of booms to: 1. Protect sensitive receptors; 2. Deflect spills away from sensitive receptors or shorelines; or 3. Deflect spills to an area that provides increased opportunity for recovery activities. This strategy is typically not effective in areas experiencing large tidal variations and associated currents.	Activities are focused on areas of high protection value in low energy environments based upon real time operational surveillance provided the environmental and metocean conditions are favourable for an effective implementation. Consequently, this strategy may not be applicable across all shorelines identified as being contacted by oil.	**Adopt**
Shoreline clean-up	During a spill response, clean-up of the oiled shorelines will be implemented using suitable methods, provided it will be beneficial to the environment based on the NEBA performed on the affected areas based on actual site conditions.	Contacted shorelines will be assessed for their shoreline clean-up potential. This response has the potential to cause secondary disturbance associated with the clean-up, so applicability of the strategy is based on aerial surveillance	**Adopt**

Strategy	Description	Environmental Benefits	Decision
		reconnaissance, shoreline assessments and NEBA in the shoreline clean-up assessment.	
Oiled wildlife response (OWR)	Responding to an oiled wildlife incident will involve an attempt to prevent wildlife from becoming oiled and/or the treatment of animals that do become oiled.	Within the EMBA, areas with importance for wildlife have been identified to be threatened by the oil spill and mobilisation of a wildlife response will likely be necessary. Mobilisation of experts, trained work forces, facilities and equipment will then be needed. Wildlife response activities may take place at sea, on shorelines and in specialised facilities further inland. Options for wildlife management are considered and a strategy determined guided by the Western Australian Oiled Wildlife Response Plan (WAOWRP).	**Adopt**
In-situ burning	In situ burning is a technique sometimes used in responding to an oil spill. In situ burning involves the controlled burning of oil that has spilled (from a vessel or a facility), at the location of the spill. The oil has to be amenable to lighting e.g. unweathered, high lighter oil fractions and not prone to emulsification. When conditions are favourable and conducted properly, in situ burning will reduce the amount of oil on the water.	Operational and oil constraints expected during a spill from the Stag Operations suggest in-situ burning is not applicable. For in-situ burning to be undertaken, oil has to be thicker than 1-2 mm but diesel tends to have high evaporation rate and spreads into very thin films rapidly. Stag crude is a highly weathered oil, with little light fractions and prone to emulsification. In addition, in-situ burning requires containment. Due to operational constraints and the expected hydrocarbon not being suitable for in-situ burning, this response strategy is deemed inapplicable for Stag Operations.	**Reject**
Scientific Monitoring	This is the main tool for determining the extent, severity and persistence of environmental impacts from an oil spill and allows operators to determine whether their environmental protection outcomes have been met (via scientific monitoring activities).	Scientific monitoring is especially beneficial for monitoring entrained and dissolved oil impacts as response strategies are generally targeted to manage the surface oil impacts.	**Adopt**

8.5 Unplanned Release of Stag Crude Oil

8.5.1 Description of hazard

Aspect	Surface release of Stag crude oil from damage to the offtake hose between the CALM buoy and third-party tanker, resulting in a maximum worst-case credible spill of **17.2 m³; and** Subsea release from the underbuoy hose at the CALM buoy resulting in a maximum worst-case credible spill of **86.5 m³**.

8.5.2 Stag Crude Oil Characteristics

Stag oil is a medium crude composed of hydrocarbons that have a wide range of boiling points and volatiles at atmospheric temperatures, and which will begin to evaporate at different rates on exposure to the atmosphere. Change in the mass balance calculated for Stag crude weathering under low (5 knots) and constant wind indicates that approximately 14% of the oil volume would evaporate within 12 hours. The remaining oil would weather at increasingly slower rate as the mixture becomes proportionally enriched by compounds with longer carbons chains, hence higher boiling points. Once all volatile compounds have evaporated, only the residual compounds will remain, and weathering rates would slow significantly. After one day approximately 40 to 80% is predicted to remain on the sea surface (% dependent upon wind variability). This reduces to approximately 32 to 68% of the crude remaining on the surface after seven days.

A summary of the physical properties of Stag crude oil is provided in Error! Reference source not found.**.**

Table 8-6: **Characteristics of Stag crude oil**

Hydro-carbon	**Initial density (g/cm³) @ 15°C**	**Viscosity (cP) @ 20°C**	**Component**	**Volatiles (%)**	**Semi-volatiles (%)**	**Low volatility (%)**	**Residual (%)**	**Aromatics (%) Of whole oil**
			BP (°C)	**<180**	**180–265**	**265–380**	**>380**	**<380**
Stag crude oil	0.944	115	% of total	0.5	16.0	40.8	42.8	11.3
			% aromatics	0.2	3.0	8.1	-	-
			-	**Non-persistent**			**Persistent**	

Source: APASA (2020)

Further detail on Stag crude oil is provided in the OPEP.

Toxicity Testing of Crude Oil

Toxicity testing using the water accommodated fraction (WAF) of Stag oil indicated that the oil would be of low acute toxicity to organisms in the water column (Battelle, 1998). In 96-hour exposure tests, no acute toxicity was observed on two species of tropical fish (a clownfish: *Amphiprion clarkii*, and a silverside: *Menidia beryllina*) in an undiluted solution of the WAF (**Error! Reference source not found.**). Similarly, there was no acute toxicity observed on a tropical prawn (*Penaus vannamei*) after 96 hours' immersion in the undiluted WAF, while a tropical mysid shrimp (*Mysidopsis bahia*) suffered mortality after 96 hours' exposure in a high-concentrations of the WAF (30% survival in undiluted WAF).

In tests on the potentially more sensitive planktonic larvae of invertebrates (using the larvae of three species of sea urchin: *Arbacia punctulata*, *Dendraster excentricus*, and *Strongylocentrotus purpuratus*), there was no reduction in the rate of normal larval development, or of survival after 60 hours' exposure to undiluted WAF.

In a final test involving relatively long-term exposure of stony corals (a five-day exposure test using *Acropora elysii*) corals survived in an undiluted solution of WAF made from fresh oil; however, growth was inhibited by two thirds. In contrast, five days' immersion in an undiluted WAF solution made from oil weathered for 0.5 to one day had no effect upon the growth of the corals.

Table 8-7: Toxicity testing results of water accommodated fraction (WAF) of Stag crude

Test Species	Test Codes	Exposure Level – Stag Crude	
		% of WAF	mg/L TPH*
Clownfish *(A. clarkii)*	LC_{50}96hLC_{50}	>100	>273
Silverside *(M. beryllina)*	LC_{50}96hLC_{50}	>100	>273
Mysid Shrimp *(M. bahia)*	LC_{50}96hLC_{50}	72	87
Penaid Prawn *(P. vannamei)*	LC_{50}96hLC_{50}	>100	>219
Sea Urchin Larvae	EC_{50}96hEC_{50}	>100	>219
Stony Coral *(A. elysii)*	EC_{50}120hEC_{50}	>50	>110

* Test Codes: 96hLC50 Concentration causing mortality to 50% of the test organisms after 96 hours (4 days) exposure; 96hEC50 concentration causing an effect on the rate of normal larval development during 60 hours (2.5 days) exposure; 120hEC Concentration causing a significant reduction in the growth rate during 120 hours (5 days) exposure

Given the low asphaltene content of the weathered residue, Stag crude will have low adherence properties when coming into contact with environmental receptors. The degree to which impacts could occur will depend upon the level of coating (concentration of oil and/or loading of oil on shorelines) and how fresh the oil is, with toxicity from oil contact likely to be more prevalent from 'fresh' oil closer to the Stag Facility.

The viscosity of Stag crude would increase through weathering and the uptake of water to form an oil-in-water emulsion. The maximum water uptake for Stag crude has been measured at 74–81% for fresh and weathered crude, respectively, resulting in a stable emulsion (Battelle, 1998). Consequently, the volume of the slick increases over time through the uptake of water to form a viscous emulsion.

8.5.2.1 Surface Release

Stag crude could be released at the surface from the offtake hose due to damage or from the marine breakaway coupling (MBC) activation.

A HAZID was conducted in November 2020 for the Stag Facility activities and **Table** 8-8 lists the credible spill scenarios identified for the release of crude oil to the marine environment at sea surface.

Table 8-8: Credible Stag crude oil spills to the marine environment at surface

Scenario	Maximum Credible Spill	Release duration	Credibility justification
Damage to offtake hose between CALM buoy and third party tanker	**17.2m³**	**30 mins**	The offtake hose is of 200 mm internal diameter with a double carcass construction with built-in flotation. The offtake hose is protected from failure due to over loading by a dry break coupling. The entire volume of the offtake hose could be released due to damage and loss of integrity (e.g. vessel running over the hose, damaged hose). The entire volume is assumed to be lost as a worst-case scenario with no failsafes (such as MBC) activating. The release duration is worst case.

Scenario	Maximum Credible Spill	Release duration	Credibility justification
MBC activation during offtake activity at offtake hose	**0.07m^3**	**Instantaneous**	The MBC activates in the event of overloading. The volume lost is assumed to be 30 minutes of pumping prior to MBC activation (worst case scenario) plus the inventory released at surface.

8.5.2.2 Subsurface Release

Stag crude could be released to subsea due to loss of integrity, process upset, equipment failure, corrosion or damage through dropped objects. A HAZID was undertaken for the Stag Facility activities and the below credible subsea release spill scenarios were identified:

Scenario	Maximum Credible Spill	Release duration	Credibility justification
Damage to flexible underbuoy hose from loss of integrity or damage	**86.5m^3**	30 mins	The volume lost is assumed to be 30 minutes of pumping plus the inventory released from the hose.
Pinhole leak in subsea export pipeline or flowline from damage or corrosion	**15m^3**	12 hours	A rate of approximately 1.2m^3/hr through a 5mm hole and assume that no Lo Lo is triggered which would result in the pipeline or flowline being shut in.

8.5.2.3 Results – Surface Release of 17.2 m^3

The data indicates that 57% of oil would evaporate over time scales of days to weeks if exposed to the atmosphere and approximately 43% would persist in the environment, decaying mainly through biodegradation. Approximately 11% is composed of aromatic hydrocarbons (RPS APASA, 2020). The annualised EMBA is derived from the seasonal stochastic modelling results (i.e. results from all 200 replicates), hence describes a substantially larger area than would be affected during any single spill event. The annualised EMBA is based on thresholds for floating oil (1 g/m^2 and 10 g/m^2), shoreline oil (100 g/m^2), entrained oil (100 ppb) and dissolved aromatic hydrocarbon (70 ppb) concentrations. The annualised maximum distance from the spill location to the outer edge of the annualised EMBA is calculated as approximately 295 km.

Floating Oil Results

For spills commencing in September to February, the slicks are most likely to be transported toward the north-east from the release location. Spills commencing during the March to August months are most likely to drift toward the west from the release location.

Results of the worst-case modelling (September to February) indicate that surface sheens of floating oil (>1 g/m^2 and 10 g/m^2) may pass over the following sensitive receptors, with a probability of >1% of reaching these locations, noting that floating oil will not accumulate on submerged features or at open ocean locations (**Table** 8-9).

Floating oil concentrations at or greater than 1 g/m^2 could travel up to 385 km from the release location (September to February), with the distances reducing to 15 km (March to August) as the contact threshold increases to 10 g/m^2.

Table 8-9: Modelling results for floating oil due to 17.2 m³ Stag crude surface release

Receptor Type	Receptor	>1 g/m²	>10 g/m²
Australian Marine Parks	Gascoyne MP	Y	N
	Montebello MP	Y	N
Biologically Important Areas	Marine Turtle BIA	Y	Y
	Seabirds BIA	Y	Y
	Fish and Sharks BIA	Y	Y
	Whales BIA	Y	Y
Islands	Montebello Islands	Y	N
Key Ecological Features	Ancient Coastline at 125m Depth Contour	Y	N
	Continental Slope Demersal Fish Communities	Y	N
	Exmouth Plateau	Y	N
	Glomar Shoals	Y	N
State Marine and National Parks	Barrow Island MMA	Y	N
	Montebello Islands MP	Y	N

Entrained Oil results

Entrained oil concentrations at or greater than 100 ppb could travel up to 101 km from the release location (March to August). Results of the stochastic modelling indicated that entrained oil concentrations greater than 100 ppb were predicted to reach the following locations at greater than 1% probability during the worst case of September–March (**Table** 8-10). For 100 ppb the minimum arrival time is 11 hours to the Montebello Marine Park. The maximum entrained hydrocarbon concentration at any depth in the worst replicate is 408 ppb at the Montebello Islands MP.

Table 8-10: Modelling results for entrained oil due to 17.2 m³ Stag crude surface release

Receptor Type	Receptor
Australian Marine Parks	Montebello Marine Park
Biologically Important Areas	Marine Turtle BIA
	Seabirds BIA
	Sharks BIA
	Whales BIA
Islands	None
Key Ecological Features	None
State Marine and National Parks	Montebello Islands MP

Dissolved Aromatic hydrocarbons

Dissolved aromatic hydrocarbon concentrations at or greater than 70 ppb are not predicted within the modelling domain for this scenario. No receptors are predicted to receive dissolved aromatic hydrocarbon concentrations equal to or greater than 70 ppb during either season.

8.5.2.4 Results – Subsea Release of 86.5 m³ crude

The results of the OILMAP-Deep simulation predicted that the discharge would generate a cone of rising gas bubbles that would 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) of approximately 48.7 m above the seabed. The discharge velocity and turbulence generated by the expanding plume is predicted to generate oil droplet sizes between 2,129–7,671 µm. These droplets will be subject to mixing due to turbulence generated by the lateral displacement of the rising plume. The largest droplets have the potential to reach the surface within minutes.

The annualised EMBA is derived from the seasonal stochastic modelling results (i.e. results from all 200 replicates), hence describes a substantially larger area than would be affected during any single spill event. The annualised EMBA is based on Jadestone's specifications of thresholds for floating oil (1 g/m² and 10 g/m²), shoreline oil (100 g/m²), entrained oil (100 ppb) and dissolved aromatic hydrocarbon (70 ppb) concentrations. The annualised maximum distance from the spill location to the outer edge of the annualised EMBA is calculated as approximately 703 km (**Figure** 8-3**)**.

Floating Oil Results

Results of the worst-case modelling (September to February) indicate that surface sheens of floating oil (>1 g/m² and 10 g/m²) may pass over the following sensitive receptors, with a probability of >1% of reaching these locations, noting that floating oil will not accumulate on submerged features or at open ocean locations (**Table** 8-11).

Floating oil concentrations at or greater than 1 g/m² could travel up to 703 km from the release location (March to August), with the distances reducing to 36 km (September to February) as the contact threshold increases to 10 g/m² (RPS APASA, 2020).

Table 8-11: Modelling results for floating oil due to 86.5 m³ Stag crude subsea release

Receptor Type	Receptor	>1 g/m²	>10 g/m²
Australian Marine Parks	Gascoyne MP	Y	N
	Argo-Rowley Terrace MP	Y	N
	Dampier MP	Y	N
	Eighty Mile Beach MP	y	N
	Montebello MP	Y	N
Biologically Important Areas	Marine Turtle BIA	Y	Y
	Seabirds BIA	Y	Y
	Fish and Sharks BIA	Y	Y
	Whales BIA	Y	Y
Islands	Montebello Islands	Y	N
	Barrow Island	Y	N
	Lowendal Islands	Y	N
Key Ecological Features	Ancient Coastline at 125m Depth Contour	Y	N
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula KEF	Y	N
	Continental Slope Demersal Fish Communities	Y	N
	Exmouth Plateau	Y	N

Receptor Type	Receptor	>1 g/m²	>10 g/m²
	Glomar Shoals	Y	N
State Marine and National Parks	Barrow Island MMA	Y	N
	Barrow Islands MP	Y	N
	Montebello Islands MP	Y	N

Entrained Oil Results

Entrained oil is most likely to drift to the east for spills commencing during summer and transition months, with drift to the west, followed by the southwest also likely for a spill commencing in the transitional seasons. For a spill commencing in winter months, entrained oil is most likely to drift to the southwest, following the offshore bathymetry of the region. Shoreline contact could occur from entrained oil at the Montebello Islands.

Highest maximum nearshore concentrations of entrained oil are predicted to occur along shorelines of the Montebello Islands at 169 ppb for spills commencing during winter months. And 181 ppb in summer months.

For 100 ppb the minimum arrival time is 11 hours to the Montebello Marine Park (in winter months). The maximum entrained hydrocarbon concentration at any depth in the worst replicate is 1,288 ppb at the Montebello Islands MP.

Table 8-12: Modelling results for entrained oil due to 86.5 m³ Stag crude subsea release

Receptor Type	Receptor
Australian Marine Parks	Montebello Marine Park
Biologically Important Areas	Marine Turtle BIA
	Seabirds BIA
	Sharks BIA
	Whales BIA
Islands	Montebello Islands
Key Ecological Features	None
State Marine and National Parks	Montebello Islands MP

Dissolved Aromatic Hydrocarbons

Dissolved aromatic hydrocarbon concentrations at or greater than 70 ppb are not predicted within the modelling domain for this scenario.

No receptors are predicted to receive dissolved aromatic hydrocarbon concentrations equal to or greater than 70 ppb during either season.

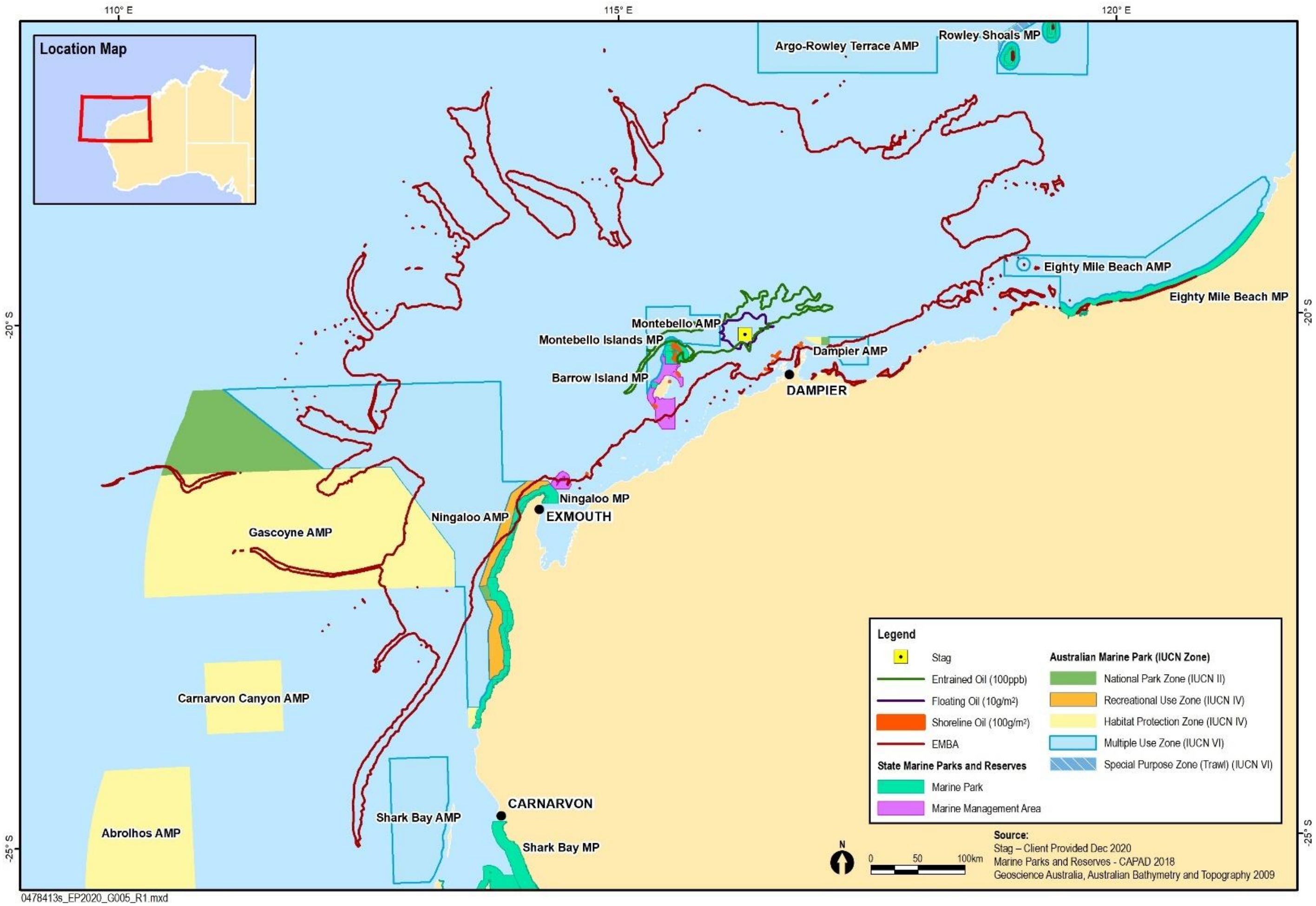


Figure 8-3: Modelled spill trajectories for all seasons for all hydrocarbon phases at moderate exposure thresholds resulting from surface release of Stag crude 86.5 m³ at the Stag Facility within Annualised EMBA of low exposure thresholds

8.5.3 Impacts and Risks

The maximum worst-case credible scenario was used to determine the nature and scale of impacts to sensitive receptors. The following sources of information were used:

- Overlaying the modelled impact from a subsurface release of 86.5m^3 oil on known benthic habitats and shorelines in the region;
- A search of the EPBC Act protected matters database; and
- Predictions of Stag crude oil shoreline contact from RPS APASA (2020).

Hydrocarbon spills can cause chemical (e.g. toxic) and physical (e.g. coating of emergent habitats, oiling of wildlife at sea surface and ingestion) impacts to marine species. The level of impact depends on the magnitude of the hydrocarbon spill (i.e. severity, extent, duration etc.) and sensitivity of the receptor contacted. **Table** 8-13 identifies the physical and chemical pathways and oil impacts to habitats, marine organisms and socio-economic receptors at locations in the EMBA.

The properties of Stag crude oil relevant to impact considerations are its persistent fraction, low likelihood of entrainment, low toxicity due to its highly weathered state, and it low adherence due to the low asphaltene content of the weathered residue.

In general, the oil floats when released on the sea surface, because it is less dense than seawater. Hence, not a big amount of a surface spill would tend to get deposited on the seabed, especially when dealing with a relatively small surface release like the one assessed in this case for the Stag operations. The modelling results show no prediction of oil deposited on the sediments.

8.5.3.1 Floating Oil

Floating oil impacts may include coating of marine flora, fauna and habitats or ingestion by marine fauna.

Shoreline habitats

Shoreline habitats which have the potential to be contacted by stranded oil include intertidal coral reefs, cays, sandy shorelines, mangroves, rocky shorelines and intertidal mud/sandflats. Fauna associated with these can be exposed to toxic effects from ingestion as fauna attempt to clean themselves (e.g. preening of feathers or licking fur), reduced mobility and inability to thermoregulate due to oil coating, contact to eyes, noses and breathing apparatus (invertebrates) from oil coating can result in irritation and/or inability to breathe or see.

Corals

Contact of floating Stag crude oil could occur with intertidal corals at low tide. The degree to which impacts such as bleaching, mortality or reduced growth could occur will depend upon the level of coating (concentration of oil and/or loading of oil on shorelines) and how fresh the oil is.

Prolonged contact of oil with corals has been observed to lead to tissue death and bleaching to exposed parts of colonies. Dosages of dissolved aromatic hydrocarbons are not predicted to reach levels where hydrocarbons dissolved under floating oil could impact intertidal or subtidal corals. Since Stag crude oil has a persistent fraction, extended contact with hard intertidal corals could occur and recovery of intertidal coral communities could be on scale of multiple years to decades, dependent upon the level of contact. A number of important coral areas could be contacted, dependent upon weather conditions and resultant spill trajectory, including Montebello/ Barrow/ Lowendal Islands, Dampier Archipelago and the Rowley Shoals (marine parks). Coral at these locations have been identified as a KPI in the respective marine park management plans (**Table** 5-3).

Table 8-13: Physical and chemical pathways and oil impacts to habitats, marine organisms and socio-economic receptors

Receptor	Location in EMBA	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Rocky Shore	Barrow Island, Montebello Island, Ningaloo Coast including North-West Cape, Dampier Archipelago	Shoreline loading and attachment.	Degree of oil coating is dependent upon the energy of the shoreline area and the type of the rock formation Solid consolidated rock is likely to receive a lower degree of persistent oiling	External contact by oil and adsorption across cellular membranes Impacts to flora and fauna as per this table	Impacts to sessile flora and fauna as per this table
Sandy Shore	Eighty Mile Beach, Muiron Islands, Imperieuse Reef, Barrow Island, Montebello Islands, Lowendal Islands, Clerke Reef MP, Dampier Archipelago, Thevenard Island, Bedout Island, Turtle Island	Shoreline loading and water movement may act to drive oil into sediments	Indirect impacts to nesting and foraging habitats for birds and turtles. Direct impacts to in-fauna	Toxicity of sediment and reduced oxygen availability within the sediments as a result of oil smothering and microbial biodegradation	Indirect impacts to nesting and foraging habitats for birds and turtles including EPBC listed species and KPIs within marine parks as per **Table** 5-3. Direct impacts (mortality) to in-fauna through toxic effects and smothering
Intertidal flats	Eighty Mile Beach (KPI), Barrow Island, Montebello Islands, Dampier Archipelago,	Shoreline loading and attachment to fine substrates	Indirect impacts to foraging habitats for birds & turtles. Direct impacts to infauna	Muddy substrates are likely to promote sedimentation of oil and binding of sediments by oil	Indirect impacts to foraging habitats for birds. Direct impacts (mortality) to in-fauna through toxic effects and smothering including EPBC listed species and KPIs within marine parks as per **Table** 5-3

Receptor	Location in EMBA	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Mangroves	Eighty Mile Beach (KPI), Barrow Island (KPI), Montebello Islands, Lowendal Islands, Dampier Archipelago	Smothering of root system reducing air and salt exchange	Yellowing of leaves, defoliation, disease, increased predation, tree death, reduced growth, reduced reproductive output, reduced seed viability	External contact by oil and adsorption across cellular membranes Uptake of dissolved aromatic hydrocarbons across cellular membranes	Yellowing of leaves, defoliation, disease, increased predation, tree death, reduced growth, reduced reproductive output, reduced seed viability, growth abnormalities
Algae and seagrass	Muiron Islands, Imperieuse Reef, Barrow Island (KPI), Montebello Islands (KPI), Lowendal Islands, Clerke Reef MP, Dampier Archipelago, Barrow-Montebello Surrounds, Rowley Shoal Surrounds, Glomar Shoals, Montebello AMP, Dampier AMP, Mermaid Reef AMP	Smothering of leaves/thalli reducing light availability and gas exchange	Bleaching or blackening of leaves, defoliation, reduced growth	External contact by oil and adsorption across cellular membranes Uptake of dissolved aromatic hydrocarbons across cellular membranes	Mortality, bleaching or blackening of leaves, defoliation, disease, reduced growth, reduced reproductive output, reduced seed/ propagule viability
Hard corals	Muiron Islands (KPI), Montebello Islands (KPI), Lowendal Islands, Dampier Archipelago, Barrow-Montebello Surrounds, Thevenard, Airlie and Serrurier Islands, Rowley Shoal MP (Clerke and Imperieuse Reef), KPI Glomar Shoals, Montebello AMP, Eighty Mile Beach AMP, Mermaid Reef AMP	Smothering of polyps reducing light availability	Bleaching, increased mucous production, reduced growth	External contact by oil and adsorption across cellular membranes Uptake of dissolved aromatic hydrocarbons across cellular membranes	Mortality, cell damage, reduced metabolic capacity, reduced immune response, disease, reduced growth, reduced reproductive output, reduced egg/ larval success, growth abnormalities

Receptor	Location in EMBA	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Invertebrates	All locations including: Eighty Mile Beach, Barrow Island, Dampier Archipelago, Rowley Shoal MP (KPI), Clerke and Imperieuse Reef), Gascoyne AMP, Ningaloo AMP, Montebello AMP, Dampier AMP, Eighty Mile Beach AMP, Mermaid Reef AMP, Argo-Rowley Terrace AMP, Kimberley AMP	Smothering of adults, eggs and larvae - Reduced mobility and capacity for oxygen exchange	Mortality, oxygen debt, starvation, dehydration, increased predation, behavioural disruption	Ingestion and internal adsorption External contact and adsorption across exposed skin and cellular membranes Uptake of dissolved aromatic hydrocarbons across cellular membranes Indirect impact to predators through ingestion of oiled prey	Mortality, cell damage, reduced metabolic capacity, reduced immune response, disease, reduced growth, reduced reproductive output, reduced egg/ larval success, growth abnormalities, behavioural disruption
Fish and Sharks (including EPBC species listed in **Table** 5-3)	All locations including BIA's for: Dwarf Sawfish, Freshwater Sawfish, Green Sawfish; and Whale Sharks (refer **Figure** 5-7) Additional locations include: Eighty Mile Beach, Muiron Islands, Barrow Island, Montebello Islands, Dampier Archipelago, Barrow-Montebello Surrounds, Rowley Shoal Surrounds (Clerke and Imperieuse Reef), Glomar Shoals, Gascoyne AMP, Ningaloo AMP, Montebello AMP, Dampier AMP, Eighty Mile Beach AMP, Mermaid Reef AMP	Smothering of adults but primarily eggs and larvae - Reduced mobility and capacity for oxygen exchange	Mortality, oxygen debt, starvation, dehydration, increased predation, behavioural disruption	Ingestion and internal adsorption External contact and adsorption across exposed skin and cellular membranes Uptake of dissolved aromatic hydrocarbons across cellular membranes (e.g. gills) Indirect impact to predators through ingestion of oiled prey	Mortality, cell damage, flesh taint, reduced metabolic capacity, reduced immune response, disease, reduced growth, reduced reproductive output, reduced egg/ larval success, growth abnormalities, behavioural disruption

Receptor	Location in EMBA	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Birds (including EPBC species listed in **Table** 5-3	BIA's for the following bird species: Wedgetail shearwater, Roseate tern, Lesser crested tern, Lesser Frigatebird, Fairy Tern, Brown booby, Little tern, White-tailed tropicbird (refer **Table** 5-6) Additional locations include: Argo-Rowley Terrace AMP, Eighty Mile Beach (including Ramsar site), Muiron Islands, Barrow Island, Montebello Islands, Lowendal Islands, Thevenard Island, Bedout Island, Clerke Reef (Bedwell Island), Dampier Archipelago Barrow-Montebello Surrounds Montebello AMP, Rowley Shoal Surrounds, Mermaid Reef AMP, Eighty Mile Beach AMP, Gascoyne AMP, Argo-Rowley Terrace AMP	Smothering - Feather matting and damage, reducing insulation, mobility and buoyancy Secondary smothering of eggs and hatchlings	Mortality, drowning, starvation, dehydration, increased predation, hypothermia, behavioural disruption	Ingestion (during feeding or preening) and internal adsorption External contact and adsorption across exposed skin and membranes Secondary contact and adsorption by eggs and hatchlings Indirect impact to predators through ingestion of oiled prey	Mortality, cell damage, lesions, secondary infections, reduced metabolic capacity, reduced immune response, disease, reduced growth, reduced reproductive output, reduced hatchling success, growth abnormalities, behavioural disruption
Marine reptiles	BIA's for the following turtle species: Flatback, the hawksbill, green, loggerhead and leatherback turtle Additional locations include: Eighty Mile Beach, Muiron Islands, Imperieuse Reef, Barrow Island, Montebello Islands, Lowendal Islands, Clerke Reef MP, Dampier Archipelago, Barrow-Montebello Surrounds, Rowley Shoal Surrounds, Glomar Shoals, Montebello AMP, Eighty Mile Beach AMP, Gascoyne AMP, Mermaid Reef AMP, Argo-Rowley Terrace AMP	Smothering (particularly hatchlings) – reduced mobility and buoyancy	Mortality, drowning, starvation, dehydration, increased predation, behavioural disruption	Inhalation of volatile compounds Ingestion and internal adsorption External contact and adsorption across exposed skin and membranes Indirect impact to predators through ingestion of oiled prey	Mortality, cell damage, lesions, secondary infections, reduced metabolic capacity, reduced immune response, disease, reduced growth, reduced reproductive output, reduced hatchling success, growth abnormalities, behavioural disruption

Receptor	Location in EMBA	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Marine mammals	BIA's for the following mammal species: the dugong, humpback whale, blue whale Other locations include: Muiron Islands, Imperieuse Reef, Broome to Roebuck, Montebello Islands, Lowendal Islands, Clerke Reef MP, Dampier Archipelago, Barrow-Montebello Surrounds, Montebello AMP, Eighty Mile Beach AMP, Rowley Shoal Surrounds, Dampier AMP, Mermaid Reef AMP, Kimberley AMP	Smothering – fur damage and matting, reduced mobility and buoyancy (for applicable species) Smothering of feeding apparatus in some species (i.e. baleen whales)	Mortality, drowning, starvation, dehydration, increased predation, hypothermia, behavioural disruption	Inhalation of volatile compounds Ingestion and internal adsorption External contact and adsorption across exposed skin and membranes Indirect impact to predators through ingestion of oiled prey	Mortality, cell damage, lesions, secondary infections. Reduced metabolic capacity, reduced immune response, disease, reduced growth, reduced reproductive output, reduced hatchling success, growth abnormalities, behavioural disruption
Socio- economic and heritage	Eighty Mile Beach, Muiron Islands, Imperieuse Reef, Barrow Island, Montebello Islands, Lowendal Islands, Dampier Archipelago, Barrow-Montebello Surrounds, Rowley Shoal and Surrounds, Glomar Shoals, Montebello AMP, Eighty Mile Beach AMP, Mermaid Reef AMP,	Smothering of socio-economic/tourism amenities such as sandy shores. Floating oil on sea surface may prevent vessels (commercial/ recreational) from utilising area Economic effect on industry due to restricted zones, impacts to values, impacts to fishery/aquaculture (e.g. pearls, seaweed) stocks	Loss of income, restriction of access, reduction in aesthetic values leading to negative effect on tourism (both short and long term), loss of aquaculture, human health risk	Entrained oil and DAH may be ingested by fish stocks Reduction in water quality can result in impacts to aquaculture	Decrease in fishery stock levels, reduced marketability of product, tainted flesh in fish, perceived reduction in health of habitat, pearl/ seaweed industry tainted stock, loss of income

Corals at the Montebello/ Barrow/ Lowendal islands and Dampier Archipelago have the potential to be impacted by the greatest volumes and more toxic (less weathered crude oil) although it should be noted that Stag crude oil has a relatively low toxicity due to its highly-weathered state.

Impacts to hard corals could be intensified if a spill was to reach shallow coral areas during the peak spawning season of March/ April since floating oil could smother intertidal corals in the process of spawning or could contact floating coral eggs and larvae following spawning events. Dependent on the level of contact, this could diminish coral recruitment, and impact longer term recovery.

Presence of surface oil can affect light qualities and the ability of macrophytes to photosynthesise. Reduced primary productivity could occur while surface oil is present.

Mangroves and salt marshes

Mangrove root systems (including pneumatophores) are sensitive to physical coating by crude oil which may persist for long periods of time given the persistent components of Stag crude oil and the tendency for mangrove root habitat to trap oil. This could have prolonged negative effects on the faunal communities within mangroves. Of the emergent habitat types mangroves are likely to be one the most susceptible and slowest recovering habitat types with recovery potentially on a decadal scale if death of trees was to occur. Mangroves could be impacted at the Montebello, Lowendal, Barrow Islands, Dampier Archipelago and shoreline areas along Eighty Mile Beach. These mangroves are identified as KPI values within many of the respective management plans (**Table** 8-13).

Floating crude oil could reach salt marsh areas (Eighty Mile Beach), which are often landward of mangrove communities, on high spring tides. Salt marshes would likely trap floating crude oil to a certain degree and therefore persistent oil may remain within these areas even after tidal water has receded. This could have prolonged negative effects on the faunal communities within salt marshes. Depending upon the degree of weathering, Stag crude oil may have toxic impacts from physical coating of salt marshes potentially ranging from death to sub lethal stresses such as reduced growth rates and reduced reproductive output/ success. Such impacts would be restricted to the seaward fringes of salt marsh communities.

Fish and sharks

Near the sea surface, fish can detect and avoid contact with surface slicks meaning fish mortalities rarely occur in the event of a hydrocarbon spill in open waters (Kennish, 1997; Scholz et al., 1992). As a result, wide-ranging pelagic fish species of the open ocean generally are not highly susceptible to impacts from hydrocarbon spills. This includes the EPBC listed whale shark (whose BIA overlaps the EMBA (**Figure 5-6**)), great white and grey nurse shark, oil pollution is identified as a threat in their respective conservation advice (SPRAT whale shark, great white shark and grey nurse shark, DEE 2017as). BIAs for sawfish are also within the EMBA and conservation advice identifies marine pollution as a risk for green sawfish.

Assessment of the effects on Timor Sea fish following the Montara incident indicated that fish collected initially in Phase I and II of monitoring showed evidence of exposure to petroleum hydrocarbons at sites close to the West Atlas drilling rig, with samples collected one year after (Phase III) suggesting an ongoing trend toward a return to normal biochemistry/ physiology (Gagnon and Rawson, 2011).

Most reef fish are expected to be buffered from contact to floating surface slicks by the overlying water column. For example, shallow water reef habitats extend to 15–20m depth along island coastlines allowing reef fish species to seek refuge from floating oil slicks. Reef fish in the shallowest areas are more susceptible to hydrocarbon spill impacts however, as many reef fish are site attached residents on the reef and are unlikely to move away if their territory is impacted. Impacts due to contact with floating oil may include reduced mobility and capacity for oxygen exchange, behavioural disruption or mortality.

Marine mammals

Whales, dolphins and dugongs are smooth skinned, hairless mammals so hydrocarbons tend not to stick to their skin therefore physical impacts from surface oil coating is unlikely. Pinnipeds are more susceptible to physical coating as hydrocarbons tend to adhere to rough surfaces, hair or calluses of animals. Irritation to eyes, ears, airways and/or skin may occur from contact with surface slicks.

Physical impacts due to ingestion are applicable to surface slicks; however, the susceptibility of cetacean and pinnipeds species varies with feeding habits. Baleen whales are more likely to ingest surface slick hydrocarbon than "gulp feeders" such as toothed whales and are particularly vulnerable to hydrocarbon ingestion while feeding. Oil may stick to the baleen while the whales "filter feed" near slicks. Humpback whales, whose BIA overlaps the EMBA are more likely to occur in the area during the northern migration period in June/July and southern migration in Sep/Oct so a sea surface plume (>10 g/m^2) of oil might contact humpback whales as they migrate. Similarly, blue whales may encounter a sea surface plume (>10 g/m^2) as they pass through the area during their northern migration in May–August as a BIA also overlaps the EMBA.

Marine mammals are at risk of inhaling volatile compounds evaporating from a spill if they surface to breathe in an oil slick (Geraci and St Aubin, 1990).

Marine reptiles

Marine turtles and sea snakes when surfacing to breathe may be affected from surface slick hydrocarbons through damage to their airways and eyes. Turtles and sea snakes may be affected by oil through tainted food source or by absorption through the skin. Risk of contact would likely be greatest along intertidal sections of nesting beaches or within shallow waters adjacent to nesting beaches. Contact might also occur within foraging areas, for example along the Ningaloo and Muiron Islands shorelines and Dampier AMP.

The flatback, green, hawksbill and loggerhead turtle BIAs overlap the EMBA, and the Stag facility overlaps a suggested 60 km inter-nesting buffer from the nesting beaches on Dampier Archipelago for the flatback turtle (**Figure** 5-8). However, while oil may be impacted as described above, oil spills are not identified as a key threat to these species in the conservation advice (SPRAT) or in the recovery plan (EA 2003).

Seabirds

Seabirds are highly susceptible to hydrocarbon spills and oiled birds may experience hypothermia due to matted feathers and an inability to fly. These impacts are primarily attributed to oiling of birds at the surface from slicks. Oiled birds may experience decreased foraging success due to a decline in prey populations following a spill (Andres 1997, NRC 2003) or due to increased time preening to remove oil from their feathers (Burger 1997). During both winter and migration, shorebirds spend much of their time feeding and depend on nonbreeding habitats to provide the fuel necessary for migratory flight (Withers, 2002).

Oil can reduce invertebrate abundance or alter the intertidal invertebrate community that provides food for nonbreeding shorebirds (Andres 1997, NRC 2003) such as at the Eighty Mile Beach Ramsar site. Reduced abundance of a preferred food may cause shorebirds to move and forage in other—potentially lower-quality—habitats. Prey switching has not been documented in shorebirds following an oil spill. However, shorebirds will feed in alternative habitats when the intertidal zone alone cannot fulfil their energy requirements.

A bird's inability to obtain adequate resources delays its pre-migratory fattening and can delay the departure for its breeding grounds. Birds arriving on their breeding grounds earlier realise higher reproductive success through increased clutch size and offspring survival (for a review, see Harrison et al. 2011). If coastal habitats are sufficiently degraded by oil that pre-migratory fattening is slowed and birds delay departure for their breeding grounds, the individual effects could carry over into the breeding season and into distant breeding habitats (Henkel et al. 2012).

The BIA of several EPBC species overlap the EMBA (**Table** 5-3) and may be affected by oil. The wedge tailed shearwater BIA overlaps the Stag facility operational area and oil pollution is identified as a low threat to the species (SPRAT Wedge-tailed shearwater, DEE 2017a).

Socio-economic

Surface oil may impact upon socio-economic receptors including the oil and gas industry, commercial shipping, fisheries/aquaculture, recreation and tourism, resulting in an economic and social impact. Floating and stranded oil can be highly visible and have a resultant negative effect on tourism. A sheen of oil (1g/m^2) may be visible slightly further than the EMBA for biological impacts boundary and impact on the values of a marine park or tourism beach – in particular Ningaloo coast and Exmouth (Error! Reference source not found.).

Many of the protected areas have 'wilderness' and 'seascapes' identified as a value, and these would be compromised by the presence of any oil.

Impacts on the values associated with Protected Areas may result in loss of fauna/ habitat diversity and/ or abundance, reduction in commercial/recreational/ subsistence fishing, loss of livelihood and loss of income from reduced tourism and commercial productivity.

There are no thresholds identified at which smothering or volume ashore will result in an impact, however those shorelines with the highest load, and those identified as significant threatened or migratory fauna habitat are the most susceptible to impact. **Table 8-6** lists key potential impacts to sensitive receptors present in the EMBA.

Several of the AMPs, have conservation values associated with biological attributes including migratory seabirds, flatback turtles, humpback whales, freshwater, green and dwarf sawfish, Australian Snubfin, Indo-Pacific Humpback and Indo-Pacific bottlenose dolphins. A concentration of 1 mg/m^2 would not be expected to have any impact on these values but may affect tourism visitation.

8.5.3.2 Entrained Oil

Total oil in the water column has the potential to coat benthic and susceptible shoreline habitats and organisms.

Shoreline habitats

Intertidal and subtidal zones may be exposed to entrained hydrocarbons with impacts similar to coral reefs. Impacts may occur due to increased hydrocarbon levels in the nearshore waters and in sediments above the low water mark. Concentrations of hydrocarbons in nearshore waters and sediments, will fluctuate over short time scales (days to weeks), due to volatilisation, wave and tidal action, biological processes and potential arrival of more oil. Fauna associated with these habitats may experience sub-lethal effects. However, due to the expected weathering of Stag crude, the accessibility of PAHs to aquatic organisms is decreased.

Similar to benthic habitats, recovery of shoreline habitats exposed to entrained hydrocarbons and experiencing impacts would be expected within weeks to months of return to normal water quality conditions.

Benthic

The smothering of submerged benthic habitats and those within tidal zones from water column oil has only been reported where very large oil spill quantities have affected these habitats or very sticky oil slicks have encountered exposed coral surfaces or polyps. Where entrained oil reaches the shoreline habitats of intertidal zones, sub-lethal effects may occur, with mangroves and reef areas being the most sensitive.

Benthic habitats in the EMBA that may be impacted by entrained oil include soft sediments and benthic fauna, coral reef, macroalgae and seagrasses. Recovery of benthic habitats exposed to entrained hydrocarbons and experiencing impacts would be expected within weeks to months of return to normal water quality conditions. Several studies have indicated that rapid recovery rates may occur even in cases of heavy oiling (Burns et al., 1993; Dean et al., 1998).

Coral

There is a paucity of information on the long-term impacts on coral reefs of hydrocarbons entrained in the water column although NOAA (2001) indicate that some effects may be transient whilst others are long-lasting depending on the type of corals, reproduction period and health of the reef. Response to hydrocarbon exposure can include impaired feeding, fertilisation, larval settlement and metamorphosis, larval and tissue death and decreased growth rates (Villanueva et al., 2008).

Entrained hydrocarbon concentrations below parts per million (ppm) concentrations in marine waters have not been associated with any observed stress, degradation or death of corals. Macrophytes, including seagrasses and macroalgae, require light to photosynthesise. Presence of entrained hydrocarbon within the water column can affect light qualities and the ability of macrophytes to photosynthesise. Reduced primary productivity could occur while entrained hydrocarbons are present in the water column.

Waters that contain extensive fringing coral reef may experience impacts from entrained hydrocarbons as described below for benthic habitats. Reefs are often characterised by increased levels of biological productivity, which attracts commercially valuable fish species. Impacts from entrained hydrocarbons will be as described below for reef fish.

Mangroves

Mangrove communities may be impacted through the sediment/ mangrove root interface. Where entrained hydrocarbons include contaminants that may become persistent in the sediments (e.g. trace metals, PAHs), this can lead to effects on mangroves due to uptake, or effects on benthic infauna leading to reduced rates of bioturbation and subsequent oxygen stress on the plants' root systems (Lewis et al., 2011).

Fish and sharks

Reef fish with high site fidelity will experience protracted water quality conditions with entrained hydrocarbon concentrations >500 ppb within the EMBA. Hydrocarbon droplets can physically affect reef fish exposed for an extended duration (weeks to months) by coating of gills. This can lead to lethal and sub-lethal effects from reduced oxygen exchange and coating of body surfaces resulting in increased incidence of irritation and infection. Fish may also ingest hydrocarbon droplets or contaminated food leading to reduced growth (NRC, 2005). Lethal effects to reef fish may be observable within days to weeks. Sub-lethal effects of coral reef fish communities will take weeks to months to become measurable.

Pelagic and demersal fish species (including sharks) exposed to entrained hydrocarbons can result in tainting and contamination of fish flesh by insoluble PAHs associated with the weathered hydrocarbon (refer **Section 8.6.2.3** for further information on tainting).

Whale sharks feed on plankton, krill and bait fish near or on the water surface and it is possible that they may come into contact with entrained oil, or ingest entrained oil if a large-scale spill occurred when they (and their prey) were present in the region (Woodside, 2005).

Whale sharks are known to transit the NW coast and aggregate from late March to June in the vicinity of the Ningaloo coast, (generally peaks in April). If a spill event overlapped with this time, whale sharks may experience entrained hydrocarbon concentrations >100 ppb. While whale sharks may be exposed to entrained hydrocarbons, they could be migrating to aggregation areas beyond the impact zone, in which case exposure would be short term and confined to the EMBA and spill duration/ dispersion periods.

Marine mammals

Impacts to marine mammals from entrained hydrocarbons could result in behavioural (e.g. deviating from migratory routes or commonly frequented feeding grounds) impacts. These impacts may affect individuals within or transiting the spill area during migration.

Whales, dolphins and dugongs are smooth skinned, hairless mammals so hydrocarbons tend not to stick to their skin therefore physical impacts from entrained oil coating is unlikely. Pinnipeds are more susceptible as hydrocarbons tend to adhere to rough surfaces, hair or calluses of animals. Irritation to eyes, ears, airways and/or skin may occur from contact with entrained oil.

Impacts from ingested hydrocarbon can be lethal or sub-lethal. However, the susceptibility of marine mammal species varies with feeding habits as with surface oil (described previously). Entrained oil attached to seagrass can also be ingested by dugongs.

Oil may foul sensory hairs around the mouth and/or contact eyes while surfacing to breathe which may cause inflammation and infections. Similar to cetaceans, inhalation of volatile compounds evaporating from a spill may also result in physiological impacts to dugongs.

Marine reptiles

Turtles and sea snakes may be affected by oil through tainted food source or by absorption through the skin. Turtle hatchlings and turtle/sea snake adults may be exposed to hydrocarbon through ingestion of entrained hydrocarbons and tainted food source. These effects may cause physiological effects such as disruption of digestion. As for other megafauna that may be exposed to entrained hydrocarbons, acute impacts due to exposure to adult turtles are not expected.

Seabirds

Seabirds may come into contact with entrained oil while searching for food (diving) below the sea surface, exposure times would be very short in this scenario limiting the opportunity for oiling of feathers. Short-term physiological effects due to ingestion of entrained oil or contaminated prey may also occur. Ingested oil can have several sublethal toxicological effects, including haemolytic anaemia, reduced reproduction, and immunosuppression.

Socio-economic

Impacts to fish may result in tainted flesh and fishery closure resulting in an economic impact on commercial and subsistence fishing. Entrained oil can also lead to impacts on aquaculture (e.g. pearls, seaweed) due to a decrease in water quality and reduced stock. Reduced marketability of products (perceived or real) could occur for target species. Tourism may be impacted by real or perceived reduction in health or mortality of habitats that support tourism activities.

Table 8-13 lists key potential impacts to sensitive receptors present in the EMBA.

8.5.3.3 Dissolved Aromatic Hydrocarbons

The moderate threshold for dissolved aromatic hydrocarbons is not reached for the crude spill scenarios; however, the detail is provided here as it is reached for the diesel spill scenario (Section 8.6).

While there is some debate in the scientific literature (Barron et al., 1999), the main component of oil generally thought to be responsible for the majority of toxicity to wildlife is the Dissolved Aromatic Hydrocarbons (DAH) compounds that dissolve into the water column following a spill. Various studies indicate that the toxic effects of aromatic compounds result from the narcosis caused in biological receptors following exposure to low molecular weight aromatics including compounds from the BTEX group and 2−4 ring PAHs (French, 2000).

Accumulation of petroleum hydrocarbons by marine organisms is dependent on the bioavailability of the hydrocarbons, the length of exposure, and the organism's capacity for metabolic transformations of specific compounds. Actual toxicity depends on both concentration and the duration of exposure, being a balance between acute and chronic effects.

Acute toxicity

Toxicity to wildlife increases with increased length of exposure; marine organisms can typically tolerate high concentrations of toxic hydrocarbons over short durations (French 2000; Pace et al., 1995).

DAHs have a narcotic effect on organisms, resulting from interference with cell function that occurs as hydrocarbons are absorbed across cell membranes (French-McCay, 2002). The narcotic effect varies among specific hydrocarbon compounds, with these variations thought to be attributable to the lipid solubility of the compounds. Over periods of hours to a few days, the narcotic effect has been found to be additive, both in severity and the number of different soluble hydrocarbons that are present (French, 2000; NRC, 2005; Di Toro et al., 2007).

Because the toxicity of DAH to aquatic organisms increases with time of exposure, organisms may be unaffected by brief exposures to a given concentration but affected at long exposures to the same concentration (French-McCay, 2002). This is due to the fact that the concentrations of hydrocarbons build up in the tissues of biological receptors from either long-term exposure or repeated exposure to sub-lethal concentrations.

Chronic toxicity and accumulation

There is sparse data available on the chronic effects of PAHs in the marine environment. A review of the processes controlling the uptake and persistence of PAH in marine organisms, especially under chronic exposure conditions, highlighted differential mechanisms of uptake, tissue distribution, and elimination (Meador et al., 1995). While vertebrates have a high capacity for metabolising aromatic hydrocarbons including PAHs (through cytochrome P450 1A mediated oxidation), PAHs can accumulate in the body of invertebrates (as they lack a cytochrome P450 1A mediated oxidation system). Organisms that may experience chronic effects include plankton, fish, marine mammals and marine reptiles. **Table** 8-13 lists key potential impacts to sensitive receptors present in the EMBA.

Pelagic fish are highly mobile and comprise species such as sharks and migratory whale sharks. The likelihood of pelagic fish being continuously exposed to DAHs for >96 hours is unlikely therefore acute/ lethal effects are not predicted (Luyeye, 2005). However, chronic/ non-lethal effects may be experienced. As a chronic action of PAHs is a neurotoxic effect, chronic exposure of pelagic fish may cause delayed predatory/ avoidance response times, disorientation, swimming action/ efficiency.

Whale sharks migrate along the NW coast from late March to September. If a spill event overlapped with this time period, whale sharks may experience exposure above the DAH threshold as they migrate through the area.

Tainting by DAHs of commercially targeted pelagic fish species may occur. Tainting can have a range of effects from affecting edible quality of the fish and have economic consequences, to containing toxic levels above recommended human consumption guidelines. While tainted pelagic fish will recover naturally over time (months) once water quality conditions have returned to normal, re-opening of a fishery will require an understanding of when recovery from tainting has occurred for the target species of interest.

Marine mammals that may occur within the EMBA for DAHs include dugongs, whales and dolphins in offshore waters. According to Geraci and St Aubin (1990), inhalation of volatile compounds evaporating from a spill at sea surface is the greater risk to cetaceans when surfacing to breathe. For these marine mammals, the potential for chemical effects due to exposure is considered unlikely, particularly for highly mobile species such as dolphins because it is very unlikely that these animals will be constantly exposed to high concentrations for continuous durations (e.g. >96 hours) that would lead to toxic effects.

The majority of publicly available information detailing potential impacts to turtles and sea snakes due to exposure to hydrocarbons is based on impacts due to heavy oils. Impacts due to exposure to DAHs are less understood. One information source provides a case study detailing a spill of 440,000 gallons of aviation gasoline nearby to an island supporting approximately 1,000 green turtles that aggregate and nest at the atoll in the west Pacific Ocean annually (Yender and Mearns, n.d.). Timing of the spill was of concern as it coincided with expected peak hatchling emergence. Population comparisons with a census that had been completed just prior to the spill were undertaken to evaluate impacts; no impacts were reported during the spill response and population effects were not detected.

For marine reptiles that may be exposed to DAHs dosages that exceed the threshold, acute impacts to turtles and sea snakes are not expected. Impacts to turtle hatchlings may occur however due to the risk of them becoming entrained in a parcel of water allowing them to be continuously exposed to toxic hydrocarbons for an extended period.

Socio-economic receptors will be affected by hydrocarbon exposure in three key ways: loss of Income (e.g. reduction in catch for commercial fisheries), restriction of access and reduction in aesthetic values. Impacts to fish may result in tainted flesh and fishery closure resulting in an economic impact on commercial fishing. DAH in the water column can also lead to impacts on aquaculture (e.g. pearls, seaweed) due to a decrease in water quality and reduced stock. Reduced marketability of products (perceived or real) could occur for target species. Tourism may be impacted by real or perceived reduction in health or mortality of habitats that support tourism activities.

8.5.3.4 Receptors

Key ecological features (KEFs)

The crude spill modelling does not indicate contact with any KEFs at moderate thresholds.

Commonwealth and State Marine Reserves

The following state and Australian Marine Parks are located within modelled spill trajectories of a crude oil release at moderate thresholds:

- Montebello Australian Marine Park; and
- Montebello Island Marine Park.

These parks were established to protect both habitats and species groups as described in **Section 5**. Many of the values are listed as KPI and are considered unique to the protected area and include habitats, fauna or ecological features. Impacts to the values may compromise the management objectives of the managed areas, which may have flow-on effects to tourism revenue of coastal communities that provide access to these marine reserves. The reserves listed above may also support nursery/ feeding/ aggregation areas for fisheries species and therefore may assist in maintaining healthy fish stocks for both commercial and recreational fisheries.

8.5.4 Protection Priorities

The Protection Priorities are the most likely to be contacted locations across ALL modelled scenarios, they are used for spill response planning purposes for the initial response capability. In a real event, the IAP, NEBA and planning process takes over; utilising real time operational data and focusing operations on locations to be contacted (which will be a subset of what is planned for). This allows for preparedness and planning for the most credible scenarios whilst retaining flexibility in response to manage an event.

The following Protection Priorities (refer S**ection 4.3.4**) for spill response have been determined from the modelling results for both crude and diesel spills:

- Eighty Mile Beach;
- Montebello Islands;
- Dampier Archipelago;
- Barrow Island; and
- Lowendal Islands.

Table 8-14 summarises the rationale for the Protection Priorities selection (also refer to **Section 4.3**) and **Appendix J** details the specific key values and modelled contact of the Protection Priorities. Note that the worst-case value is presented for the receptor as a whole e.g. Montebello Islands includes the marine park, MMA and surrounds, the minimum time to contact/maximum concentration on any one of those receptors is taken. The only exception is that shoreline oil is only reported for receptors with shorelines (i.e. MP boundaries are not reported for shoreline contact). Note that diesel results are also presented to inform the assessment of protection priorities.

An assessment was conducted to determine the Environmental Performance Outcome (EPO) for the locations and the spill response measures that would be required to meet the EPO and thereby reduce impacts associated with spill response to ALARP (**Table** 8-15). These assessments form the basis of determining the required level of spill response resourcing, as detailed in the OPEP and the justification that spill risk has been reduced to ALARP.

8.5.5 Net Environmental Benefit (NEBA)

Net Environmental Benefit Analysis (NEBA) is a structured approach used by the spill response community and stakeholders to select spill response strategies that will effectively remove oil, are feasible to use safely in particular conditions, and will reduce the impact of an oil spill on the environment.

The NEBA process is used during pre-spill planning (Strategic NEBA) and during a response (Operational NEBA). A Strategic NEBA is an integral part of the contingency planning process and is used to ensure that response strategies for scenarios are well informed. An Operational NEBA is used to ensure that evolving conditions are understood, so that the response strategy can be adjusted as necessary to manage individual response actions and end points.

Balancing trade-offs may involve differing and conflicting priorities, values and perceptions of the importance of sensitive receptors. There is no universally accepted way to assign perceived value or importance and is not a quantitative process. Overall, the NEBA process provides an estimate of potential environmental effects which are sufficient to allow the parties to compare and select preferred combinations of response strategies to reduce environmental impacts to ALARP.

Table 8-15 provides a summary of spill response strategies available for each of the Protection Priorities identified and the potential impact that a response strategy has on the environmental values of the area, noting that response strategies are not used in isolation. This information is to be considered in the NEBA process during the development of the Incident Action Plan in a spill response (i.e. an Operational NEBA). An Operational NEBA will also consider feedback from operational and scientific monitoring activities (refer OPEP), real time monitoring of the effectiveness and potential impacts of a response and will also consider accessibility, feasibility and safety of responders.

Table 8-14: Rationale for Determination of Protection Priorities for Spill Response from worst case spill scenarios

[thresholds – >10g/m^2 floating oil, >100ppb entrained oil, >70ppb dissolved oil]

Location in Risk EMBA	Stag Crude spill (Subsea 86.5m^3) all seasons	Diesel spill (surface 250m^3) all seasons	Protection Priority?	Rationale
Dampier Archipelago	<1% floating oil contact probability above the threshold <1% entrained oil contact probability, maximum concentration below threshold <1% dissolved oil contact probability, maximum concentration in worst replicate 7ppb Max accumulated volume along shoreline with concentrations exceeding 100 g/m^2: 19m^3 Minimum time to contact for floating oil >10g/m^2, 165 hours	<1% floating oil contact probability above the threshold <1% entrained and dissolved oil contact probability above the threshold, maximum concentrations 40ppb Maximum local accumulated concentration in worst replicate 0.3g/m^2 No contact for floating oil >10g/m^2	Y	Some shoreline loading of crude - maximum volume ashore 19m^3, 165 h to floating oil contact (minimum), <1% probability of contact. Entrained and dissolved diesel contact above thresholds
Middle Pilbara Islands and Shoreline	<1% floating oil contact probability above the threshold <1% entrained and dissolved oil contact probability above the threshold, maximum concentrations <1ppb No accumulated volume along shoreline with concentrations exceeding 100 g/m^2 Minimum time to contact for floating oil >10g/m^2, 561 hours	<1% floating oil contact probability above the threshold <1% entrained oil above threshold with a maximum concentration of 3ppb <1% dissolved oil contact probability above the threshold, maximum concentrations <1ppb Maximum local accumulated concentration in worst replicate 0.3g/m^2 No contact for floating oil >10g/m^2	N	Very low shoreline loading from crude and diesel spills
Greater North Coast / Eighty Mile Beach inc CMR and RAMSAR	<1% floating oil contact probability above the threshold, <1%, entrained and dissolved oil contact probability above the threshold and maximum concentrations <1ppb Max accumulated volume along shoreline with concentrations exceeding 100 g/m^2: 7m^3 Minimum time to contact for floating oil >10g/m2, 430 hours	<1% floating oil contact probability above the threshold <1% entrained and dissolved oil above threshold with maximum concentration of 15 ppb No accumulated volume along shoreline with concentrations exceeding 100 g/m^2 No contact for floating oil >10g/m^2	Y	Contains 80MB Ramsar site, KPI habitats (mangroves and saltmarsh) within 80MB Marine Park, maximum crude volume ashore 10m^3, limited diesel volumes
Montebello Islands inc. CMR	<1% floating oil contact probability above the threshold 2% entrained oil above threshold with a maximum concentration of 181ppb (at the marine park boundary) <1% dissolved oil above threshold with a maximum concentration of 34 ppb in the worst replicate (at the marine park boundary) Max accumulated volume along shoreline with concentrations exceeding 100 g/m^2: 33m^3 Minimum time to contact for floating oil >10g/m^2, 554 hours	<1% floating oil contact probability above the threshold 40% entrained oil above threshold with a maximum concentration of 5,973ppb (at the marine park boundary) 2% dissolved oil above threshold with a maximum concentration of 168 ppb in the worst replicate (at the marine park boundary) Maximum local accumulated concentration in worst replicate 6.6g/m^2 No contact for floating oil >10g/m^2	Y	Shoreline loading - significant turtle nesting beaches identified in recovery plan (2003), intertidal coral habitats (KPI) in marine park, EPBC bird nesting habitat, floating, entrained and dissolved oil contact from crude and diesel spills
Lowendal Island	<1% floating oil contact probability above the threshold <1% entrained oil contact probability and maximum concentration 28ppb in the worst replicate <1% dissolved oil contact probability and maximum concentration 15ppb in the worst replicate Max accumulated volume along shoreline with concentrations exceeding 100 g/m^2: 7m^3 Minimum time to contact for floating oil >10g/m^2, 563 hours	<1% floating oil contact probability above the threshold 2% entrained oil contact probability and maximum concentration 424ppb in the worst replicate <1% dissolved oil contact probability and maximum concentration 16ppb in the worst replicate Maximum local accumulated concentration in worst replicate 8.1g/m^2 No contact for floating oil >10g/m^2	Y	Low shoreline loading from crude spill, higher entrained diesel volumes
Barrow Island inc. surrounds (MMA and MP)	<1% floating oil contact probability above the threshold, <1% entrained oil contact probability and maximum concentration 2ppb in the worst replicate <1% dissolved oil contact probability and maximum concentration 3ppb in the worst replicate Max accumulated volume along shoreline with concentrations exceeding 100	<1% floating oil contact probability above the threshold 2% entrained oil contact probability and maximum concentration 544ppb in the worst replicate <1% dissolved oil contact probability and maximum concentration 30ppb in the worst replicate Maximum local accumulated concentration in worst replicate 2.5g/m^2	Y	Shoreline loading significant turtle nesting beaches identified in recovery plan (2003), intertidal coral habitats (KPI) in marine park, bird nesting habitat, - maximum volume ashore 6m^3, 52 hours to floating oil contact (minimum). 544ppb entrained diesel and some dissolved oil contact.

Location in Risk EMBA	Stag Crude spill (Subsea 86.5m³) all seasons	Diesel spill (surface 250m³) all seasons	Protection Priority?	Rationale
	g/m²: 2m³ Minimum time to contact for floating oil >10g/m², 52 hours	No contact for floating oil >10g/m²		
Exmouth Gulf (SE & W)	<1% floating oil contact probability above the threshold <1% entrained and dissolved oil contact probability, Maximum concentration of entrained and dissolved oil <1ppb No accumulated volume along shoreline with concentrations exceeding 100 g/m²	No contact above any threshold	N	low probability floating oil contact above the threshold, very low shoreline loading from entrained only
Karratha to Port Hedland	<1% floating oil contact probability above the threshold <1% entrained and dissolved oil contact probability maximum concentration of entrained and dissolved oil <1ppb No accumulated volume along shoreline with concentrations exceeding 100 g/m² Minimum time to contact for floating oil >10g/m², 289 hours	<1% floating oil contact probability above the threshold <1% entrained oil contact probability and maximum concentration 5ppb in the worst replicate <1% dissolved oil contact probability and maximum concentration 1ppb in the worst replicate No accumulated volume along shoreline with concentrations exceeding 100 g/m² No contact for floating oil >10g/m²	N	Low shoreline loading, limited sensitive receptors
Port Hedland to Eighty Mile Beach	<1% floating oil contact probability above the threshold <1% entrained and dissolved oil contact probability maximum concentration of entrained and dissolved oil <1ppb No accumulated volume along shoreline with concentrations exceeding 100 g/m² Minimum time to contact for floating oil >10g/m², 265 hours	No contact above any threshold	N	Low shoreline loading 80MB already a PP
Mermaid Reef and Commonwealth Waters surrounding Rowley Shoals KEF	<1% floating oil contact probability above the threshold <1% entrained and dissolved oil contact probability maximum concentration of entrained and dissolved oil <1ppb No accumulated volume along shoreline with concentrations exceeding 100 g/m² Minimum time to contact for floating oil >10g/m², 565 hours	No contact above any threshold	N	Low contact volumes
Clerke Reef	<1% floating oil contact probability above the threshold, <1% entrained and dissolved oil contact probability maximum concentration of entrained and dissolved oil <1ppb No accumulated volume along shoreline with concentrations exceeding 100 g/m² Minimum time to contact for floating oil >10g/m², 629 hours	No contact above any threshold	N	low probability floating oil contact above the threshold, very low shoreline loading from entrained oil only
Imperieuse Reef	<1% floating oil contact probability above the threshold, <1% entrained and dissolved oil contact probability maximum concentration of entrained and dissolved oil <1ppb No accumulated volume along shoreline with concentrations exceeding 100 g/m² Minimum time to contact for floating oil >10g/m², 565 hours	No contact above any threshold	N	Minimal shoreline loading
Ningaloo Coast including World Heritage, State MP	No contact above any threshold	<1% floating oil contact probability above the threshold <1% entrained oil contact probability and maximum concentration 94ppb in the worst replicate <1% dissolved oil contact probability and maximum concentration 4ppb in the worst replicate Maximum local accumulated concentration in worst replicate 0.3g/m² No contact for floating oil >10g/m²	N	Minimal shoreline loading
Muiron Islands	No contact above any threshold	No floating oil contact probability above the threshold	N	Minimal shoreline loading

Location in Risk EMBA	Stag Crude spill (Subsea 86.5m³) all seasons	Diesel spill (surface 250m³) all seasons	Protection Priority?	Rationale
MMA		<1% entrained oil contact probability and maximum concentration 55ppb in the worst replicate <1% dissolved oil contact probability and maximum concentration 3ppb in the worst replicate No local accumulated concentration No contact for floating oil >10g/m²		
Gascoyne AMP	No contact above any threshold	No floating oil contact probability above the threshold <1% entrained oil contact probability and maximum concentration 81ppb in the worst replicate <1% dissolved oil contact probability and maximum concentration 9ppb in the worst replicate No local accumulated concentration No contact for floating oil >10g/m²	N	Minimal shoreline loading

Table 8-15: Impact of a spill response strategy on the environmental values of Protection Priorities

Protection Priority environmental values	No controls	Source control	Dispersant (surface)*	Operational Monitoring	Containment and recovery	Shoreline Protection	Shoreline Cleanup	Oiled Wildlife Response	Scientific Monitoring
Environmental Outcomes	- Reduce oil volumes from reaching the shoreline to as low as reasonably practicable - Prioritise sanctuary zones and KPI species and habitats (as per marine park management plan if relevant) - Reduce impacts to marine and coastal fauna through the implementation of the WA Oiled Wildlife Response Plan								
Eighty Mile Beach									
Migratory birds									
Mangroves								N/A	
Tidal creeks								N/A	
Turtle nesting beaches									
Wetlands/ salt marshes								N/A	
Dampier Archipelago									
Mangroves								N/A	
Turtle nesting beaches									
Corals						N/A	N/A	N/A	
Marine habitat						N/A	N/A	N/A	
Birds									
Cultural values									

Protection Priority environmental values	No controls	Source control	Dispersant (surface)*	Operational Monitoring	Containment and recovery	Shoreline Protection	Shoreline Cleanup	Oiled Wildlife Response	Scientific Monitoring
Environmental Outcomes	- Reduce oil volumes from reaching the shoreline to as low as reasonably practicable - Prioritise sanctuary zones and KPI species and habitats (as per marine park management plan if relevant) - Reduce impacts to marine and coastal fauna through the implementation of the WA Oiled Wildlife Response Plan								
Montebello Islands									
Turtle nesting beaches									
Mangroves								N/A	
Corals						N/A	N/A	N/A	
Seabirds									
Barrow Island									
Bird habitat at Bandicoot Bay and Double Island								N/A	
Seabirds									
Turtle nesting beaches									
Mangroves								N/A	
Tidal creeks								N/A	
Marine habitat						N/A	N/A	N/A	
Lowendal Islands									
Turtle nesting beaches									

Protection Priority environmental values	No controls	Source control	Dispersant (surface)*	Operational Monitoring	Containment and recovery	Shoreline Protection	Shoreline Cleanup	Oiled Wildlife Response	Scientific Monitoring
Environmental Outcomes	- Reduce oil volumes from reaching the shoreline to as low as reasonably practicable - Prioritise sanctuary zones and KPI species and habitats (as per marine park management plan if relevant) - Reduce impacts to marine and coastal fauna through the implementation of the WA Oiled Wildlife Response Plan								
Mangroves								N/A	
Corals						N/A	N/A	N/A	
Seabirds									
Marine mammals (dugongs, dolphins)						N/A	N/A		
Marine habitat						N/A	N/A	N/A	
Legend									
*	The potential impact of chemical dispersant addition based on analysis presented in **Section 7.9.2**								
	Beneficial impact								
	Possible beneficial impact dependent upon the situation (e.g. Timeframes and metocean conditions to dilute entrained oil)								
	Negative impact								
N/A	Not applicable for the environmental value								

8.5.6 Environmental Performance

EPOs and control measures for oil spill response activity implementation are presented in Section 19 of the OPEP.

Environmental Risk		**Release of Stag crude (EUH-4)**		
Performance Outcome		**No spill of hydrocarbon to the marine environment**		
ID	**Management controls**	**Performance standards**	**Measurement criteria**	**Responsibility**
	Unplanned release of Stag crude oil from CPF production equipment (including process upset)			
088	Tests and maintenance completed in accordance with Stag Performance Standards Report (GA-70-REP-F-00007) to ensure emergency shutdown can occur and equipment is fit for purpose	The SIS are tested according to the assurance plan which is part of GA-70-REP-F-00001, these are planned and managed using Bassnet CMMS	Inspection and testing records	Stag OIM
089		Emergency Shutdown (ESD) push buttons located in the central control room and throughout the CPF, tested and fit for purpose every six months	Audit records confirm standard.	
090		ESDVs are regularly tested and fit for purpose 6 monthly	ESDV testing records	
091		CPF hydrocarbon containing equipment is regularly inspected and maintained and found fit for purpose – Internal inspection of tanks 48 months External inspection of tanks 24 months	Inspection and maintenance records	
092		PSVs undergo external inspection annually and internally inspected every 4 years	Inspection and testing records	
093	Permit to Work Procedure implemented	A Permit to Work (PTW) system is implemented on the CPF to assure competent personnel and implementation of relevant procedures during maintenance.	PTW Documentation demonstrates compliance	
094	Wellhead valves maintained and tested as per Stag Performance Standards Report (GA-70-REP-F-00007)	Wellhead Valves are maintained and tested annually and found fit for purpose	Maintenance and testing records	
095	Operational personnel competent and trained in accordance with	Position classification and skills matrix for all personnel involved in operation, maintenance and incident response on the CPF	Skills matrix and annual audit of Competency Management system.	

Environmental Risk		Release of Stag crude (EUH-4)		
Performance Outcome		No spill of hydrocarbon to the marine environment		
ID	**Management controls**	**Performance standards**	**Measurement criteria**	**Responsibility**
	Competency and Training Management System [JS-60-PR-Q-00015]			
	Unplanned release of Stag crude oil from offtake hose (CALM buoy to third-party tanker)			
096	Monitoring of crude oil offtake hose to third-party tanker during loading in accordance with Stag Marine Tanker Operations Manual (GF-00-MN-H-00037)	Dedicated bow, and dedicated manifold watch, equipped with communications to the Cargo Control Room kept for the whole offtake period	Deck Log Book PMS log	Operations Manager
097				
098	Hose maintenance process in accordance with OCIMF guidelines	Floating hoses maintained and managed in accordance with OCIMF *Guidelines for the handling, storage, inspection and testing of hoses in field* and includes visual inspections, pressure tests and replacement schedules.		
099	CALM Buoy Hawser Changeout occurs as per PMS	Hawser changed out at intervals of up to 20 months Hawser visual check hourly as part of hourly checks program		
100	Marine breakaway coupling on offtake hose	Maintenance of hose undertaken in accordance with the Preventative Maintenance System and confirms presence of breakaway coupling		
101	Leak Detection	Detection of spill is by means of drop in delivery pressure monitored on the CPF. Delivery pressure monitoring at CPF is done continuously during loading operations by the Panel Operator.		
102	Jadestone Stag Marine Tanker Operations Manual (GF-00-H-00037)	Connection and disconnection of the offtake hose will be undertaken in accordance with this manual		
103		Offtake hose flushed with seawater at the completion of each discharge to third-party offtake tanker		

Environmental Risk		Release of Stag crude (EUH-4)		
Performance Outcome		**No spill of hydrocarbon to the marine environment**		
ID	**Management controls**	**Performance standards**	**Measurement criteria**	**Responsibility**
104	implemented during offtake activities	Pilot will review the Stag Marine Facility Operating Procedures with the third party Offtake Tanker Master before proceeding to the Berth, and confirm any special conditions imposed due to prevailing local conditions to ensure safe offtake. The manual outlines requirements for offtake to ensure prevention of spills including: - Weather limitations that determine if the terminal is open, restricted or closed for offtake - Personnel competency and induction requirements - Communication test requirements to be conducted prior to load commencement - Leak testing once the offtake hose is in place and connected, and prior to loading commencing - Location of MBC in the hose string to minimize risk of impact with third party tanker		
105	Tankers vetted in accordance with Stag Offtake Vessel Vetting (GF-90-PR-G-00019) prior to mobilisation	Offtake tankers are vetted prior to acceptance against the following criteria as a minimum to prevent damage or other risks to, or oil pollution from, the facility's offtake equipment, during offtake: - Confirm tanker is double hull and vessel dimensions - Confirm the tanker management system complies with the requirements of ISM code - Confirm the manifold and associated equipment complies with the latest edition of OCIMF's: "Standards for Oil Tanker Manifolds and Associated Equipment" - Confirm the forecastle layout/ equipment complies with OCIMF guidelines for single point moorings "Recommendations for Equipment Employed in the Mooring of Ships at a Single Point Mooring"	Completed questionnaire screened and accepted	Marine Superintendent
Subsea release of Stag crude				
106	Subsea equipment inspected in accordance with Subsea Inspection	Subsea equipment shall be inspected in accordance with the schedule, applicable standards, regulatory requirements and procedures described referenced in Safety	Inspection records in Bassnet	

Environmental Risk		Release of Stag crude (EUH-4)		
Performance Outcome		**No spill of hydrocarbon to the marine environment**		
ID	**Management controls**	**Performance standards**	**Measurement criteria**	**Responsibility**
	Procedure (GF-16-PR-U-00030)	Critical Elements (SCEs) performance standards reports associated with subsea inspection: Stag Performance Standards Report, GA-70-REP-F-00007		Engineering & Maintenance Manager
107	Inspection of underbuoy hose to ensure hose integrity in accordance with Stag Performance Standards Report (GA-70-REP-F-00007) and Topside Riser & Wellhead conductor Inspection Procedure (GA-02-PR-S-00177)	Inspection of underbuoy hose (PLEM to CALM buoy) is performed in accordance with the maintenance schedule and OCIMF *guidelines for the handling, storage, inspection and testing of hoses in the field*.		
108	Underbuoy Hose Removal and Replacement Procedure (GF-19-IG-00023) implemented as required	If hoses must be replaced, the procedure includes: • Flush line from STAG CPF to third-party tanker until clean water being received at third-party tanker • Disconnect third-party tanker • Air blow underbuoy hose contents back to STAG CPF • Divers close PLEM valve	Close-out Reports in Bassnet	
109	Stag Marine Facility Operating Manual (GF-90-MN-G-00038) details designated anchoring locations	AMSA designated anchoring locations is listed as a 3nM radius around facility and marked on Aus Charts	Annual audit	Stag OIM

*[1] The Stag Marine Tanker Operations Manual (GF-00-MN-H-00037) contains the pertinent information required by the nominated Tanker in preparation for arriving at anchoring location to prepare for safe arrival, embarkation of Pilot and Surveyor, and transit to the Stag Marine Facility for offtake duties. Pilot will review the Stag Marine Facility Operating Procedures with the Offtake Tanker Master before proceeding to the Berth

8.5.7 ALARP assessment

All safety options have been considered for the Stag Operations, with no additional safety options possible it is considered that the risk of a loss of containment occurring has been reduced to ALARP. The combination of the standard controls (which reduce the likelihood of the event happening), and the spill response strategies (which reduce the consequence) together aim to reduce potential impacts from a hydrocarbon spill. An oil spill response workshop was undertaken and subsequently, a review of capability by AMOSC. A summary of the spill response measures selected is provided in **Table** 8-16.

Vessel Collision Control

Vessel activities are required to maintain the functioning of the facility and cannot be eliminated. The Stag facilities are marked on Australian Hydrographic Service Nautical Charts which identifies the location of the CPF berthing activities to other sea users. Collision prevention equipment (i.e. navigation and radio equipment) and seagoing qualifications used on vessels/ CPF comply with applicable AMSA Marine Orders which enact the International Convention of the Safety of Life at Sea (SOLAS) 1974 through the Navigation Act 2012. These requirements reduce the risk of errant vessel collisions and the potential for crude oil release from these vessels.

For vessels engaged in operational activities, the procedures outlined in the Stag Marine Facility Operating Manual (GF-90-MN-G-00038) provide controls to reduce the risk of collision. Communication is established between third party vessels and the CPF well before they enter the Operational Area to ensure proposed activities are safe to proceed and to reduce the potential for vessel collision during simultaneous operations.

Controls are in place (refer **Section 8.5.6**) which reduce the likelihood of spill events. There are no further controls that are considered to provide a net benefit in reducing the likelihood or consequence of a release of Stag crude to the marine environment and thus, the controls are considered ALARP.

Topside production system controls

Crude oil processing equipment (e.g. vessels, valves, piping and pumps) is inspected, tested and maintained as per operational performance standards and the CMMS which ensure the correct functioning of equipment and systems that are critical in ensuring hydrocarbon containment and safety of crew. Safety systems are utilised on the hydrocarbon processing equipment which reduce the likelihood of loss of integrity and/or release of crude oil. These include pressure safety valves (PSVs), emergency blowdown systems and emergency shutdown (ESD) systems.

Load alarms on cranes provide warning of excessive crane loads and reduce likelihood of dropped objects. Lifting procedures, lifting equipment testing, equipment protection, competency requirements and the permit to work (PTW) system reduce the risk of dropped/swinging loads impacting process equipment. The competency of personnel working on production equipment is assessed through a competency-based assessment framework and assurance that tasks are scheduled and completed safely is provided through the PTW system. Controls are in place (refer **Section 8.5.6**) which reduce the likelihood of spill events. There are no further controls that are considered to provide a net benefit in reducing the likelihood or consequence of a release of Stag crude to the marine environment and thus the controls are considered ALARP.

Subsea Controls

The integrity of the subsea export pipeline, PLEM and underbuoy hose is monitored through the Subsea Inspection Procedure (GF-16-PR-U-00030). The pipeline inspection and maintenance activities conducted by Jadestone are managed via the CMMS. The pipeline has been through a lifecycle extension in 2014 (refer GA-02-RX-10002), where it was given a fit for service date of 2022.

The identified causes of pipeline, PLEM or underbuoy hose rupture from external factors is through dropped objects, vessel collision and anchor drag. The threat of dropped objects from support/supply vessel loading/unloading is mitigated by the CPF lift zone being located away from the subsea export pipeline. The rigid riser section of the pipeline is also protected by a frame and runs inside the jacket leg footprint providing additional protection from swinging loads and vessel impacts.

Controls are in place (refer **Section 8.5.6**) which reduce the likelihood of spill events. There are no further controls that are considered to provide a net benefit in reducing the likelihood or consequence of a release of Stag crude to the marine environment and thus the controls are considered ALARP.

Spill Response Controls

For a Level 1 crude oil spill, containment and clean-up is assisted through the bunding system provided around process equipment and the regular inspection program. Spills are responded to as per incident and spill response procedures which are practised through regular spill/ incident response drills on the CPF and vessels. Spill kits are located near high risk areas and maintenance of spill equipment is assured through regular inspections. In the event that diesel or crude oil is not contained through the barriers and procedures,, the Stag Facility Operations OPEP (GF-70-PLN-I-00001) which outlines the detailed response and logistical requirements necessary to combat a maximum credible crude oil release, will be implemented to reduce the impacts of a crude oil spill to ALARP.

Where a spill of crude oil reaches the marine environment, spill response activities will be implemented in accordance with the OPEP. A Net Environmental Benefit Analysis (NEBA) will be used to determine which spill response strategies are appropriate for a given spill scenario and is an integral part of the IAP process.

In the case of any spill to the marine environment, source control and operational monitoring activities will be implemented.

The spill response strategies have undergone a robust evaluation and environmental risk assessment process (refer **Figure 4-2** and **Table 8-8**. The applicability of the control to the spill scenario and establishing requirements for each control to ensure its effectiveness in meeting the EPO was also undertaken.

The assumption was that existing controls were ineffective (i.e. 100% probability of vessel collision) and each control would be exposed to the full volume of oil under the maximum credible worst-case scenario with the shortest time to contact. This approach promoted a level of conservatism in the proposed control strategies, and, in particular, the measures for determining the effectiveness of controls and the requirements to achieve the level of effectiveness.

The ALARP assessment for the level of resourcing required for each of the spill response strategies adopted is provided in **Table** 8-16 and **Table** 8-17, based on the capability described in the OPEP. This considers the incremental benefit of increasing resourcing levels for each spill response strategy and the associated upfront costs. The effectiveness of each of these response strategies has been increased to a point where further sacrifice made would result in a disproportionately small reduction in environmental risk/impact managed.

It is considered that through the resourcing arrangements outlined within the OPEP (including spill response equipment and personnel from internal and external sources including via the AMOSPlan, AMSA, other operators and other national suppliers) the spill response strategies and control measures reduce spill risk to ALARP. As a member of an industry-wide oil spill response organisation (AMOSC) as a party to a Master Services Contract (MSC) with AMOSC for services for training purposes or in response to a threatened or actual oil spill (MutualAid resources, the AMOSC Core Group) refer **Appendix L** and a party to an MOU with AMSA (refer **Appendix K**) for support for oil spill preparedness and response Jadestone has access to sufficient response capability to reduce the environmental risk to ALARP.

Table 8-16: **Summary of spill response controls**

Spill Response Control	Yes/No
Source control	
Refuelling watch alert	Y

Spill Response Control	Yes/No
Secure cargo/trimming	Y
Pipeline isolation and repair	Y
Bunded areas around machinery and engines	Y
Operational Monitoring	
Vessel Surveillance	Y
Aerial Surveillance	Y
Tracking Buoys	Y
Fluorometry	Y
Oil Spill Modelling	Y
Remote Sensing/Satellite Imagery	Y
UAVs	Y
Shoreline and Coastal habitat assessment	Y
Chemical Dispersant	
Existing dispersant stockpiles and transport arrangements	Y
Additional Jadestone dispersant stockpiling	N
Dispersant application aircraft	Y
Dispersant application vessels	Y
Containment and Recovery	
Targeted C&R operations	Y
Pre-deployed at site	N
C&R Planning	Y
Protection and Deflection	
Targeted protection	Y
Pre-deployed at site	N
Protection Planning	Y
Shoreline Clean-up	
Targeted clean-up operations	Y
Pre-deployed at site	N
Shoreline Clean-up Planning	Y
Oiled Wildlife Response (OWR)	
Targeted OWR activities	Y
Pre-set up staging site	N
Waste Management	
Waste Management Planning	Y
Emergency Management System	

Spill Response Control	Yes/No
IMT process (including IAP, NEBA processes)	Y
Scientific Monitoring	
Scientific Monitoring Planning	Y

Table 8-17: ALARP assessment for the level of resourcing available for spill response strategies from those described in the OPEP

Strategy tasks and resources arrangements	Environmental/Social/Economic consequences of additional resources from those described in the OPEP	Practicality of additional resources from those described in the OPEP	ALARP assessment
Source Control Section 8 of OPEP	Reduce volume or speed of spill entering marine environment	Vessel has the response capability as described in the SOPEP and geared towards a Level 1 incident. The SOPEP is to provide shipboard notification and response procedures for stopping or minimizing the unexpected discharge of oil from a ship without compromising the safety of the crew, the vessel or the environment. Unexpected discharge includes the discharge of oil during vessel operations, or vessel casualty. Significant cost would be incurred for Jadestone to alter the contractual arrangements with the third-party tanker operator to increase capability with consideration for equipment, storage, maintenance, crew training and safety of crew when deploying gear.	It is consistent with the National Plan that vessels have a level 1 capability. For Jadestone to increase the vessel response capability to a Level 3 would be a disproportionate benefit for the effort. In addition, the worst-case spill results from a vessel collision and the priority of the vessel master is to safeguard the crew and remove all non-essential personnel. Therefore, there is no value in supplementing the vessel SOPEP capability, and therefore the arrangements described in the OPEP are considered ALARP.
Aerial surveillance Section 9.4 of OPEP	The two passes per day separated by six hours' philosophy allows coverage of oil movement. The spill is a defined volume and not amenable to entrainment. The morning pass will validate the current IAP and the second afternoon pass will inform the development of the next IAP operational period. This will be used along with the other surveillance tactics and validate these (e.g. trajectory modelling and vessel surveillance). Therefore, there is considered no environmental benefit for resourcing an overpass frequency of greater than two passes per day.	Additional charter costs would be incurred by Jadestone to increase from two passes per day. There may be a need for additional resources if determined through the IMT based on the amount of available information and potential data gaps. These can be arranged without need for further upfront costs or planning.	Aerial surveillance is not the only dedicated surveillance tactic. Opportunity for surveillance will also occur from responder movements and opportunistic aerial surveillance through the shared use of aircraft deployed for other purposes e.g. aerial dispersant spraying, C&R and shoreline strategies). The spatial extent of the spill is more dependent on tidal influences than the wind. Tides are twice per day and are best captured by twice daily aerial flights. The two dedicated passes are sufficient to validate and inform the IAP process to ensure overall response is commensurate with nature and scale of incident. Therefore, there is no value in increasing dedicated overpasses and therefore the arrangements described in the OPEP are considered ALARP.

Strategy tasks and resources arrangements	Environmental/Social/Economic consequences of additional resources from those described in the OPEP	Practicality of additional resources from those described in the OPEP	ALARP assessment
Vessel surveillance Section 9.4 of OPEP	One dedicated resource within 48 hours is considered ALARP. There would be no environmental benefit for additional dedicated resources given the need is met through vessel sharing and surveillance will also be conducted through a number of complementary operational monitoring strategies (aerial surveillance, tracker buoys).	In the event that additional dedicated vessels are required due to data gaps, resources are available. The cost of the additional vessels will be added to the cost of the response.	There is no benefit in having additional dedicated surveillance vessels given surveillance can be performed from any vessel and these duties will be shared amongst spill response vessels. Aerial surveillance, tracker buoys and UAVs are more efficient and effective at determining extent of oil movement, vessel surveillance is a secondary tactic. Therefore, there is no value in increasing dedicated vessel numbers and therefore the arrangements described in the OPEP are considered ALARP.
Tracking buoys Section 9.4of OPEP	The buoys will be deployed within one hour and then 24 hours of spill release. As the spill is instantaneous and of a defined volume, there is no additional benefit to increasing tracker buoys.	Additional buoys are available through AMSA and AMOSC within days. There is no additional upfront cost for accessing these secondary buoys.	Tracking buoys are one tactic in the operational monitoring strategy. The number of buoys immediately available is sufficient to cover tracking of oil given the worst-case spill is a defined volume and timeframe. Placing a tracker buoy on the support vessel would have no additional benefit than from the CPF as the distance between the support vessel (when in field) and CPF is small and subject to same tidal influences. Also, tracker buoys require maintenance which can be scheduled from the CPF as part of the spill response equipment. Therefore, there is no value in increasing tracker buoy numbers and therefore the arrangements in the OPEP are considered ALARP.
Fluorometry Section 9.4 of OPEP This remains the same unless Jadestone changes service providers	The purpose of fluorometry is to: 1) inform the scientific monitoring; 2) provide validation for trajectory modelling predictions. Additional fluorometers may limit missed data opportunities. Fluorometry will target subsea plumes approaching those sites that have the greatest potential for environmental impact (i.e. the most sensitive areas with the highest predicted concentration of entrained oil). Any additional fluorometers would be deployed to other sensitive areas in the EMBA and once those fluorometers have confirmed presence of entrained oil, these units can be moved to other	Jadestone can access 5 subsea gliders with fluorometers through Blue Ocean Monitoring (via Astron) and additional fluorometers through CSIRO. This is considered sufficient for upfront planning. Additional tow behind fluorometers can be sourced from CSIRO if apparent there are data gaps that can't be filled by existing arrangements. This would not be an upfront cost but the need and costs would be assessed after a spill event.	The existing arrangements are considered sufficient to meet fluorometry purpose. Additional fluorometers can be arranged and deployed should the need arise this is not considered time critical and the additional benefit is considered low. Therefore, there is no value in increasing fluorometery numbers and therefore the arrangements described in the OPEP are considered ALARP.

Strategy tasks and resources arrangements	Environmental/Social/Economic consequences of additional resources from those described in the OPEP	Practicality of additional resources from those described in the OPEP	ALARP assessment
	areas. Therefore, it is considered there is little additional environmental benefit in having more fluorometers. Access to vessels for towing (small vessels) will be per the Logistics Management Plan.		
UAVs Section 9 of OPEP	UAVs can monitor in difficult to access areas and prevent unnecessary intrusion by responders. Information is real time and utilised in the IAP for targeted response. UAVs allow more data captured quicker than by deploying responders alone. There is no environmental benefit from additional UAVs as the Protection Priorities are covered by four.	There would be additional cost in obtaining more than the four UAVs outlined in the OPEP, also for additional vessels and personnel to interpret data.	The resourcing provides UAV capability for each Protection Priority (with 4 deemed sufficient to cover Dampier, 80 Mile Beach, Barrow, Montebellos and Lowendal Islands). Additional UAVs will not provide additional benefit (except for redundancy). The UAVs are considered a secondary aid in locating oil in difficult terrain. Additional UAVs can be sourced as needed after a spill event given their high availability. The number outlined in the OPEP is for pre-deployment planning purposes only. Given the use of UAVs is a secondary strategy and not critical to reducing environmental impact the existing arrangements described in the OPEP are considered ALARP.
Shoreline and coastal habitat assessment using SCAT surveys. Section 9.4 of OPEP	Shoreline Cleanup and Assessment Technique (SCAT) is a systematic method for surveying an affected shoreline after an oil spill. SCAT is designed to support decision-making for shoreline cleanup. It is flexible in its scale of surveys and in the detail of datasets collected. SCAT continues during the response to verify shoreline oiling, cleanup effectiveness, and eventually, to conduct final evaluations of shorelines to ensure they meet cleanup endpoints.	The cost of additional resources is not considered the limiting factor; the limiting factor is the availability to use resources at the physical location. Additional people from described in the OPEP could cause unnecessary environmental impacts. If required, additional equipment will be sourced and the additional cost borne by Jadestone.	Jadestone undertook an evaluation to determine the most effective resource capability to reduce the environmental risk from a worst-case spill event (refer OPEP). SCAT numbers are not cumulative as this data represents stochastic modelling outputs. A spill would not contact all receptors modelled and not all at once. Then number required would be based on direction of spill and timeframes to contact. Capability required is 7 teams across the 5 priority receptors with 10 people per team. The existing arrangements are considered sufficient to meet SCAT purpose. Additional personnel can be sourced and deployed should the need arise; this is not considered time critical and the additional benefit is considered low. Therefore, there is no value in increasing SCAT numbers and therefore the arrangements described in the OPEP are considered ALARP.
Chemical dispersant application Section 10 of OPEP	Application of additional chemical dispersants within the timeframe planned and implementing a faster application timeframe.	Additional resources include: Dispersant costs of \$10,000 per m^3. The maximum volume of dispersant that can be applied within the activity timeframe has been calculated to be $258m^3$.	The worst-case spill scenario where chemical dispersant is recommended is asubsea spill from the underbuoy hose, with a finite volume of oil and defined timeframe. The estimated Window of Opportunity (WoO) for chemical dispersant application diminishes after 72 hours. Jadestone has evaluated that the earliest chemical dispersant operations can commence is

Strategy tasks and resources arrangements	Environmental/Social/Economic consequences of additional resources from those described in the OPEP	Practicality of additional resources from those described in the OPEP	ALARP assessment
	These have the potential for further reduction of floating oil and shoreline loading (reducing/eliminating further environmental impacts - clean-up and protection and deflection intrusions, oiled wildlife) and an increased ability of the environment to biodegrade the oil more rapidly to below threshold levels; thus, reducing the severity and duration of the spill and subsequent economic and social impacts such as beach tourism. A negative consequence is the further increase in localised entrained and dissolved oil concentrations with subsequent risk of additional environmental impacts to organisms in the water column (refer Section 8.5.2 and Table 8-7). This could have negative flow-on social and economic consequences e.g. recreational and commercial fishing, diving.	FWADC aircraft $15,000 per aircraft per day. Vessels $15,000 per day plus fuel costs of $1,600 per day. Additional expert personnel. Chemical dispersant operations are to be conducted in daylight hours only. Indicative costs: Cost of suitable aircraft (e.g. crop duster) USD$350,000 Standby for Jadestone specialist personnel $150,000 p.a. Purchasing dispersant stock and maintenance in Karratha $400,000 p.a. Purchasing dispersant vessel and application equipment $300,000. OSRL resources: Hercules aircraft (excluding fuel) USD17000 per hour Access to dispersant stocks UK2500 and additional 15% on invoiced stocks. Chemical dispersant stocks charged at replacement purchase price plus all invoiced costs. Dispersant efficacy testing using MacKay Apparatus approx. $5000 per dispersant tested	18 hours after a spill (refer Section 10 of OPEP). This would enable dispersant application to oil within the WoO and does not compromise the effectiveness of other strategies. Jadestone undertook an evaluation to determine the most effective resource requirements to reduce the environmental risk from a worst-case spill event to ALARP. Aspects considered were volume of floating oil, timeframe and spread of spill, best case target area (i.e. thickness of oil), location of sensitive receptors, geographic location of application, location and type of dispersant stocks, volume of dispersant required, number of vessels and aircraft and ancillary resources. The results of the best-case capability evaluation for dispersant application is described in Section 10 of the OPEP and demonstrates that environmental risk will be reduced to ALARP. Due to the small volume of dispersant required, Jadestone has identified the AMOSC Exmouth and AMOSC Karratha dispersant stocks more than sufficient to meet the required volume (<10m^3). Laboratory tests for dispersant efficacy are sometimes carried out to rank the effectiveness of one dispersant relative to another for a particular oil. However, caution is advised (ITOPF 2011) when extrapolating these results as accurate replication of the conditions at sea is difficult in a laboratory environment. Effectiveness tests are conducted in closed systems and may not be representative of actual performance expected at sea. SQT testing for dispersants on Stag crude was undertaken and identified that the AMSA National Plan stock and AMOSC stock (namely Slickgone NS and Corexit 9500) is on average 40% effective (refer OPEP Section 10.3). Jadestone considered conducting another dispersant efficacy test on Stag crude using the MacKay Apparatus test; however, this was rejected due to caution advised in expecting laboratory tests to describe what may occur in the real environment, the lack of change in dispersant stock, the availability of the tested dispersants in the market and the lack of change in Stag crude properties since the Quadrant tests. Jadestone considers that it is best practice and ALARP to utilise this information for planning and exercise purposes and conduct real-time field testing in the event of a spill as described in the OPEP (Section 10 of the OPEP). Controls placed on chemical dispersant application (Section 7.9.3 of the EP and Table 16-1 of the OPEP) are in place to ensure environmental risk is reduced to ALARP. An analysis was undertaken to determine the most effective mix of aircraft and vessels applying dispersant. Comparisons made between 1, 2 and 3 FWADC aircraft and different vessel numbers indicated that 1 FWADC and 1 vessels was the optimum capability within the WoO, beyond which the rate of benefit from application effort diminished (OPEP Section 10). Although Aerotech 1st Response is capable of dispatching up to 3 FWADC aircraft at Karratha airport within 18 hrs of activation and another 3 aircraft at Karratha within 48hrs of activation

Strategy tasks and resources arrangements	Environmental/Social/Economic consequences of additional resources from those described in the OPEP	Practicality of additional resources from those described in the OPEP	ALARP assessment
			it would be unnecessary as one aircraft can meet the dispersant demand for the available oil (OPEP Section 10). Additional FWADC will not be an efficient use of resources, and would result in overspraying, increasing the concentrations of oil in the water column unnecessarily, which is not an environmental benefit. Vessel dispersant application is a supporting option to FWADC to target breakaway slicks that are not within the application area of the aircraft. Time constraints presented by the WoO, sourcing and steaming time to target location discount the benefit of additional vessel based application. Jadestone Energy has evaluated the options and consider that it has access to what is required for ALARP via existing arrangements. As a member of an industry-wide oil spill response organisation (AMOSC) and a party to an MOU with AMSA for oil spill response. Jadestone has access to sufficient response capability to reduce the environmental risk associated with the worst credible spill to ALARP. Real-time planning for where the spill is going is undertaken as part of the Incident Action Planning process and provides a better operational picture for efficient and effective chemical dispersant application. The arrangements for incident management described in the OPEP reduce the environmental risks associated with chemical dispersant applications and are considered ALARP.
Containment and recovery Section 11 of OPEP	By increasing the recovery of oil off the water, less is able to contact shorelines thereby reducing potential environmental impacts. Additionally, shoreline waste volumes and associated environmental impacts on shorelines is reduced.	Approximate costs: Vessels $15000 each per day plus $1,600 per day for fuel Boom hire $12,000 per day for 6 teams. 6 skimmers $6000. Additional personnel $1500 per day	Containment and recovery operations will be focussed on the trajectory of the spill. If this is tracking towards the Montebellos (the highest probability and shortest timeframe determined by the modelling), there are not estimated to be big volumes at Dampier or Eighty Mile Beach (or contact at all). Operations will focus on the Protection Priorities (as the most commonly contacted and environmentally valued locations across all modelled scenarios) and the need is met by the access to resources as described in the OPEP. Jadestone undertook an evaluation to determine the most effective resource capability to reduce the environmental risk from a worst-case spill event (refer Section 11 of OPEP). It was found that 2 containment and recovery teams (4 vessels, 2 skimmers, 800 m boom) are estimated to contain and recover up to 80 m^3 of oil per day. This is more than sufficient to recover the oil available from weathering from the worst-case spill. Jadestone could mobilise additional containment and recovery teams to the spill site, however this is likely to be ineffective, given that containment and recovery is not an efficient strategy (usually limited to between 5% and 20% of the initial spilled volume (IPIECA-IOPG, 2015)).

Strategy tasks and resources arrangements	Environmental/Social/Economic consequences of additional resources from those described in the OPEP	Practicality of additional resources from those described in the OPEP	ALARP assessment
			Jadestone could purchase and maintain suitable vessels and equipment to be on standby 24/7/365, however this is cost prohibitive and disproportionate to the risk. In addition, it is not feasible to pre-deploy containment and recovery equipment as modelling identifies different potential shoreline contact locations (depending on the season) which are, largely remote and uninhabited. Even when the Protection Priorities are focussed on (as being the most commonly contacted locations across all modelled scenarios), the intrusion caused by equipment deployment and maintenance (considering the continuing operational aspect of Stag (24/7/365) would result in unnecessary additional impact to these locations and potential safety risks. In addition, the cost of doing this is disproportionate to the benefit. The current level of resources meets for the need as it allows flexibility in response operations as not all locations will be contacted in a single spill event. Containment and recovery arrangements described in the OPEP are considered ALARP.
Protection and Deflection Section 12 of the OPEP	Additional Protection and Deflection resources reduces shoreline contact and accumulation of oil, and subsequent impacts to shorelines. However, additional resources on shorelines will increase potential environmental contact and intrusion opportunities and increase safety risks of responders.	Boom hire costs are variable depending on the configuration and type used however they are estimated to be approximately $5000 per day. The cost of additional resources is not considered the limiting factor; the limiting factor is considered to be the availability to use resources at the physical location. If required, additional equipment will be sourced and the additional cost borne by Jadestone.	Protection and deflection has limited application for some locations due to tidal influences and lack of anchoring points for booms. Jadestone undertook an evaluation to determine the most effective resource capability to reduce the environmental risk from a worst-case spill event (refer OPEP Section 12). For Jadestone to purchase equipment and store and maintain is cost prohibitive when access via AMOSC will meet the need, and the limiting factor is people (who are accessed from outside Dampier). It is cost prohibitive and disproportional to the risk for Jadestone to purchase and maintain equipment to be on standby 24/7/365 when access to vessels and equipment is possible through contracts and AMSOC. Vessels and people will be utilised as determined through the IAP and NEBA. Given the remoteness of the locations with shoreline contact modelled and continuing operational aspect of Stag (24/7/365) there is considered limited benefit for pre-deployment of resources as this would create unnecessary long-term environmental disturbance (both for placement of resources and continuing maintenance) and unnecessary safety risks. In addition, the cost of doing this is disproportionate to the benefit. The current level of resources meets for the need as it allows flexibility in response operations as not all locations will be contacted in a single spill event. Therefore, the arrangements described in the OPEP are considered ALARP.

Strategy tasks and resources arrangements	Environmental/Social/Economic consequences of additional resources from those described in the OPEP	Practicality of additional resources from those described in the OPEP	ALARP assessment
Shoreline Clean-up Section 13 of the OPEP	While oil is arriving there is limited benefit from additional resources that might remove oil more quickly and any additional resources may be counterproductive in that additional impacts may outweigh benefits. After the oil has finished arriving, there may be an additional benefit in having increased resources at particular locations dependent upon environmental considerations. For example a turtle nesting beach during the nesting/hatching season may benefit in having additional resources deployed to clean the beach before nesting/hatching events. There may be benefit in deploying additional machinery in the event of greater opportunities for use, given machinery has the capacity to remove far greater volumes of bulk oil in the right circumstances. The numerous factors and consideration in determining the best approach for shoreline clean-up, the benefit of additional resources will be determined for each Operational Period. However, additional resources on shorelines will increase potential environmental contact and intrusion opportunities, increase safety risks of responders, cause physical damage and could be a negative impact.	The cost of additional resources is not considered the limiting factor; the limiting factor is considered to be the ability to use resources at the physical location. If required, additional personnel and machinery will be sourced and the additional cost borne by Jadestone.	Jadestone undertook an evaluation to determine the most effective resource capability to reduce the environmental risk from a worst-case spill event (refer OPEP Section 13). Intrusive shoreline clean-up techniques (e.g. mechanical and manual removal) have the potential to damage sensitive shorelines. Given that the majority of protection priorities predicted to be contacted have mangroves and species sensitive to shoreline clean-up activities (e.g. nesting birds) the appropriateness of clean-up will be determined via NEBA (as opposed to natural attenuation). It is therefore the opportunity for use rather than the availability of machinery and personnel which is considered the limiting factor to increase shoreline clean-up capability. In addition, volumes predicted ashore from spill modelling indicate 2-33m^3 accumulated oil on shorelines above 100g/m^2 in the worst replicate. For Jadestone to purchase equipment, store and maintain it is cost prohibitive when access via AMOSC Mutual Aid and mainstream suppliers will meet this need, and the limiting factor is people (who have to be accessed from outside Dampier), health and safety issues for shoreline work and suitable vessels. Given the remoteness of the locations with shoreline contact modelled and continuing operational aspect of Stag (24/7/365) there is considered no benefit for pre-deployment of resources as this would create unnecessary environmental disturbance (both for placement of resources and continuing maintenance) and unnecessary safety risks. In addition, the cost of doing this is grossly disproportionate to the benefit. The current level of resources meets for the need as it allows flexibility in response operations as not all locations will be contacted in a single spill event. The arrangements described in the OPEP are considered ALARP.

Strategy tasks and resources arrangements	Environmental/Social/Economic consequences of additional resources from those described in the OPEP	Practicality of additional resources from those described in the OPEP	ALARP assessment
Waste Management OPEP	Additional resources for waste management would have a benefit for reducing secondary contamination. However, additional resources in waste zones will increase potential environmental contact and intrusion opportunities, increase safety risks of responders, cause physical damage and could be a negative impact.	Additional cost would be incurred for additional laydown zones, decontamination areas, receptacles, PPE, people, transport and access to facilities.	Jadestone undertook an evaluation to determine the most effective resource capability to reduce the environmental risk from a worst-case spill event (refer OPEP). Additional resources can be sourced through existing arrangements with NWA if during a response it becomes apparent that additional resources are required. Planned resources are considered to match worst-case modelled waste requirements. Increased resources will have additional stressors and potential negative impact to the environment and operational areas. The arrangements described in the OPEP are considered ALARP.
OWR Section 14 of the OPEP	The OWR level is a Level 3 (refer WAOWRP and POWRP) as Eighty Mile Beach has been identified as a Protection Priority. OWR aims to prevent/reduce the impact to marine fauna (in particular birds and turtles) and any longterm effects.	Significant additional cost would be incurred if Level of response increase to Level 4 or above in particular around the people and facility aspect. Significant additional cost would be incurred if Jadestone provided its own oiled wildlife response (personnel, experts, facilities, plans etc).	Jadestone undertook an evaluation to determine the most effective resource capability to reduce the environmental risk from a worst-case spill event (refer OPEP). Additional strategies that have been considered include: • Additional arrangements to improve mobilisation times of international OWR resources (e.g. additional contracts/arrangements with OWR organisations or pre-mobilisation of international OWR personnel) • Additional training of Australian based OWR personnel to increase numbers of competent OWR personnel Given the local (AMOSC and DBCA) and global (OSRL/Sea Alarm) response capability through existing arrangements could be mobilised within required timeframes, the response arrangements are considered ALARP as these plans are contextualised for the Pilbara. The WAOWRP and the POWRP were developed by the State environmental agency in conjunction with industry, Perth Zoo and academia. Therefore, represents the best-oiled wildlife response plans that WA and Jadestone can utilise. The level of oiled wildlife response required for a worst-case impact event was considered to be potentially a Level 3 based on worst-case population density and distribution of shorebirds and an examination of applicable case studies of similar characteristics (i.e. Macondo). The arrangements of OWR outlined within the OPEP are considered sufficient for a controlled escalation of response prior to the worst-case minimum contact times for oil at the sites of highest abundance and sensitivity (i.e. Eighty Mile Beach) Stag crude is not toxic and has low adherence properties, but it is persistent. The arrangements described in the OPEP are considered ALARP.

8.5.8 Acceptability Assessment

The potential impacts due to an unplanned release of Stag crude oil are considered d 'Broadly Acceptable' in accordance with the Environment Regulations, based on the acceptability criteria outlined below.	
Policy compliance	Jadestone's HSE Policy objectives are met.
Management system compliance	**Section 9** demonstrates that Jadestone's HSE Management System is capable of continuously reviewing and updating activities and practices at the Stag facility, including spill response arrangements.
Social acceptability	Stakeholder consultation has been undertaken (see **Section 6**), including engagement with the State and National response agencies of DoT and AMSA, AMOSC, nearby operators, as well as commercial and recreational fishing industry bodies and fishers. No stakeholder concerns have been raised with regards to impacts of the spill response activities on relevant persons. During any spill response, a close working relationship with key regulatory bodies (e.g. DoT, DBCA, AMSA, DER) will occur and thus there will be ongoing consultation with relevant persons during response operations.
Laws and standards	Jadestone is obligated to respond to a hydrocarbon spill under the following legislative instruments: • OPGGS Act Section 572A-F – polluter pays for escape of petroleum) • AMSA Marine Orders Part 91 • Protection of the Sea (Prevention of Pollution from Ships) Act 1983 • Protection of the Sea (Civil Liability for Bunker Oil Pollution Damage) Act 2008
Industry best practice	Response planning and preparedness undertaken in accordance with: • NatPlan (AMSA, 2020) • AMOSPlan (AMOSC, 2017) • NOPSEMA Guidance Notes (e.g. Oil Pollution Risk Management Information Paper Rev 2 February 2018) • DoT Offshore Petroleum Industry Guidance Note, Marine Oil Pollution: response and Consultation Arrangement July 2020 • DoT OSCP (2015) • State Hazard Plan – Maritime Environmental Emergencies (MEE), 2019) • Fingas, M.F. (2012) The Basics of Oil Spill Clean-up. CRC Press. Florida, United States of America. • ITOPF Technical Information Papers including: ○ ITOPF (2014) Technical Information Paper Dispersant Use ○ ITOPF (2020). ITOPF Members Handbook 2020/2021 ○ ITOPF (2014) Technical Information Paper Clean-up of oil from shorelines ○ ITOPF (2013). Technical Information Paper Use of Booms in oil pollution response · • IPIECA International Association of Oil and Gas Producers Good Practice Guide Series including: ○ IPIECA-IOGP. (2015) A Guide to Oiled Shoreline Clean-up Techniques: Good practice guidelines for incident management and emergency response personnel ○ IPIECA-IOGP (2015) Oil spill preparedness and response: an introduction ○ IPIECA-IOGP (2015) Contingency planning for oil spills on water Good practice guidelines for the development of an effective spill response capability • Oil Spill Response (OSRL) handbooks including: ○ Shoreline operations handbook ○ Containment and recovery handbook • Dispersant application field guide

Environmental context	The worst-case credible Stag crude spill scenario for the Stag facility operating activities is as a resultof damage to the underbuoy hose at the CALM buoy. . The worst case release of oil occurs over 30 minutes and the area of dispersion over which the oil travels is between Eighty Mile beach to the north and Ningaloo in the south. The oil is primarily floating and sensitive receptors at risk include seabirds, shorebirds, marine fauna and coastal habitats. While some response strategies (e.g. application of chemical dispersants and booming operations) pose risk to sensitive receptors, to not implement response activities would likely result in greater negative impact to the receiving environment and a longer recovery period. The mutual interests of responding and protecting sensitive receptors from further impact due to response activities is managed through the use of the net environmental benefit analysis during response strategy planning in preparedness arrangements as well as during a response.
ALARP	The residual risk has been demonstrated to be ALARP.

8.6 Unplanned Release of Diesel

8.6.1 Description of Hazard

Aspect	Release of diesel may occur from a support vessel due to platform/vessel collision within the Operational Area or from a dropped object event. Alternatively, diesel may be released to the marine environment due to a leak or rupture of the bunkering hose. The maximum worst-case credible spill volume of diesel has been calculated as 250 m^3 based on a typical maintenance support vessel used at Stag.

Diesel is stored on the CPF and is the main fuel source for support vessels. The CPF uses Stag crude oil as its primary fuel source.

A HAZID was undertaken for the Stag Field activities and the below credible scenarios resulting in a diesel spill were identified (**Table** 8-18).

Table 8-18: Credible diesel releases to the marine environment

Scenario	Maximum Credible Spill	Credibility justification
Release of diesel from support vessel due to CPF/ vessel collision or from dropped object	Based on AMSA (2015) 'other vessel collision' – volume of largest fuel tank = **80m³** (based on a typical operations support vessel); **250 m³** (based on a typical maintenance support vessel)	AMSA (2015) Indicative maximum credible spill volumes table is directly applicable for determining the volume that may be released in a vessel collision scenario. An operations support or supply vessel would typically carry a total fuel capacity of 250 m^3 in a single tank.
Leak or rupture of bunkering hose during support vessel to CPF diesel transfer	Based on AMSA (2015) 'Production platform refuelling – continuous supervision' Transfer rate x 15 minutes (continuous supervision) = 20 m^3/hr for 15 minutes = **5m³**	AMSA (2015) Indicative maximum credible spill volumes table is directly applicable for production platform refuelling. Continuous supervision is the appropriate credible level of supervision given that transfers are of short duration and refuelling procedures stipulate continuous supervision.
Dropped object damaging vessel hull and internal tanks	**250 m³** (based on a typical maintenance support vessel)	The volumes determined for the collision scenarios have also been used to estimate the volume that may be released due to a dropped object damaging the support vessel hull (and internal tanks).

The HAZID identified scenarios where the event leading to a diesel release would not occur, or, where due to the small volumes or inherent barriers in the facility design did not result in the diesel being released into the marine environment. These include:

1. Release diesel to the marine environment from a leak or rupture to the bunkering hose during diesel transfer from vessel to vessel – this is considered not credible for vessel to vessel transfers, as no diesel bunkering occurs for support vessels. Note that fuel transfers to the CPF do occur, see above.
2. Release of diesel to the marine environment from the CPF bulk diesel storage tank from a collision with a vessel (errant vessel) – the CPF bulk storage tank (inventory of 65 m^3) is enclosed within the hull structure of the CPF which is raised off the sea surface by ~50 m. The CPF is designed to withstand a 2,000 t vessel impacting at 0.5 m/s (typical support vessel at required low manoeuvring speed) so it is not considered credible that the bulk storage tank would be damaged resulting in a release to the marine environment.
3. Release of diesel to the marine environment from the CPF bulk diesel storage tank or ancillary pipework/diesel conditioning unit – the CPF bulk storage tank (inventory of 65 m^3) is enclosed within the hull structure of the CPF and therefore corrosion or loss of integrity would not lead to diesel released to the marine environment. The diesel is intermittently treated by a conditioning system on the main deck. Loss of diesel from pipework associated with the diesel storage tank and the conditioning system due to loss of integrity/ corrosion would be contained within barriers (e.g. bunding, hull structure).
4. Release of diesel to the marine environment from day tanks – small quantities of diesel could be spilt when manually filling day tanks or from leaks in day tanks and associated hoses/ pipework (e.g. CPF Hydraulic Workover Unit diesel day tank – 3 m^3, CPF firewater pump day tanks – 8 m^3, CPF emergency generator day tank – 3 m^3). These potential small spill volumes would be restricted to within barriers of the CPF, third-party tanker or support vessels (e.g. within the hull or within bunded areas on the topside deck).

Spill volume

The volume of diesel that could be released to the marine environment from vessel collision and subsequent rupture of fuel tank is largely dependent upon fuel tank position on the vessel, and the degree and location of tank damage. The AMSA (2015) guideline: *Technical guidelines for preparing contingency plans for marine and coastal* facilities has been used in determining the potential release volume of the credible scenarios. These calculations provide a spill volume of 250 m^3 for maintenance support vessels, and 5 m^3 during transfer of diesel between a support vessel and CPF storage tank. For the purpose of determining potential impacts, the larger volume of 250 m^3 has been used as it is considered to be representative of a typical maintenance vessel and subsumes the 5 m^3 scenario outlined above.

8.6.2 Diesel characteristics

Characteristics for marine diesel were extracted from the ASA oil database for similar operational temperatures (**Table** 8-19). Diesel fuel oil 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). Approximately 5% of the oil is shown to be persistent. The aromatic content of the oil is approximately 3%.

If released in the marine environment and in contact with the atmosphere (i.e. surface spill), approximately 41% by mass of this oil is predicted to evaporate over the first couple of days depending upon the prevailing conditions, with further evaporation slowing over time (RPS APASA, 2020).

Table 8-19: Characteristics of diesel (RPS APASA, 2020)

Initial Density @ 25°C (g/cm^3)	Viscosity @ 25°C (cP)	Component	Volatiles (%)	Semi-volatiles (%)	Low-volatility (%)	Residual (%)	Aromatics (%)
		Boiling Points (°C)	<180 C4 to C10	180-265 C10 to C15	265-380 C15 to C20	>380 >C20	Of whole oil <380
			Non-Persistent			Persistent	
0.829	4	% of total	6	34.6	54.4	5	3
		% aromatics	1.8	1	0.2	-	-

In the marine environment diesel will behave as follows:

- Diesel will spread rapidly in the direction of the prevailing wind and waves;
- Evaporation is the dominant process contributing to the fate of spilled diesel from the sea surface and will account for >50% reduction of net hydrocarbon balance;
- Diesel will entrain under the water surface particularly when wind speed and resultant wave action increase;
- The evaporation rate of diesel will increase in warmer air and sea temperatures such as those at the Stag Operations location; and
- Diesel residues usually consist of heavy compounds that may persist longer and will tend to disperse as oil droplets into the upper layers of the water column.

8.6.3 Modelling Results

To determine the spatial extent that may be affected by a 250 m^3 diesel spill released instantaneously, modelling was conducted by APASA (2020).

A summary of the modelling methods used to evaluate the weathering and distribution of a 250 m^3 diesel spill within the Stag permit area are as per those described in **Section 8.4.2.1**.

The mass balance forecast for the constant-wind case (calm winds at constant 5 knots) for diesel fuel oil shows that approximately 41% of the oil is predicted to evaporate within 24 hours. Under these calm conditions the majority of the remaining oil on the water surface will weather at a slower rate due to being comprised of the longer-chain compounds with higher boiling points. Evaporation of the residual compounds will slow significantly, and they will then be subject to more gradual decay through biological and photochemical processes.

Under the variable-wind case (4-19 knots), where the winds are of greater strength, entrainment of diesel fuel oil into the water column is indicated to be significant. Approximately 24 hours after the spill, around 72% of the oil mass is forecast to have entrained and a further 24% is forecast to have evaporated, leaving only a small proportion of the oil floating on the water surface (<1%). The residual compounds will tend to remain entrained beneath the surface under conditions that generate wind waves (approximately >6 m/s).

8.6.3.1 Results – Surface release of 250m³ diesel

The annualised EMBA is derived from the seasonal stochastic modelling results (i.e. results from all 200 replicates), hence describes a substantially larger area than would be affected during any single spill event. The annualised EMBA is based on Jadestone's specifications of thresholds for floating oil (1 g/m^2 and 10 g/m^2), shoreline oil (100 g/m^2), entrained oil (100 ppb) and dissolved aromatic hydrocarbon (70 ppb) concentrations. The annualised maximum distance from the spill location to the outer edge of the annualised EMBA is calculated as approximately 295 km (**Figure** 8-4).

Floating Oil Results

Results of the worst-case modelling (September to February) indicate that surface sheens of floating oil (>1 g/m^2 and 10 g/m^2) may pass over the following sensitive receptors, with a probability of >1% of reaching these locations, noting that floating oil will not accumulate on submerged features or at open ocean locations (**Table** 8-20).

In the worst case season, floating oil concentrations at or greater than 1 g/m^2 could travel up to 129 km from the release location (March to August), with the distances reducing to 27 km (March to August) as the contact threshold increases to 10 g/m^2 (RPS APASA, 2020).

No receptors are predicted to be contacted by shoreline oil concentrations at or greater than 100 g/m^2 during either season. The worst-case accumulated concentration is predicted as 8.1 g/m^2 forecast at Lowendal Islands in the March to August period.

Table 8-20: Modelling results for floating oil due to 250 m^3 diesel surface release

Receptor Type	Receptor
Australian Marine Parks	Montebello MP
Biologically Important Areas	Marine Turtle BIA
	Seabirds BIA
	Fish and Sharks BIA
	Whales BIA
Islands	Barrow Island
	Lowendal Islands
	Montebello Islands
Key Ecological Features	Ancient Coastline at 125m Depth Contour KEF
	Continental Slope Demersal Fish Communities KEF
	Glomar Shoals KEF
State Marine and National Parks	Barrow Island MMA
	Barrow Islands MP
	Montebello Islands MP

Entrained Oil Results

Entrained oil is most likely to drift to the south-west for spills commencing during summer and winter months. Entrained oil concentrations at or greater than 100 ppb could travel up to 267 km from the release location (March to August).

Highest maximum nearshore concentrations of entrained oil are predicted to occur along shorelines of the Montebello Islands at 5,973 ppb for spills commencing during winter months. And 1,818 ppb in summer months.

For 100 ppb the minimum arrival time is 11 hours to the Montebello Marine Park (in winter months). The maximum entrained hydrocarbon concentration at any depth in the worst replicate is 42,850 ppb at the turtles, seabird and whale BIAs.

Results of the worst-case modelling (March to August) indicate that entrained hydrocarbons >100ppb may pass over the following sensitive receptors, with a probability of >1% of reaching these locations (**Table** 8-21).

Table 8-21: Modelling results for entrained oil due to 250 m³ diesel surface release

Receptor Type	Receptor
Australian Marine Parks	Montebello Marine Park
Biologically Important Areas	Marine Turtle BIA
	Seabirds BIA
	Sharks BIA
	Whales BIA
Islands	Montebello Islands
Key Ecological Features	None
State Marine and National Parks	Montebello Islands MP

Dissolved Aromatic Hydrocarbons

Dissolved aromatic hydrocarbon concentrations at or greater than 70 ppb could travel up to 267 km from the release location (March to August). The maximum dissolved aromatic hydrocarbon concentration at any depth in the worst replicate is 168 ppb at the Montebello marine park.

Results of the worst-case modelling (March to August) indicate that dissolved aromatic hydrocarbons >70 ppb may pass over the following sensitive receptors, with a probability of >1% of reaching these locations (**Table** 8-22).

Table 8-22: Modelling results for dissolved oil due to 250 m³ diesel surface release

Receptor Type	Receptor
Australian Marine Parks	Montebello Marine Park
Biologically Important Areas	Marine Turtle BIA
	Seabirds BIA
	Sharks BIA
	Whales BIA
Islands	None
Key Ecological Features	None
State Marine and National Parks	None

8.6.4 Impacts and Risks

Marine diesel oil is a highly volatile hydrocarbon with a high proportion of toxic monocyclic aromatic hydrocarbons (MAHs) that are harmful in varying degrees to marine fauna. Diesel contains some heavy components (or low volatility components) that have a strong tendency to physically entrain into the upper water column in the presence of moderate winds (i.e. >12 knots) and breaking waves and can resurface if these energies abate.

In the event of a substantial diesel spill, the heavier components of diesel can remain entrained or at sea surface for an extended period. Given the properties of diesel, it is expected that marine fauna, marine habitats, protected and significant areas and socio-economic receptors, have the potential to be impacted by surface and entrained thresholds.

See **Appendix H** and **Table** 8-13 for more detail on the physical and chemical pathways and oil impacts to habitats, marine organisms and socio-economic receptors within the risk EMBA. A summary is also provided in Table 8-23 below.

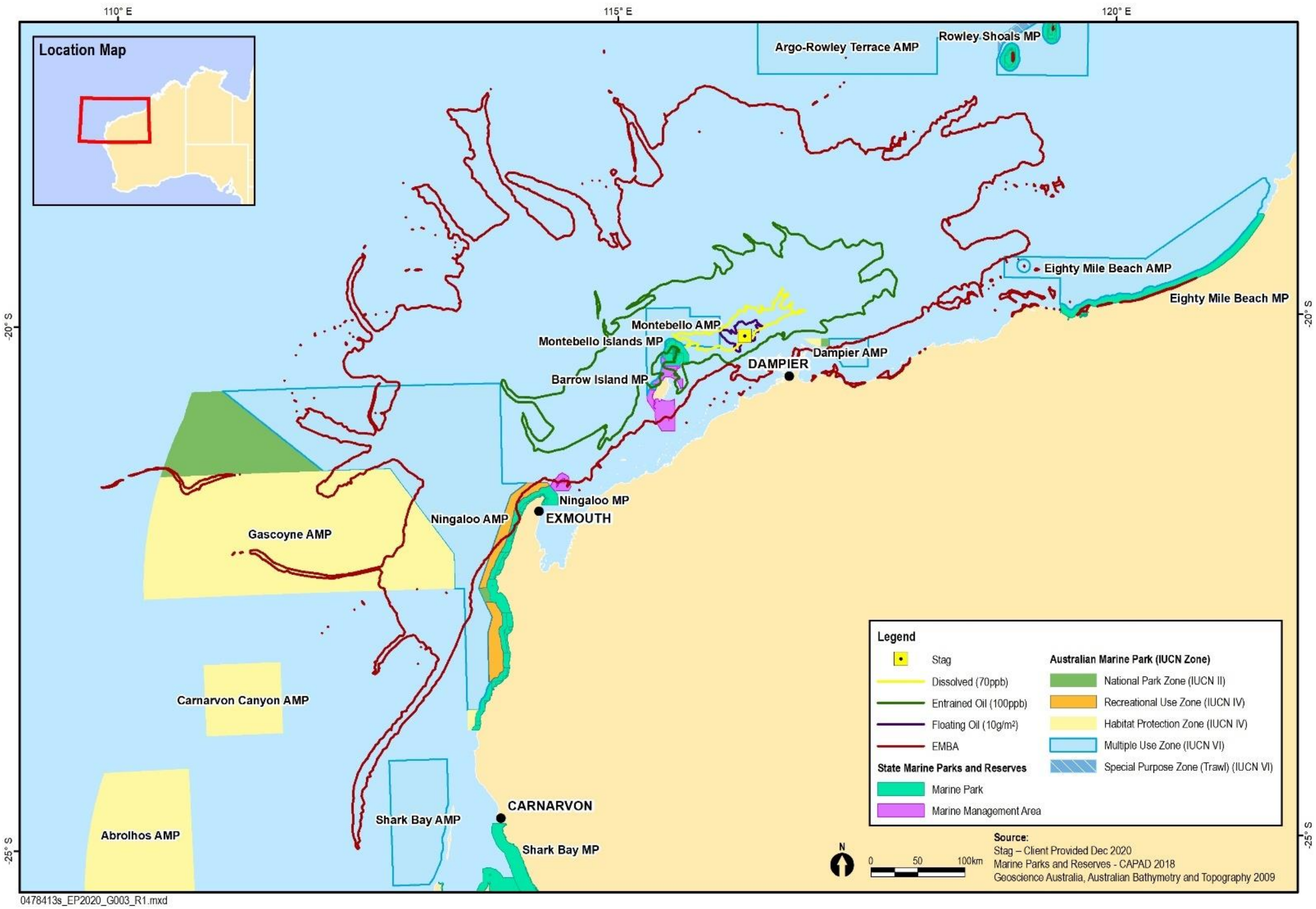


Figure 8-4: **Modelled spill trajectories for all seasons for floating and entrained diesel resulting from surface release of 250 m³ diesel at the Stag Facility and the EMBA.**

Table 8-23: Potential Impacts to sensitive receptors from diesel spill

Receptors	Potential Impacts from a diesel spill to receptors within the Risk EMBA		
	Floating and/or shoreline	**Entrained**	**Dissolved**
Plankton	*Potential impacts from diesel spill* There is potential for localised mortality of plankton due to reduced water quality and toxicity. Effects will be greatest in the upper 10 m of the water column and areas close to the spill source where hydrocarbon concentrations are likely to be highest.		
	Impact assessment to receptors within the risk EMBA High abundance of phytoplankton typically occurs around topographical features that may result in upwelling or a disruption to the current flow which may be present around banks and shoals. The Risk EMBA has the potential to overlap with spawning of some fish species given the year round spawning of some species. In the unlikely event of a spill occurring, fish larvae may be impacted by hydrocarbons entrained in the water column with effects greatest in the upper 10 m of the water column where the majority of plankton concentrate and closest to the spill source. However, following release, the diesel will rapidly evaporate, disperse and degrade in the offshore environment, reducing the concentration and toxicity of the spill. Given duration of fish spawning periods, lack of suitable habitat for aggregating fish populations near the surface, combined with the quick evaporation and dispersion of diesel, impacts to overall fish populations are not expected to be significant.		
Benthic habitat and communities **(Including deepwater habitats and shallow shoals)**	n/a – benthic habitats not present at surface	*Potential impacts from dissolved and entrained oil* Benthic habitats at shoals may be affected by marine diesel. This may result in toxic effects to both the habitat (in the case where the habitat is biological such as coral reefs) and associated flora and fauna. The degree of impact will depend on several variables, including the duration of exposure to DAHs and other diesel components. Sea grasses and macroalgae may experience a phytotoxic effect caused by absorption of DAHs from the water column. The hydrocarbon molecules can concentrate in membranes of aquatic plants, inhibiting photosynthetic efficiency (Runcie *et al*., 2004). Recovery of habitats experiencing chronic effects are expected within weeks to months of return to ambient water quality. Direct contact to shallow hard corals by entrained diesel could lead to impacts such as short or long-term sub-lethal effects including reduced feeding capacity and growth, reduced reproductive output and increased mucous production (IPIECA, 1992). In the worst case instance irreversible tissue necrosis and death could occur.	
	There are a number of shoals that may be present within the risk EMBA for the worst-case diesel spill. Shoals have a diversity of benthic habitats and associated fish and invertebrate assemblages which could be affected by entrained or dissolved oil. The shoals have a number of representative		

Receptors	Potential Impacts from a diesel spill to receptors within the Risk EMBA		
	Floating and/or shoreline	**Entrained**	**Dissolved**
	habitats including corals, sponges, seagrass		
Marine mammals	*Potential impacts from surface oil* Physical and chemical effects of diesel in sea surface waters have been demonstrated through direct contact with organisms, for example through physical coating, adsorption to body surfaces and ingestion (NRC, 2005). Lethal or sub-lethal physical and toxic effects such as irritation of eyes/mouth and potential illness. Whales and dolphins are smooth skinned, hairless mammals, so hydrocarbons tend not to adhere to their skin and the potential impacts of oiling on them is limited.	*Potential impacts from dissolved and entrained oil* The high volatility of the diesel will result in the rapid evaporation and loss of the more toxic aromatic components of the diesel, resulting in a reducing toxicity threat to marine fauna with time. Surface respiration could lead to accidental ingestion of hydrocarbons or result in the coating of sensitive epidermal surfaces. For marine mammals that may be exposed to the more toxic aromatic components of the marine diesel, chemical effects are considered unlikely since these species are mobile and therefore not be constantly exposed for extended durations that would be required to cause any major toxic effects. Clogging of baleen structures and toxicological effects from ingestion, although recorded, is sparse in the literature (Geraci and St. Aubin, 1985). The susceptibility of marine mammal species to physiological effects through ingestion of surface and water column hydrocarbon varies with the feeding mechanism of each species: • Whales with a baleen mechanism filter nutrient-rich waters containing food such as plankton and small fish over the baleen (a sieve type structure) before subsequently moving the food to the oesophagus using the tongue; • Baleen whales that skim surface waters and the water column (e.g. southern right whales) are more likely to be affected by surface hydrocarbons than other whales that 'gulp' feed such as the humpback whale; and Toothed whales are also less susceptible to impacts owing to gulp feeding behaviour (Geraci and St. Aubin, 1985).	
	Impact assessment to receptors within the risk EMBA Marine mammals present within the diesel risk EMBA include threatened and migratory whales and dolphins, and potentially dugongs, and the risk EMBA overlaps BIAs for humpback and blue whales. The activity is being undertaken all year round and may overlap with blue whale migration and humpback whale migration and calving, therefore diesel may contact whales during these life stages. However, given the rapid evaporation of diesel it is unlikely that significant numbers would be impacted. The absence of key feeding, resting or breeding areas for other threatened and migratory species and rapid evaporation and dissipation of diesel means significant numbers are unlikely to be impacted.		

Receptors	Potential Impacts from a diesel spill to receptors within the Risk EMBA		
	Floating and/or shoreline	**Entrained**	**Dissolved**
Marine Reptiles	*Potential impacts from surface oil* Marine turtles may be impacted by surface hydrocarbons through exposure during surface respiration, particularly where volatiles are being emitted in areas where fresher oil is weathering. Surface respiration could lead to accidental ingestion of hydrocarbons or result in the coating of sensitive epidermal surfaces.	*Potential impacts from dissolved and entrained oil* Whilst turtle nesting beaches may be contacted by weathered marine diesel, turtles will always nest above the high tide mark and any diesel moving through the beach profile should not come into contact with nests. Entrained and dissolved oil may result in harm to internal anatomy if ingested, irritation or damage to sensitive external features such as eyes and skin and damage to respiratory processes if significant inhalation of volatile fumes occurs at the surface	
	Impact assessment to receptors within the risk EMBA Threatened and migratory marine reptile species may occur within the diesel spill area risk EMBA as turtles are widely dispersed at low densities across the NWS and in the unlikely event of a diesel spill occurring, individuals traversing open water may come into contact with water column or surface diesel. The diesel spill EMBA overlaps with the BIAs for some turtle species and therefore there is the risk of contact with nesting turtles and hatchlings with surface and dissolved oil.		
Fish, Sharks, Rays	*Potential impacts from surface oil* Near the sea surface, fish are able to detect and avoid contact with surface slicks and as a result, fish mortalities rarely occur in open waters from surface spills (Kennish, 1997; Scholz et al., 1992). Pelagic fish species are therefore generally not highly susceptible to impacts from hydrocarbon spills. However, hydrocarbon droplets can physically affect fish and sharks exposed for an extended duration (weeks to months). Smothering through coating of gills can lead to the lethal and sub-lethal effects of reduced oxygen exchange, and coating of	*Potential impacts from dissolved and entrained oil* In offshore waters near to the release point, pelagic fish are at risk of exposure to the more toxic aromatic components of the marine diesel. Pelagic fish in offshore waters are highly mobile and comprise species such as tunas, sharks and mackerel. Due to their mobility, it is unlikely that pelagic fish would be exposed to toxic components for long periods in this spill scenario. The more toxic components would also rapidly evaporate and concentrations would significantly diminish with distance from the spill site, limiting the potential area of impact. Rays are typically found on benthic habitats and may be present around shoals in the area and likely below the area of water column affected by a diesel spill.	
	Impact assessment to receptors within the Risk EMBA *Whale sharks could potentially transit through the spill trajectory area, however this is considered unlikely given the small area affected by the diesel spill and its distance from known aggregation areas. Owing to the rapid evaporation expected and dispersion, impacts to the whale shark would be expected to be minimal.* *The NWS supports a diverse assemblage of fish and shark species, particularly in shallower water near islands and shoals. Other shark and pelagic fish species may transit the spill trajectory area but impacts would be anticipated to be negligible as most species will be well below the affected area of the water column.*		

Receptors	Potential Impacts from a diesel spill to receptors within the Risk EMBA		
	Floating and/or shoreline	**Entrained**	**Dissolved**
Avifauna	*Potential impacts from surface oil* Estimates for the minimum thickness of floating oil that will harm seabirds (through ingestion from preening of contaminated feathers or loss of thermal protection of their feathers) range from 10 g/m² (O'Hara and Morandin, 2010) to 25 g/m² (Koops et al. 2004). Seabirds have the potential to become oiled through interactions with surface waters in the spill area or through secondary ingestion of toxins as a result of feeding on affected prey. Potential impacts to seabirds are from contact, ingestion and/ or oiling of feathers. In addition, diesel can erode feathers causing chemical damage to the feather structure that subsequently affects ability to thermo regulate and maintain buoyancy on water. Seabirds may also come into contact with marine diesel around shorelines as it percolates through the beach profile during feeding, breeding and roosting activities. This may result in chemical impacts to feathers and exposed skin from the diesel.	*Potential impacts from dissolved and entrained oil* As most fish survive beneath floating slicks, they will continue to attract foraging seabirds, which typically do not exhibit avoidance behaviour. Potential impacts to avifauna due to entrained oil include: • Harm to internal anatomy if ingested; • Irritation or damage to sensitive external features such as eyes and skin; • Damage to feathers of marine birds; Damage to respiratory processes of air breathing marine fauna if significant inhalation of volatile fumes occurs at the surface.	
	Impact assessment to receptors within the Risk EMBA Threatened and migratory seabirds and shorebirds that may occur within the EMBA may have foraging, feeding, breeding and or nesting habitat in the vicinity of the EMBA. The EMBA intercepts with breeding BIAs for several migratory species and therefore foraging and breeding habitat in the area may be impacted by surface and water column while foraging (dive and skim feeding). Higher numbers would be expected during breeding periods. Due to the quick evaporation and dispersion of diesel, significant impacts are not anticipated.		
AMPs	*Potential impacts from surface oil* Surface oil may occur at the Montebello Marine Park where mangroves, sandy beaches, rocky shores occur affecting shoreline and intertidal habitats.	*Potential impacts from dissolved and entrained oil* Entrained and dissolved hydrocarbons will or may impact the coral and seagrass habitats, as well as other marine park values fauna including dugongs, sea snakes (protected), fish and other marine mammals. Impacts to these receptors are described above.	

Receptors	Potential Impacts from a diesel spill to receptors within the Risk EMBA		
	Floating and/or shoreline	Entrained	Dissolved
	Impacts on the values associated with Protected Areas may result in loss of fauna/ habitat diversity and/ or abundance, reduction in commercial/recreational/ subsistence fishing, loss of livelihood and loss of income from reduced tourism and commercial productivity. The Montebello MP, has conservation values associated with biological attributes including migratory seabirds, nesting turtles, humpback whales, freshwater, green and dwarf sawfish, and dolphins. Tourism may be impacted by real or perceived reduction in health or mortality of habitats that support tourism activities		
State Marine Parks	Values associated with the Montebello Islands MP and Barrow Island MP and MMA include marine fauna and coral reefs, mangroves, saltmarshes and sandy beaches. These values may be contacted by surface, entrained and dissolved oil which would potentially impact the receptors as described in this table.		
World, National and Commonwealth Heritage Places	There are no World, National and Commonwealth Heritage Places within the diesel risk EMBA.		
Threatened Ecological Communities	There are no threatened ecological communities within the diesel risk EMBA.		
Wetlands of International Importance	There are no wetlands of international importance within the diesel risk EMBA.		
KEFs	*Potential impacts from surface oil* There are no KEFS that would be impacted by surface oil as the KEFs relate to geomorphologic features which are not expected to be impacted by hydrocarbons.	*Potential impacts from dissolved and entrained oil* Values and sensitivities associated with the KEFs include marine fauna due to the higher diversity of fish species associated with the higher diversity in fish communities or nutrients such as Continental Slope Demersal Fish Communities. Impacts to marine fauna are discussed above.	
	Impact assessment to receptors within the EMBA There are three KEFs which are overlapped by the diesel EMBA, these include: • Continental Slope Demersal Fish Communities; • Glomar Shoals; and • Ancient coastline at 125 m depth contour		

8.6.5 Environmental Performance

Environmental Risk		**Unplanned release of diesel (EUH-5)**		
Performance Outcome		**No spill of hydrocarbon to the marine environment.**		
ID	**Management controls**	**Performance Standards**	**Measurement Criteria**	**Responsibility**
110	Compliance with Stag Performance Standards Report (GA-70-REP-F-00007) ensures risks of spills during refuelling are reduced	All hoses are fitted with dry-break couplings and are buoyant or fitted with floats	Bunkering checklist for fuel	Stag OIM
111		Visual inspection of dry break couplings and hoses prior to diesel transfer		
112		Permit-to-work documentation is complete and signed off to ensure refueling is undertaken in accordance with the refueling procedure		
113		Bunding, sumps and drains are inspected monthly	Bassnet shows maintenance has been satisfactorily completed as scheduled	Stag OIM
114		Bunding/ drip trays under all skids and potential leak sources on CPF are inspected monthly	Bassnet shows maintenance has been satisfactorily completed as scheduled	Stag OIM
115	Compliance with Pressure Vessel Inspection Procedure (JS-90-PR-P-00181) to ensure CPF storage tanks are maintained and fit for purpose	CPF bulk diesel storage tank inspected (internal and external) as per procedure and deemed fit for purpose.	Bassnet shows maintenance has been satisfactorily completed as scheduled	Stag OIM
116	Compliance with Diesel Fuel Bunkering Procedure (GA-19-PR-P-0026) to ensure diesel bunkering equipment is maintained and fit for purpose	Diesel transfer hose is pressure tested at least annually and deemed fit for purpose	Bassnet shows maintenance has been satisfactorily completed as scheduled	Stag OIM
117	Vessel crew are trained in accordance with Competency and Training Management System [JS-60-PR-Q-00015] to	Vessel crew qualified in accordance with International Convention of Standards of Training, Certification and Watch-keeping for Seafarers (STCW95)	Records of crew certificates or third-party inspection document	Supply Chain Manager (initial Contract) Contract Owner (Contract Execution)

Environmental Risk		Unplanned release of diesel (EUH-5)		
Performance Outcome		**No spill of hydrocarbon to the marine environment.**		
ID	**Management controls**	**Performance Standards**	**Measurement Criteria**	**Responsibility**
	ensure competent personnel undertake the activity			
N/A	Refer Section 7.6.3 for additional controls and performance standards.			

8.6.6 ALARP Assessment

The use of diesel at the Stag Facility is necessary for the operation of various equipment (including emergency equipment) on CPF, and as the main fuel supply on vessels. Vessel presence is implicit in the operation of the facility to transfer supplies/ equipment, offload equipment and waste, perform inspection and maintenance and assist in offtake berthing and crude oil transfer. Therefore, vessels and the risk of a diesel release cannot be completely eliminated from the Operational Area. The use of diesel by support vessels is standard industry practice. Diesel is considered a more environmentally friendly fuel than heavier fuel oils which have a greater persistence in the marine environment should a spill occur.

A number of controls are in place (refer **Section 0**) which reduce the likelihood of spill events. No further controls have been identified that could provide a net benefit in reducing the likelihood or consequence of a diesel release to the marine environment and thus the risk and impacts are considered to have been reduced to ALARP.

On the basis of the impact and risk assessment completed, Jadestone considers the control measures described above are appropriate to manage the risk of an unplanned release of diesel to the marine environment. The residual risk ranking for this potential impact is considered Low, and therefore ALARP has been demonstrated. Additional controls considered but rejected are detailed below.				
Rejected control	**Hierarchy**	**Practicable**	**Cost effective**	**Justification**
N/a	Eliminate	N/a	N/a	The use of diesel for fuel for vessels and machinery cannot be eliminated, vessels and machinery are required for the operations and diesel is therefore required. Other energy sources are not readily available to power all equipment and vessels.
Substitute diesel for another hydrocarbon type	Substitute	No	No	The substitute for diesel is bunker fuel oil or Stag crude, both of which would have a higher environmental impact than diesel. No fuel source has been identified that is more environmentally friendly than diesel
N/a	Engineering	N/a	N/a	Machinery is designed for using diesel as the fuel oil which reduces the potential impact from an unplanned release to as low as possible. As no other hydrocarbon has been identified that is more environmentally friendly that could still fulfil the equipment requirements, no engineering controls have been identified.
N/a	Isolation	N/a	N/a	The Activity is located at distance from sensitive receptors and the coastline.
N/a	Administrative	N/a	N/a	Through the application of specific controls and procedures, and maintenance of machinery, no further administrative controls were identified.

8.6.7 Acceptability Assessment

The potential impacts of an unplanned diesel release to the marine environment are considered 'Broadly Acceptable' in accordance with the Environment Regulations, based on the acceptability criteria outlined below. The control measures proposed are consistent with relevant legislation, standards and codes.	
Policy compliance	Jadestone's HSE Policy objectives are met.
Management system compliance	**Section 9** demonstrates that Jadestone's HSE Management System is capable of continuously reviewing and updating activities and practices at the Stag facility, including spill response arrangements.
Social acceptability	Stakeholder consultation has been undertaken (see **Section 6**), including engagement with the State and National response agencies of DoT and AMSA, commercial and recreational fishing industry bodies and fishers. No concerns have been raised with regards to impacts of a diesel spill by relevant persons. During any spill response, a close working relationship with key regulatory bodies (e.g. DoT, DBCA, AMSA, DER) will occur and thus there will be ongoing consultation with relevant presons during response operations.
Laws and standards	Jadestone is obligated to respond to a hydrocarbon spill under the following legislative instruments: • OPGGS Act Section 572A-F – polluter pays for escape of petroleum) • AMSA Marine Orders Part 91 • Protection of the Sea (Prevention of Pollution from Ships) Act 1983 • Protection of the Sea (Civil Liability for Bunker Oil Pollution Damage) Act 2008
Industry best practice	Response planning and preparedness undertaken in accordance with: • NatPlan (AMSA, 2020) • AMOSPlan (AMOSC, 2017) • NOPSEMA Guidance Notes (e.g. Oil Pollution Risk Management Information Paper Rev 2 February 2018) • DoT Offshore Petroleum Industry Guidance Note, Marine Oil Pollution: response and Consultation Arrangement July 2020 • DoT OSCP (2015) • State Hazard Plan – Maritime Environmental Emergencies (MEE), 2019) • Fingas, M.F. (2012) The Basics of Oil Spill Clean-up. CRC Press. Florida, United States of America. • ITOPF Technical Information Papers including: o ITOPF (2014) Technical Information Paper Dispersant Use o ITOPF (2020). ITOPF Members Handbook 2020/2021 o ITOPF (2014) Technical Information Paper Clean-up of oil from shorelines o ITOPF (2013). Technical Information Paper Use of Booms in oil pollution response · • IPIECA International Association of Oil and Gas Producers Good Practice Guide Series including: o IPIECA-IOGP. (2015) A Guide to Oiled Shoreline Clean-up Techniques: Good practice guidelines for incident management and emergency response personnel o IPIECA-IOGP (2015) Oil spill preparedness and response: an introduction o IPIECA-IOGP (2015) Contingency planning for oil spills on water Good practice guidelines for the development of an effective spill response capability • Oil Spill Response (OSRL) handbooks including: o Shoreline operations handbook o Containment and recovery handbook • Dispersant application field guide

Environmental context	The worst-case credible diesel spill scenario for the Stag facility operating activities is a result of a vessel collision within the Operational Area, a dropped object or a transfer pipe rupture or leak. The release of oil occurs over five hours and floating oil is not predicted to contact any shorelines. Entrained oil is predicted to contact the Montebellos, Lowendals and Barrow in the worst-case scenarios. The oil is primarily entrained and sensitive receptors at risk include seabirds, shorebirds, marine fauna and habitats including EPBC listed species, or matters protected under Part 3 and KPIs within respective protected area management plans. Jadestone will have regard to the representative values of the reserves and other information published and endeavor to ensure that priority is given to the social and ecological values, of any AMPs, or state marine parks impacted by a release of Stag crude. The 'Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species' will be applied/used as guidance in the event of an oil spill.
ALARP	The residual risk has been demonstrated to be ALARP.

8.7 Dropped Objects

8.7.1 Description of Hazard

Aspect	Disturbance of benthic habitats resulting from dropped objects.

8.7.2 Impacts and Risks

Damage or loss to marine habitats may occur from dropped objects from the CPF and support vessels, although these are not expected to be of a scale to cause significant damage or loss. The impacted benthic habitats and associated biota are well represented in the region (**Sections 5.2** and **5.3**) and there are no known areas of benthic primary producer habitat (e.g. corals, seagrass), KEF habitat (nearest KEF ~70 km N) or protected area habitat within the Stag Field Operational Area. The operational area is within a habitat critical to survival for flatback turtles (as referred to in Table 6 of the 2017 National marine turtle recovery plan). The risk to marine turtles or impact pathway is through reduction in available feedig grounds. However, the study by Sperling et al. (2010) concluded that flatback turtles do not feed during the inter-nesting period. If individuals were likely to use this area as foraging grounds, outside of nesting season it would represent an insignificant percentage of all available feeding grounds and not significantly effect individuals or population.

This is confirmed by Kinhill (1997, 1998) and potential losses represent a very small fraction of the widespread available habitat.

8.7.3 Environmental Performance

Hazard		**Dropped Objects (EUH-6)**		
Performance outcome		**No unplanned disturbance to the seabed or marine environment within the Operational Area**		
ID	**Management Controls**	**Performance standards**	**Measurement criteria**	**Responsibility**
118	Personnel are competent in the Lifting Operations Procedure (JS-90-PR-F-00036) which details lifting requirements	All personnel involved with lifting equipment operations and maintenance are trained and competent to their level of responsibility	Competency matrix	Stag OIM
119		JSA is completed for all lifts and approved under the PTW	Completed PTW documentation	
120		A Lift Plan completed for Complex and/or Engineered Lifts	Approved Lift Plan	
121	Lifting operations and maintenance and testing requirements comply with Safety Critical Element Performance Standards A06537 – PSDS – 018 Offshore Crane (Man Riding)	Man riding operations only performed when a risk assessment has shown that there is no safer way for the task to be performed	Inspection records PMS records confirm maintenance and tests conducted	Engineering & Maintenance Manager
122		3 monthly inspection of lifting gear and colour tag		
123		6 monthly check of crane		
124		Annual service/inspection/certification of offshore crane		
125		Monthly general inspection of workboat		
126		Annual test/replacement and inspect of workboat		
127	Lifting operations managed under PTW systems as required by Safety Critical Elements Performance Standards Report (GA-70-REP-F-00007): SCMS-03 Permit to Work	Lifting operations to be managed under the PTW system	PTW records	Stag OIM
128	Lifting equipment maintained in accordance with Safety Critical Elements Performance Standards Report (GA-70-REP-F-00007): PS-05 Cranes & Lifting Equipment	Annual review of Lifting equipment inspection, repair and maintenance records	Annual compliance audit	

8.7.4 ALARP Assessment

On the basis of the HAZID conducted, Jadestone considers the control measures described above are appropriate to manage the risk of dropped objects. The residual risk ranking for this unplanned event is considered **Low** and therefore ALARP has been demonstrated. Additional controls considered but rejected are detailed below.

Rejected control	Hierarchy	Practicable	Cost effective	Justification
No lifting operations conducted	Eliminate	No	N/a	Lifting operations are an unavoidable activity to ensure the Stag facility is supplied with necessary goods and equipment, to remove wastes and to enable marine inspection and intervention activities to take place and so cannot be eliminated
N/a	Substitute	N/a	N/a	Not relevant
Increase lifting capacity of cranes to decrease number of lifts required	Engineering	No	No	It is considered that to increase the lifting capacity of the cranes, they would need to be larger which would result in an increase in deck space usage. Whilst larger cranes could result in less lifts being required, it also increases risks to personnel from increased loads, increases risks to the seabed in the event that they are dropped and these are considered grossly disproportionate the risk of dropping objects.
N/a	Isolation	N/a	N/a	Lifting areas are over top deck and landing platforms isolating subsea infrastructure including pipelines from dropped load events, therefore no further isolation controls have been identified
N/a	Administrative	N/a	N/a	Lifting procedures and plans and Permit to Work requirements ensures all lifts are managed and reduces risk of dropped objects.

8.7.5 Acceptability Assessment

The potential impacts of a dropped object on benthic habitats are considered 'Broadly Acceptable' in accordance with the Environment Regulations, based on the acceptability criteria outlined below. The control measures proposed are consistent with relevant legislation, standards and codes.

Policy compliance	Jadestone's HSE Policy objectives are met.
Management system compliance	**Section 9** demonstrates that Jadestone's HSE Management System is capable of meeting environmental management requirements for this activity.
Social acceptability	Stakeholder consultation has been undertaken (see **Section 6**), and no stakeholder concerns have been raised.
Laws and standards	No applicable laws or standards identified
Industry best practice	The APPEA Code of Environmental Practice (CoEP) (2008) objectives are met with regards to offshore production operations.

Environmental context	Disturbance is localised to immediately under or near to the footprint of Stag Facility subsea infrastructure within the Operational Area. The impacted benthic habitats and associated biota are well represented in the region. The operational area is within a habitat critical to survival for flatback turtles (interesting). However, the potential scale of habitat loss and seabed disturbance from dropped objects is a very small percentage of the total area. The potential impact is considered acceptable after consideration of: - Potential impact pathways - Preservation of critical habitats - Assessment of key threats as described in species and Area Management /Recovery plans - Consideration of North-West Bioregional Plan; and - Principles of ecologically sustainable development ESD
ALARP	The residual risk has been demonstrated to be ALARP.

9. IMPLEMENTATION STRATEGY

As required under Regulation 14(1) of the OPGGS 2009 (Environment) Regulations, Jadestone must provide an implementation strategy that will ensure:

- All environmental impacts and risks of the activity will be continually identified and reduced to a level that is ALARP;
- Control measures identified in the EP are effective in reducing the environmental impacts and risks of the activity to ALARP and acceptable levels;
- That environmental performance outcomes and environmental performance standards are met;
- Arrangements are in place to respond to, and monitor impacts of, oil pollution emergencies; and
- Stakeholder consultation is maintained through the activity as appropriate.

To meet these requirements the implementation strategy outlined in this EP includes the following:

- Details on the systems, practices and procedures to be implemented (Section 9.1);
- Key roles and responsibilities (Section 9.2);
- Training, competencies and ongoing awareness (Section 9.3);
- Monitoring, auditing, management of non-conformance and review (Sections 9.4 and 9.5);
- Incident response including Oil Pollution Emergency Plan (Section 9.5 and OPEP);
- Record keeping (Section 9.4.3); and
- Stakeholder consultation (Section 6).

Jadestone is responsible for ensuring that activities within the Operational Area are managed in accordance with the EP, the implementation strategy and the Jadestone Health, Safety and Environment Policy and Business Management System. To ensure Jadestone's environmental management standards and performance outcomes are achieved, all personnel will be required to comply with all relevant requirements of Jadestone's systems and, policies and standards.

9.1 Jadestone Business Management System

Jadestone applies an integrated Business Management System that is aligned with ISO 55001:2014 Asset Management. This covers all activities and includes provision for the systematic management of environment and safety and all other business functions. The Jadestone Business Management System ensures alignment between company objectives and the activities associated with operation of the Stag facility in a structure that is illustrated by **Figure 9-1**.

The management system sets a structured framework that provides governance across company processes for all organisational activities, with defined accountabilities and performance requirements for employees and contractors to deliver activities aligned to the vision and requirements of Jadestone Energy, including those identified in this EP.

At the highest level, environmental performance expectations are communicated by the Value Plan for the asset, and by the Jadestone HSE Policy and HSE Plan.

The structure of the management system is organised to describe the business activities by objective functions (**Figure** 9-2).

Figure 9-1: Business Management System structure

Figure 9-2: Business activities and objective functions

The objective functions are organised into 'Lead', 'Core' and 'Help', which describe how the intent of the business is delivered. The Lead functions are the activities that provide direction to the Core functions, which represent the life cycle of oil and gas activities. The purpose of the Lead functions is to enact and inform strategy and to guide the Core functions in the delivery of their activities.

Delivery of HSE management and performance is fully integrated (including implementation of the EP) throughout the objective functions relevant to operation of the Stag facility. The relevant functions are:

- Operational excellence;
- Value discipline;
- People;

- Stakeholder management;
- Risk management;
- Develop;
- Produce; and
- Provide goods and services.

Below is a summary of the mechanisms by which these functional areas contribute to HSE management and performance at the Stag facility.

9.1.1 Operational Excellence

'Operational Excellence' provides the systems, tools and processes which ensure that all learning experiences that have the potential to improve operational safety, integrity and efficiency, and reduce negative impacts to the environment, to be captured, evaluated and disseminated for future implementation.

The Operational Excellence function is a continuous process and is summarised in **Figure 9-3**.

The Operational Excellence function addresses the key points of:

- Capturing of lessons learnt;
- Review of lessons learnt; and
- Incorporation of knowledge in future work.

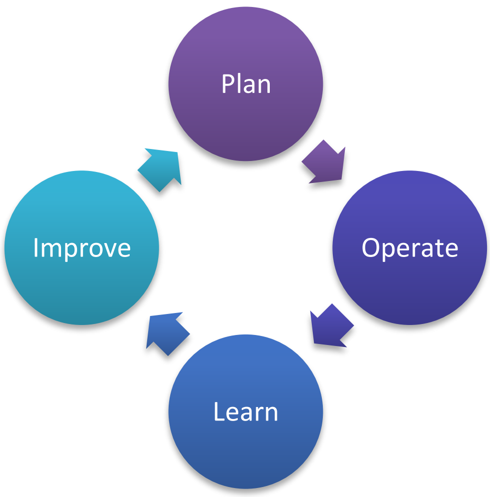


Figure 9-3: Operational excellence business function

Knowledge and best practices can be captured from many sources including internal and external, such as:

- Audits and inspections;
- Emergency response drills;
- Incident reviews;
- Technical papers, legislation and journals; and
- Prior experience.

Any actions arising from the assessment of information are incorporated into Bassnet. Processes, procedures and systems are improved based on the historical lessons learnt and applied in subsequent phases.

9.1.2 Value Discipline

The 'Value discipline' function represents the processes – including annual budgeting, capital funding – that ensure value and capital requirements are met and support the management system functions delivering their business objectives including HSE performance. Commonly HSE performance is a proxy for business performance and therefore HSE management is of interest to the Value discipline function of the management system.

9.1.3 People

The Jadestone Energy Competency Assurance Framework provides the formal systems, tools and processes which ensure that personnel are appropriately trained and competent to complete assigned tasks to an expected standard. Competency assurance is a necessary component of any approach to reduce safety, integrity and environmental risks to a level that is ALARP.

The Competency Assurance Framework addresses the key points of:

- Competency requirements (qualification, experience and training) are maintained for all Jadestone Energy positions where the incumbent is required to undertake, supervise, review or verify critical tasks or where the incumbent has the technical authority to approve critical documents;
- Competent persons are members of the workforce who meet the competency requirements for the respective positions to perform critical tasks without direct supervision;
- Candidates being considered for appointment in a critical position are assessed against the applicable competency requirements before being formally appointed;
- Incumbents must be reassessed against the competency requirements as per the required frequency stipulated in the competency matrix; and
- All contractors with personnel in the field are prequalified in accordance with the Contractor Management Framework.

Jadestone Energy personnel are subject to the provisions of the Jadestone Competency Assurance Framework which outlines the training, development and assessment requirements necessary to ensure that all employees have the relevant knowledge and skills required to conduct their activities in a safe and environmentally responsible manner.

A training and skills matrix has been developed for all positions which identifies responsibilities, training and competency requirements. Personnel will complete relevant training and hold qualifications and certificates for their specific role (e.g. well control certificates, rigging and crane operator certificates etc.). Training records will be retained.

9.1.4 Stakeholder Management

Subregulation 11A(3) of the Environment Regulations provides that:

> *The Implementation strategy of the environment plan must provide for appropriate consultation with:*
>
> *a) Relevant authorities of the Commonwealth, a State or Territory; and*
>
> *b) Other relevant interested persons or organisations*

Ongoing consultation activities build upon Jadestone's consultation for the Stag EP. Section 4 of the Stag EP Consultation Plan (**Appendix E**) outlines the processes that will be followed to ensure a standard approach to interacting with relevant persons during the life of the EP, including revision of relevant persons' list and process for dealing with feedback during this period. As part of ongoing consultation Jadestone will undertake the following activities (**Table** 9-1).

Table 9-1: Standard Consultation Actions

ID	Activity	Frequency and method	Responsibility
129	Provisions of updates on activity progress	Annual updates placed on Jadestone website and email notification to relevant persons, including Commonwealth and WA State government agencies identified in Table 4 of the Stag EP Consultation Plan (Appendix E).	Country Manager
130	Close out of communication commitments made during pre-start consultation including: • Provide response organisations with a copy of the OPEP; • Summary Notification to DMIRS of NOPSEMA EP approval.	• Copy of EP Summary on Jadestone's website • Email DMIRS stakeholder contact within 3 months	Country Manager HSE Manager
131	Email DPIRD stakeholder contact	• Within 3 months of commencement date	HSE Manager
132	Review of relevant persons list	• Annually unless triggered earlier	Country Manager
133	Provision of broader information relating to Jadestone environmental policy	• Website updates as required	Country Manager

In addition, Jadestone will undertake additional triggered consultation as outlined below, should an unplanned event occur (**Table** 9-2).

Table 9-2: Triggered Consultation Actions

ID	Trigger	Action	Responsibility
134	Feedback received from relevant person	Follow consultative process outlined in of the Consultation for Environmental Approvals procedure.	Country Manager
135	Deviation to Stag operations from those originally provided in consultation	Notification to relevant persons via email Website update Email DoF stakeholder contact a minimum of 3 months prior to commencement of any varied activity.	Country Manager
136	Change to risk profile in operational area	Notification to government agencies via email to key contact.	Country Manager
137	Change to risk profile in EMBA	Notification to government agencies via email to key contact.	HSE Manager

ID	Trigger	Action	Responsibility
138	Oil spill event	Notification to response agencies and government agencies immediately by phone. Attempt to electronically notify all relevant persons listed in Stag EP Consultation plan within 72 hours of spill. Ongoing updates and communication in accordance with requirements and response procedures. Notification of DoF via environment@fish.wa.gov.au) within 24 hours of incident report. Notification of TO's and all other stakeholders identified in Table 4 within 72 hours of event.	IMT Leader
139	Biosecurity incident: suspected marine pest or disease	Notification of DoF via biosecurity@fish.wa.gov.au or 1800 815 507 within 24 hours.	HSE Manager
140	Change to Offshore Petroleum Greenhouse Gas Storage (Environment) Regulations 2009 consultative requirements	Review of Consultation Plan	HSE Manager
141	Change to Stag's operating jurisdiction such that other legislative instruments stipulate new or additional consultative requirements	Review of Consultation Plan	Country Manager
142	An element of Jadestone's continuous improvement process identifies the procedure needs to be amended	Review of Consultation Plan	Country Manager
143	Change to infrastructure that affects exclusion zone	Notify the Australian Hydrographic Service of activities and infrastructure for inclusion in Marine Notices	Country Manager

9.1.5 Risk Management

Jadestone has an integrated approach to risk management to cover all its business activities.

The Risk Management function provides a view of risk that is independent of production delivery. This includes strategic, commercial, and control and compliance risks. In addition, it manages Health Safety and Environment activities, including the preparation and approval of regulatory approvals (including this EP) and the management of change process, which addresses all change activities regardless of type – technical, organisational, software or procedural. Further information on the management of change process is provided in **Section 9.4.2**.

At the activity level, the risk management function includes all the planned activities and accidental events. Risk identification and assessment is a continuous process that identifies all the physical control measures necessary to manage the risks. Control measures are subjected to regular assurance activities. In a similar way, audits of the management system are conducted according to review cycle with timing agreed in the annual planning process. Findings from assurance activities, audits and ongoing review of performance are considered in the Operational Excellence process, which considers opportunities for continuous improvement (refer **Section 9.1.1**).

The Risk Management function is accountable for approval of facility level risk assessments and risk reduction measures; and by so doing, providing a view of risk that is independent from production delivery.

9.1.6 Produce

The Produce function delivers safe and reliable operations as well as environmental performance.

The Produce function works closely with the Operational Excellence and Risk Management functions to evaluate operational performance, including environmental performance, and reduce risk through delivery of continuous improvement activities. Produce is responsible for asset optimisation, reliability, integrity and maintaining compliance. It thus interacts with most functions.

The Produce function delivers environmental management at the activity level via the Computerised Maintenance Management System (CMMS) including detailed work instructions and tasks allowing the activity to meet the environmental performance requirements of this EP. These instructions and tasks are monitored and reviewed to ensure appropriate close out of tasks is achieved as well as ensuring the required outcomes/ performance have been achieved.

9.1.7 Provide Goods and Services

HSE performance in all activities associated with operation of the Stag Facility is achieved either through management of personnel involved, or via management of contracted works.

The Jadestone Competency Management Framework provides personnel with a systematic and uniform approach for managing and improving Health, Safety and Environmental (HSE) performance throughout the life cycle of an individual's appointment, from their selection through to post-completion performance evaluation. The Personnel Management Framework addresses the key points of selection, competency, development requirements and management.

HSE performance is also achieved through Jadesetone's Contractor Management Framework. The contract management life-cycle follows four steps: pre-qualification; selection; engagement; and contract completion review process. Through each of these steps Jadeston and service provider/ supplier is evaluated for previous HSE performance and engaged in the mechanisms by which HSE performance will be achieved in the contract to be established.

9.2 Key Roles and Responsibilities

As per Regulations 14(4) and 14(5), a clear chain of command setting out the roles and responsibilities of personnel involved in operation of the Stag Facility, is required as well as detail on what measures are in place to ensure personnel are aware of their role requirements and how Jadestone evaluates their competency and training needs in these roles. In response to these regulatory requirements, provided in this sub-section is information on:

- Section 9.3.1 Organisational Chart: outlines the key roles involved in operation of the Stag facility;
- Section 9.3.2 Role responsibilities: summarises the responsibilities of each key role involved in operation of Stag facility;
- Section 9.3.3 Communication requirements: outlines how personnel fulfilling key roles are made aware of their responsibilities as described in the EP; and
- Section 9.3.4 Assessment of Competency and Training: outlines how Jadestone assesses and evaluate the competencies and training requirements of personnel responsible for achieving the commitments with this EP.

9.2.1 Organisational Structure and Responsibilities

The Stag Facility is governed by the hierarchy of positions on the CPF. The organisational structure is presented in **Figure 9-4**. Organisation charts showing the reporting relationships including the hierarchy for safety responsibility will be maintained.

Each position has a position description outlining their HSE role and responsibilities, accountabilities and reporting lines (**Table** 9-3). It is the responsibility of all Jadestone personnel to ensure that the requirements of the HSE Policy are applied in their area of responsibility and that personnel are suitably trained and competent in their respective roles. Mandatory training requirements are mapped out in a competency matrix. Further information is provided in the Competency and Training Management System [JS-60-PR-Q-00015].

It is the responsibility of all Jadestone personnel to ensure that they have read and understood the requirements of the HSE Policy. All personnel are suitably trained and competent in their respective roles.

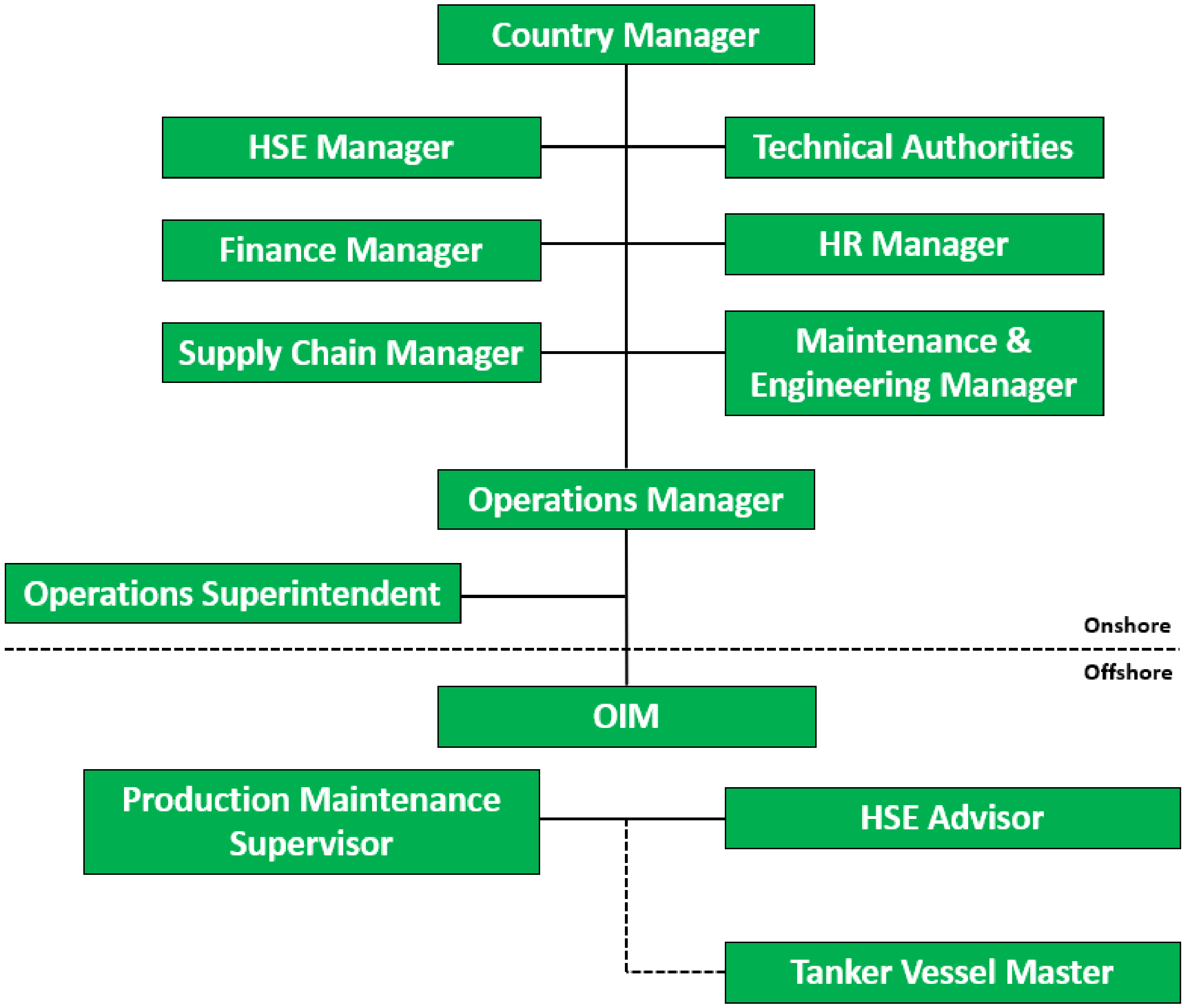


Figure 9-4: Stag Operations Organisation Chart

Table 9-3: Responsibilities of Key Roles

Role	Key Responsibilities
Country Manager	• Ensures that activities are conducted in accordance with the Jadestone's HSE Policy. • Primary responsibility for Jadestone Australia operations and for meeting or exceeding corporate targets for all aspects of performance, including conducting activities in accordance with Jadestone's HSE Policy and this Environment Plan. • Responsible for providing adequate resources for environmental management. • Accountable for Operational Excellence. • Ensures the incident response strategy is implemented in the case of an incident. • Responsible for compliance with the BMS. • Maintains communication with company personnel, government agencies and the media, where appropriate.
Operations Manager	• Primary responsibility for offshore operations and for meeting environmental performance and compliance requirements, including provision of adequate operations resources for delivery of EP commitments. • Liaises with regulatory authorities as required. • Responsible for ensuring that audits and reviews of the Environment Plan are conducted.
Maintenance & Engineering Manager	• Responsible for coordinating all maintenance and integrity works and maintaining the technical integrity of the Stag Facility. • Manage HSE hazards and risks related to maintenance activities by ensuring procedures and risk reduction processes have been employed for all activities under their control. • Ensure that regular planned maintenance is carried out to meet the requirements embodied within the Computerised Maintenance Management System (CMMS). • Ensures maintenance personnel are competent in their respective tasks.
Supply Chain Manager	• Overall responsibility for implementation of the contractor management framework, including communication of EP requirements to contractors at the appropriate stages of contract management cycle.
Offshore Installation Manager (OIM)	• Responsible for day to day operations on the Stag Facility. • Ensures completion of routine performance reporting for the Stag Facility. • Responsibility for the implementation and compliance with the requirements of the Environment Plan and the Jadestone's HSE Policy at the facility. • Ensures that risk management processes are employed to manage HSE hazards and risks at the facility. • Communicates the importance of appropriate levels of training, competency and environmental awareness to all personnel. • Ensures the importance of appropriate levels of training, competency and environmental awareness are communicated to facility personnel and that the training matrix is fully implemented. • Ensures all personnel undertake appropriate Stag inductions and are aware of their HSE responsibilities. • Ensures sufficient resources are made available for offshore environmental management to meet the requirements of the Environment Plan. • Ensures all relevant HSE incidents are reported in accordance with internal incident reporting and investigation procedures.

Role	Key Responsibilities
	• Conducts regular workplace inspections. • Implements corrective and preventative actions arising environmental inspections, audits, incidents and hazard reports. • Overall responsibility for HSE and emergency response management at the Facility. • Ensure that adequate skills are maintained for effective incident response. • Ensure regular drills and exercises are conducted and all personnel actively participate. • Ensure Facility HSE meetings are conducted as required by the BMS. • Communicates HSE hazards and risks to the workforce and the importance of following good work practices.
Production Maintenance Supervisor (PMS)	• Manage HSE hazards and risks related to maintenance activities by ensuring procedures and risk reduction processes have been employed for all activities under their control. • Authorises work permits in accordance with BMS and PTW procedures. • Ensures persons appointed to roles in PTW have undergone the required training. • Identify risks associated with maintenance tasks and ensure control measures are established and implemented. • During an incident forms part of the Incident Response Team.
HSE Manager	• Ensures review of daily, weekly and monthly reporting, as applicable, from the CPF, third-party tanker and support vessels. • Ensures environmental department liaison with the OIM and third-party tanker operator to deliver compliance with all aspects of this EP. • Plans and schedules environmental compliance assurance activities (including audits) of the CPF, third-party tanker and support vessels. • Ensures regulatory documents are prepared and meet regulatory requirements. • Ensures emergency response plans are in place. • Develops and participates in oil spill response activities. • Ensures reporting of all relevant environmental incidents to NOPSEMA within the required timeframes. • Ensure environmental incident reporting meets regulatory requirements (as outlined in the EP) and AEL's internal incident reporting and investigation procedure. • Ensures that proposed changes to environmental management activities are subject to Management of Change and approved prior to application.
HSE Advisor	• Works with the HSE Manager and OIM to support environmental management and delivery of EP commitments. • Contributes to inspections, audits and reviews of the Environment Plan.
Tanker Operator	• Ensures completion of daily and monthly reporting from the third-party tanker. • Monitors daily activities on the third-party tanker to ensure that the relevant environmental legislative requirements, EP commitments and operational procedures are being followed. • Reports all incidents and potential hazards to the OIM to ensure required reporting timeframes are achieved. • Ensures the importance of appropriate levels of training, competency and environmental awareness are communicated amongst third-party tanker personnel.

Role	Key Responsibilities
	• Implements corrective and preventative actions arising environmental audits, incidents and hazard reports. • Communicates hazards and risks to the workforce and the importance of following good work practices. • Ensures third-party tanker personnel comply with environmental requirements. • Monitors the performance of the third-party tanker maintenance management system. • Conducts regular workplace inspections. • Maintains their vessel in a state of preparedness for emergency response. • Reports environmental incidents to OIM and ensures follow-up actions are carried out.
Facility personnel and contractors	• Adhere to work systems and procedures defined for the activities being undertaken. • Follow good housekeeping work practices. • Report HSE incidents, hazards or non-conformances to supervisors in a timely manner. • Identify HSE improvement opportunities wherever possible.

9.2.2 Communication of Responsibilities

The primary mechanism for ensuring personnel involved in the operation of the Stag facility are aware of the environmental commitments as listed in this EP are via: provision of environmental performance commitments lists via the CMMS; management of service providers and suppliers (refer to **Section 9.2.4** below); and online induction prior to attending the Stag facility.

Summary lists of environmental performance commitments as required by this EP are provided directly to key roles (refer **Section 9.2.2**) involved in activities associated with operation of the Stag Facility via the CMMS.

All personnel working at the Stag facility (including the third-party tanker) are required to complete an online induction that contains environmental components prior to arrival at the facility. Inductions are updated to account for site-specific factors or activities, or EP management improvements. Induction attendance records for all personnel are maintained. At a minimum, inductions include:

- The Jadestone HSE Policy;
- Description of the environmental sensitivities within the operational area and surrounding waters;
- Identification of environmental risks and mitigation measures;
- Permit to work;
- Procedures for reporting of any environmental incidents or hazards;
- Waste management requirements;
- Overview of incident response and spill management procedures, including roles and responsibilities;
- Roles and environmental responsibilities of key personnel aboard the survey vessel; and
- Direction on where to find copies of the EP and OPEP.

9.2.3 Competencies and Training

Jadestone Energy’s Contractor Management Framework [JS-90-PR-G-00002] provides a process for ensuring that Contractors and Services Providers have the appropriate level of HSE capability. The assessment of

Contractors and Service Providers competency provides a sound level of assurance that all key third-party personnel involved in Stag operations have the necessary skills, knowledge, experience, and ability to perform their work in accordance with their company's training and competency systems.

Contractors and service personnel are assessed against their company's criteria and any additional criteria required by Jadestone Energy. Records of competent people are maintained in Bassnet.

Competencies and training arrangements for personnel involved in oil pollution response are detailed in the OPEP and records maintained in Bassnet.

9.3 Monitoring, Auditing, Management of Non-conformance and Review

As required under subregulation 14(6), Jadestone must provide for sufficient monitoring, recording, audits, management of non-conformance and review of Jadestone's environmental performance and implementation strategy to ensure that environmental performance outcomes and standards in the EP are being met and continue to minimise impacts to the environment.

Environmental performance outcomes and standards as well as management controls as detailed in this EP (**Sections 7** and **8** and the **OPEP**) are monitored and recorded as described. Ongoing monitoring activities to determine if environmental commitments as required in this EP are being met include the CMMS, inspection program, auditing and exercising of response arrangements. In particular, routine commitments in the EP have been loaded into the CMMS that directs work activities for onshore and offshore personnel. Work activities include review of monitoring checklists, audits, inspections, maintenance and continuous improvement reviews, allowing environmental performance of the activity to be monitored. Non-conformances of EP commitments are reported, tracked and closed-out in accordance with **Section 9.3.2**.

The collection of data from environmental performance monitoring activities forms the basis of demonstration that the commitments as listed are being met, that specified mitigation measures are in place to manage environmental risks, and that they remain working, and contribute to continually reducing risks and impacts to ALARP and acceptable levels.

9.3.1 Routine Monitoring

The purpose of monitoring and inspections is to record performance data and routinely check conformance with environmental performance standards and achievement of environmental performance outcomes defined by the EP. Routine inspection activities are scheduled and records kept in Bassnet.

Emissions and discharges to the environment as a result of operations are monitored to assess the environmental performance of the Stag facility on an ongoing basis. **Table** 9-4 details the quantitative records that are maintained for all emissions and discharges during routine or emergencies within the Operational Area as per Regulation 14(7) of the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009*.

Table 9-4: Summary of routine monitoring

Measurement	Frequency	Monitoring Strategy	Record
CPF produced water [OIW] (in mg/L)	A minimum of 2 samples analysed every 24h for [OIW]	Manual sampling as outlined within *Measurement, management and reporting of produced water* (GA-19-PR-P-00007)	Bassnet Stag Laboratory Routine Analysis Data Sheet
CPF continuous OIW monitor calibration	Every 3 months	CPF continuous OIW monitor is calibrated every 3 months	Calibration report
CPF spectrophotometer calibration and OIW standards	Biannual	Independent chemist calibrates CPF spectrophotometer OIW measurement annually and checks OIW standards used during manual analysis as outlined in *Measurement, management and reporting of produced water* (GA-19-PR-P-00007)	Independent laboratory report
Characterisation of CPF PW finds contaminant concentrations (inc. NORMs) meet 99% species protection concentration after applying a dilution rate of 1:332	Biannual	Independent chemist samples produced water which is analysed by an independent laboratory for a detailed range of parameters.	Independent laboratory report
Volume of chemical used	Monthly	Volumes used determined from change in inventory	Monthly report
Production chemical concentration within production equipment	Monthly	Routine analysis of chemical concentrations within process equipment determines correct dosage of chemicals	Stag Laboratory Daily Result Sheet
Quantity (kms^3) Gas emissions	Continuous	Metering on the Stag CPF	P2 Greenhouse Gas reporting Stag CPF daily report

Measurement	Frequency	Monitoring Strategy	Record
Volumes of the following waste types are recorded: • General and putrescible waste • Hazardous waste • Timber/ wood • Recyclables • Cardboard/ paper • Scrap metal • Metal drums & containers • Batteries (lead acid) • Plastic drums and containers	Logged on Stag Facility when transferred via vessel to shore then to licensed waste facility. This is done approximately every two to four weeks (supply run).	CPF manifests Waste disposal log	Monthly waste reports generated from service provider (tied to invoicing) Waste Record Log Annual EP compliance report

9.3.2 Audits

An audit is a systematic examination and evaluation against defined criteria and performance indicators to determine whether activities/ processes and related results conform to planned arrangements, whether these arrangements are implemented effectively, and if they are suitable to achieve Jadestone's performance objectives and requirements.

Audits will be in accordance with Jadestone's Audit Manual (JS-90-PR-G-00003). Auditing is Jadestone management's primary tool for:

- Determining whether management systems are suitable, available where required, implemented and effective in accomplishing the documented policies and objectives of the organisation;
- Verifying conformance with legal and contractual requirements;
- Obtaining and maintaining confidence in the capability of suppliers; and
- Contributing to the improvement of the Business Management System (BMS).

Environmental audits provide assurance that the systems and processes in place to deliver the EP (i.e. the implementation strategy) are suitable and effective. The Jadestone Audit Manual (JS-90-PR-G-00003) describes the planning and conduct of audit activities. External parties may be invited to participate as team members on audits.

The annual review process for Jadestone occurs in the third quarter of the calendar year with the outcome being preparation of an Annual Plan (Annual and 120-day Planning Procedure GF-90-PR-G-00008). An important component of the Annual Plan is the audit program. As stated in the Audit Manual (JS-90-PR-G-00003), Jadestone's Annual Plan and audit program, including frequency and scope of audits, are developed to reflect the risk profile of Jadestone's activities for the forecasted period. As well as regular, planned audits of the management system including assessment of compliance against Environmental Performance Outcomes and Standards, extraordinary audits undertaken by the Country Manager and reactive audits (e.g. triggered by incidents or non-conformances) may also be added to the audit program in place at the time. Checklist templates (i.e. scopes) for environmental audits that may be undertaken are provided in the Audit Manual (JS-90-PR-G-00003), including for quality (in line with ISO 9001:2015 requirements) and the environmental management system (in line with ISO 14001:2015 requirements) which makes provision for deeper dives on the EP.

Along with monitoring, records, inspections and management of non-conformance, audit results are a key input to the quarterly review of environmental performance which considers the overall effectiveness of the EP implementation strategy / BMS (**Section 9.4.1**).

An outline of Jadestone's auditing schedule is provided in **Table 9-5**.

Table 9-5: Annual audit schedule

Type	Scope	Minimum per year
Planned	Compliance with EPOs and EPSs	Two
	Drill down on close-out of corrective actions and/or areas of compliance focus (e.g. produced water, oil spill response)	Two
	Contractor management	One
	Independent audit by third-party (Independent Competent Person, ICP)	One
Reactive	As determined by performance / non-compliances identified during internal/ external inspections, reviews, audits and incident investigations	Two

Jadestone's first audit program will be prepared before acceptance of the Jadestones's first EP and will then be updated annually. In addition, quarterly reviews of Jadestone's performance, including environmental performance are undertaken allowing continuous improvement to be achieved (Knowledge Management Guidelines GA-90-PR-G-00006). Part of the quarterly review process will include review of the audit program and the findings generated during the review period.

9.3.3 Non-compliances and Corrective Actions

Non-conformances from audits, inspections, regular monitoring or response testing are communicated immediately to the OIM and tracked and monitored by the Country Manager until closed.

Opportunities for improvement and corrective actions from reviews, audits, inspections, monitoring and testing activities are documented and tracked to closure by Bassnet.

9.3.4 Reporting

Table 9-6 details the approach to routine environmental performance reporting to the Regulator. Reporting activities relating to reportable and recordable incidents will be as per Regulations 26, 26A, 26AA and 26B.

9.4 Continuous Improvement (Operational Excellence)

9.4.1 Review of environmental performance

The owner of the Operational Excellence business function, with input from other business functions with responsibilities relating to the EP (e.g. operations, maintenance, supply chain), conducts an annual review of environmental performance and the effectiveness of the EP implementation strategy (i.e. BMS). This includes a review of the effectiveness of control measures in reducing impacts and risks to ALARP and acceptable levels, and may result in improvements being identified, evaluated and implemented.

The annual review process occurs in the third quarter of the calendar year with the preparation of an Annual Plan, as per Jadestone's Annual and 120-day Planning Procedure (GF-90-PR-G-00008). Once the Annual Plan has been established, quarterly reviews allowing continuous improvement to be achieved are undertaken as instructed by the Knowledge Management Guidelines (GA-90-PR-G-00006).

Outcomes of the Annual Performance Review are recorded and contribute to the EP Annual Performance Report (**Section 10.1**).

The review of environmental performance includes an assessment of:

- Review of compliance with environmental performance outcomes and performance standards, and adequacy of measurement criteria;
- Function of environmental management controls relevant to reportable and/or recordable incidents;
- Monitoring data and trends;
- Results of audits and incident investigations;
- Inspection and checklist approaches; and
- Adequacy of monitoring, inspections and audits.

The Annual Review is also an opportunity to ensure new information is incorporated into the EP and will consider the following:

- Existing information in relation to any component of the receiving environment described in this EP including, but not limited to, biologically important areas, KEFs, and threatened species;
- Available scientific literature;
- New issues raised by stakeholders;

- Relevance of existing and identification of new stakeholders; and
- Australian Marine Park status (including any changes in status) and relevant IUCN principles.

The results of the review and any identified improvements or recommendations will be incorporated into processes and procedures used to operate the Stag facility, or the EP, to facilitate continuous improvement in environmental performance.

In the event that new information (audits, inspections, reviews etc.) suggests risks and impacts are no longer reduced to acceptable levels, or controls are no longer effective in reducing the risks and impacts to ALARP and acceptable levels, then the process for identification of further controls through a risk assessment will follow that of the risk assessment methodology for this EP (refer **Section 4**).

Any opportunities for improvements identified through the risk assessment (i.e. new controls adopted) will be evaluated via a Management of Change process prior to the EP, procedures or processes being modified (**Section 9.5.6**).

Table 9-6: Summary of reporting requirements

Regulation	Requirement	Required Information	Timing	Type	Recipient
Before the Activity					
Regulation 29(1) & 30 - Notifications	NOPSEMA must be notified that the Activity is to commence.	Complete NOPSEMA's Regulation 29 Start or End of Activity Notification form for both notifications.	At least 10 days before the Activity commences	Written	NOPSEMA
During the Activity					
Regulation 16(c), 26 & 26A – Reportable Incident	NOPSEMA must be notified of any reportable incidents For the purposes of Regulation 16(c), a reportable incident is defined as: • An incident relating to the Activity that has caused, or has the potential to cause, moderate to significant environmental damage • Types of reportable incidents are described in **Table 10-1**.	The oral notification must contain: • All material facts and circumstances concerning the reportable incident known or by reasonable search or enquiry could be found out; • Any action taken to avoid or mitigate an adverse environmental impact due to the reportable incident; and • The corrective action that has been taken, or is proposed to be taken, to stop, control or remedy the reportable incident.	As soon as practicable, and in any case not later than 2 hours after the first occurrence of a reportable incident, or if the incident was not detected at the time of the first occurrence, at the time of becoming aware of the reportable incident	Verbal	NOPSEMA
		A written record of the verbal notification must be submitted. The written record is not required to include anything that was not included in the verbal notification	As soon as practicable after the verbal notification	Written	NOPSEMA

Regulation	Requirement	Required Information	Timing	Type	Recipient
		A written report must contain: • All material facts and circumstances concerning the reportable incident known or by reasonable search or enquiry could be found out; • Any action taken to avoid or mitigate adverse environmental impact due to the reportable incident; • The corrective action that has been taken, or is proposed to be taken, to stop, control or remedy the reportable incident; and • The action that has been taken, or is proposed to be taken, to prevent a similar incident occurring in the future.	Must be submitted as soon as practicable, and in any case not later than 3 days after the first occurrence of the reportable incident unless NOPSEMA specifies otherwise.	Written	NOPSEMA
Regulation 26B – Recordable Incidents	NOPSEMA must be notified of a breach of an EPO or EPS, in the environment plan that applies to the Activity that is not a reportable incident	Complete NOPSEMA's Recordable Environmental Incident Monthly Report form via submissions@nopsema.gov.au	The report must be submitted as soon as practicable after the end of the calendar month, and in any case, not later than 15 days after the end of the calendar month. If no recordable environmental incidents have occurred during a particular month, a Nil Incident report must be submitted	Written	NOPSEMA

Regulation	Requirement	Required Information	Timing	Type	Recipient
Regulation 14(2) Regulation 26C Environmental Performance	Regulation 14(2) requires that "*the titleholder report to the Regulator in relation to the titleholder's environmental performance for the activity, and provide that the interval between reports will not be more than one (1) year*". This is known as the Annual Report. Regulation 26(C) requires "*a titleholder undertaking an activity must submit a report to the Regulator in relation to the titleholder's environmental performance for the activity, at intervals provided for in the environment plan.*"	Annual reports will contain sufficient information to determine whether or not environmental performance outcomes and standards in the EP have been met. At a minimum, reports shall include: • An overview of the operations and activities undertaken at the Facility; • Summary of environmental incidents (recordable and reportable); • Summary of any Management of Change (MOC), if applicable; • Summary of audits; • An assessment of adherence to requirements of the EP, including the EPO and EPS; • Environmental performance (adequacy of environmental management tools against number of reportable and/or recordable incidents); • Continued relevance of performance objectives and performance standards; • Monitoring data and trends; • Any additional consultation required; • Lessons learnt. The annual report shall be submitted to satisfy the requirement of Regulation 26 (C).	The annual reporting period for the activity is 12 June to 11 June. Jadestone will submit annual performance reports within 3-months of the end of the reporting period.	Written	NOPSEMA
End of Activity					
Regulation 29(2) – Notifications	NOPSEMA must be notified that the Activity is completed	Complete NOPSEMA's Regulation 29 Start or End of Activity Notification form for both notifications	Within 10 days after finishing	Written	NOPSEMA

Regulation	Requirement	Required Information	Timing	Type	Recipient
Regulation 14 (2) & 26C – Environmental Performance	NOPSEMA must be notified of the environmental performance of the Activity	Report must contain sufficient information to determine whether or not environmental performance outcomes and standards in the EP have been met	Annual report submitted within 3 months after the anniversary of the reporting period, with the period commencing on the dated Regulation 29 notification form	Written	NOPSEMA
Regulation 25A Plan ends when titleholder notifies completion	NOSPEMA must be notified that the Activity has ended and all EP obligations have been completed	Notification advising NOPSEMA of end of the Activity	Within six months of the final Regulation 29 (2) notification	Written	NOPSEMA

9.4.2 Management of Change and Revisions of the Environment Plan

Regulation 17 of the *Offshore Petroleum Greenhouse Gas Storage (Environment) Regulations 2009* makes clear the following requirements in respect of a number of circumstances that may lead to the deviation of an activity from the EP, or a new activity requiring an EP.

17 Revision because of a change, or proposed change, of circumstances or operations	
New activity	
17(1)	A titleholder may, with the Regulator's approval, submit to the Regulator a proposed revision of an environment plan before the commencement of a new activity.
Significant modification or new stage of an activity	
17(5)	A titleholder must submit to the Regulator a proposed revision of the environment plan for an activity before the commencement of any significant modification or new stage of the activity that is not provided for in the environment plan as currently in force.
New or increased environmental impact or risk	
17(6)	A titleholder must submit a proposed revision of the environment plan for an activity before, or as soon as practicable after:
(a)	The occurrence of any significant new environmental impact or risk, or significant increase in an existing environmental impact or risk, not provided for in the environment plan in force for an activity; or
(b)	The occurrence of a series of new environmental impacts or risks, or a series of increases in existing environmental impacts or risks, which, taken together, amount to the occurrence of:
(i)	A significant new environmental impact or risk; or
(ii)	A significant increase in an existing environmental impact or risk;
	That is not provided for in the environment in force for the activity.

Jadestone's Management of Change process will determine whether a proposed change to activities triggers the requirements of Regulation 17, which may result in a revision and resubmission of an EP to NOPSEMA. This process is described in the Jadestone's Change Management Procedure (MoC) [JS-90-PR-G-00017]. The procedure describes a system for identifying, tracking, responding, progressing and closing out change requests or queries raised by any party involved in Jadestone Energy activities. It also directs and instructs activity owners on the environmental regulatory requirements relating to a change in operations. For granularity, the Appendix from the MoC procedure that provides guidance on assessment of proposed changes to the EP has been included as Appendix M.

The procedure provides for proper consideration of temporary or permanent changes to activities, including an impact and risk assessment, approved and communicated to all appropriate stakeholders together with providing a record of the change. In particular, the system ensures the following:

- All changes required to critical outputs will be identified, recorded, risk assessed and approved – internally and externally as required – before being implemented;
- Processes and procedures are in place to ensure requirements for change are identified and unauthorised changes are prevented;
- All changes must be assessed to determine if the change introduces a new risk or impact or increases an existing impact or risk, as required by Regulation 17;
- The MoC is prepared internally by Jadestone personnel which includes consultation with relevant parties as necessary such as technical/ subject matter experts and external stakeholders as required;

- Only authorised and competent members of the workforce can approve changes, including relevant Technical Authorities. Technical Authorities are deemed as authorised and competent via the Technical Authority Framework (GA-60-STD-Q-00001);
- Approval of a change internal to Jadestone requires confirmation that impacts and risks have been assessed and appropriate reduction measures implemented (if required) to manage risk to ALARP and impacts to acceptable levels;
- All approved changes that affect the Environment Plan are properly documented and communicated to all relevant internal and external members of the workforce, e.g. via toolbox talk or HSE meetings and JSA; and
- An audit trail is kept of all changes and documents and drawing are updated accordingly.

MOC must be designed to meet the particular requirements of the type of change required and will include:

- Risk assessment to assess potential impacts to the receiving environment as detailed in this EP, including matters of NES and those protected under the EPBC Act;
- Strategies and actions to mitigate any adverse effects; identify opportunities offered by the change; and determine how impacted interfaces shall be managed;
- Timeframes for implementation;
- Documents (e.g. drawing, plan, program, procedure) against which change is monitored;
- Outline drawings or controlled documents affected; and
- Responsibilities for execution, review and approval of the:
    - Justification for the change,
    - Assessment of the impact and risk to environment,
    - Detailed implementation requirements,
    - Dissemination of the change, training personnel and updating of documentation.

All alterations and updates to controlled documents, including regulatory approvals, procedures or drawings must be in accordance with Document Control requirements. If the change meets any of the criteria detailed above, a revision/resubmission of the EP will occur, and the proposed change to the activity will not commence until the revised EP has been accepted by NOPSEMA.

Maintenance work, which covers the replacement of parts or equipment with identical (or equivalent specification) parts or equipment, and with no change to operating arrangements, is not subject to change control.

9.4.3 Record Keeping

This section of the EP meets Regulation 27(2) by detailing a systematic, auditable record of the results of monitoring and auditing of the environmental performance of the Stag Operations. The records retained are linked to the performance outcomes, standards and measurement criteria, and monitoring and reporting requirements.

As a minimum, Jadestone will store and maintain the records for five years, where records include:

- Written reports including monitoring, audit and review regarding environmental performance or the business management system;
- Environmental performance reports and associated documentation;
- Documentation generated through stakeholder consultation;
- Records of emissions and discharges;
- Records of calibration and maintenance; and

- Reportable and recordable incident reports.

9.5 Incident Preparedness and Response

Under the Environment Regulations 14(8) the Implementation Strategy must contain an oil pollution emergency plan and provide for the updating of the plan containing adequate arrangements for responding to and monitoring oil pollution. These details are contained within the OPEP which is part of this EP and details incident response arrangements in the event of an oil spill and should be referred to for all details. Refer to Section 15 of the OPEP.

Incident response procedures and manuals are in place to describe how controls and consequences are mitigated. These documents are available on the Stag facility, vessels and are made accessible to all personnel. The relevant incident response procedures and manuals are detailed in the OPEP.

The incident response procedures and manuals are regularly updated with the revised contact details of relevant organisations and individuals included. They are also frequently tested to determine where they can be improved. The OPEP Appendix A details the schedule for testing the response preparedness of Jadestone.

10. REPORTING

10.1 Routine Reporting

Table 10-1 details the approach to routine environmental performance reporting to the regulator. Reports will be of sufficient detail to demonstrate whether specific environmental performance objectives and standards have been met.

10.2 Incident Reporting

Table 10-1 defines the differences between a reportable and recordable incident. It also defines reporting protocols for initial notification of a reportable incident, written reportable incident reporting and monthly recordable incident reporting. The Incident Reporting Procedure (JS-60-PR-F-00016) which incorporates reporting timeframes for incidents depending on their environmental impacts is provided to the Stag Facility and reviewed on an annual basis.

Table 10-1: Routine and incident reporting requirements

Requirements	Timing
Routine Reporting	
Annual Environmental Performance Report The Annual Performance Report for Stag Facility Operations will assess compliance with the EP performance objectives, standards and procedures and performance criteria and will include: • An overview of the operations and activities undertaken at the Facility; • Summary of environmental incidents; • Summary of any Management of Change (MOC), if applicable; • Summary of audits conducted.	Annual Performance report is to be submitted to NOPSEMA within 3 months of end of annual reporting period (12 June to 11 June). Therefore, the Annual Performance report is due by 11 September each year.
Annual Review of Environment Plan The review will include an assessment of: • Environmental performance (adequacy of environmental management tools against number of reportable and/or recordable incidents). • Continued relevance of performance objectives and performance standards. • Review of existing performance standards and measurement criteria (giving consideration to updated or new standards). • Inspection and checklist approaches. • Monitoring data and trends; • Any additional consultation required; • Lesson learnt; • Results of audits; and • Adequacy of auditing and monitoring	Annual review of the Environment Plan triggered by the annual environment performance report process. If the Environment Plan requires revision, then in accordance OPGGS Regulations, it will be resubmitted to NOPSEMA.

Requirements	Timing
Recordable Environmental Incident Monthly Report A written report will be provided to NOPSEMA of any breaches of a performance objective or performance standard identified in the EP, and is not classed as a reportable incident (refer above). The monthly report will include the following: • Circumstances and material facts concerning the incident; • Actions taken to avoid or mitigate any adverse environmental impacts; • Corrective action taken to prevent recurrence.	Not later than 15 days after the end of each calendar month.
Reportable Incidents: Notifications	
NOPSEMA NOPSEMA will be notified of reportable environmental incidents: i.e. any unplanned event identified as having caused, or having the potential to cause moderate to significant environmental damage. The following is a list of reportable environmental incidents that could occur: • Uncontrolled release of hazardous chemicals or hydrocarbons more than 80 litres to the marine environment. • Gaseous releases of more than 300kg (~255m^3 at Standard Ambient Temperature and Pressure) • Any unforeseen event that has caused or has the potential to cause an impact with moderate or greater environmental consequence as outlined within this EP.	Verbal report to NOPSEMA as soon as practicable but not later than two (2) hours of incident having been identified. As soon as practicable a written record of the verbal notification will be provided to NOPSEMA. Notifications to other regulators are described in Oil Spill Response Arrangements (GF-70-PLN-I-00001).
AMSA Oil pollution incidents in Commonwealth waters must be reported to AMSA.	Within 2 hours of incident having been identified: Tel: 1800-641-792
Department of Agriculture, Water and Environment (DAWE) DAWE will be notified of the following incidents: • Harm or mortality to Commonwealth EPBC Act Listed Marine Fauna (attributable to the operations activity). • Spills of hydrocarbons or environmentally hazardous chemicals more than 80 litres to the marine environment. • Any unplanned event identified as having caused, or having the potential to cause moderate to significant impact to a matter of NES.	Within 2 hours of incident having been identified: Tel: 1800-110-395 Tel: 02-6274-1372 compliance@environment.gov.au
Reportable Incidents: Written Reports	
NOPSEMA A written report of a reportable environmental incident will be provided to NOPSEMA and will contain: • Immediate action taken to prevent further environmental damage and contain the source of the release; • Arrangements for internal investigation; • All material facts and circumstances concerning the reportable incident that the operator knows or is able, by reasonable search or enquiry, to find out; • Immediate cause analysis; and • Corrective actions taken or proposed to prevent recurrence of similar incidents with responsible party and completion date.	Written report (Part 1) to NOPSEMA is required within three (3) days. Within 7 days of submitting the written report (Part 1) to NOPSEMA, a copy of the written report will be provided to NOPTA and DMIRS. Written report (Part 2) to NOPSEMA is required within 30 days.

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APPENDIX A – RELEVANT LEGISLATION

COMMONWEALTH LEGISLATION

Offshore Petroleum and Greenhouse Gas Storage Act 2006

The *OPGGSA 2006* (OPGGSA) entered into force in 2008, superseding and repealing the previous offshore petroleum legislation – the *Offshore Petroleum Act 2006* (OPA) and the *Petroleum (Submerged Lands) Act 1967* (PSLA).

Facilities located entirely in Commonwealth offshore waters are controlled by the Commonwealth OPGGSA and its regulations, including but not limited to the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (OPGGS (E) Regulations).

The Act, and its regulations, is currently administered by the Joint Authority, which consists of the Commonwealth Minister for Resources and Energy and the State Minister for Mines and Petroleum. The WA Minister for Mines and Petroleum acts as a Designated Authority and is advised by the DMIRS whilst the Commonwealth Minister for Resources is advised by the Commonwealth Department of Industry, Innovation and Science (DIIS).

Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS (E) Regulations)

Under the OPGGS (E) Regulations an EP is required for proposals under Commonwealth jurisdiction, comprising a description of the environmental effects and risks of the project, and proposed mitigation measures to reduce these risks.

The EP must be submitted to, and accepted by, the Designated Authority (DA). The DA for Commonwealth waters adjacent to Western Australian state waters and out to the Australian Exclusive Economic Zone (EEZ) at 200 nm is NOPSEMA, who administers the regulations.

Environment Protection (Sea Dumping) Act 1981

This Act relates to the waters surrounding Australia's coastlines are protected from wastes and pollution dumped at sea by the *Environment Protection (Sea Dumping) Act 1981* (the Sea Dumping Act). The Sea Dumping Act regulates the loading and dumping of waste at sea. The Act fulfils Australia's international obligations under the London Protocol to prevent marine pollution by dumping of wastes and other matter

Environment Protection and Biodiversity Conservation Act 1999

While the Environment Regulations under the OPGGS Act (see below) manage day to day petroleum activities and apply to any activity that may have an impact on the environment, the EPBC Act (Chapter 4) regulates assessment and approval of proposed actions that are likely to have a significant impact on a matter of National Environmental Significance (NES). Actions that are likely to have a significant impact on a matter of NES require approval by the Commonwealth Environment Minister; the assessment process is administered by the Department of the Environment and Energy. The EPBC Act does not replace the need for an Environment Plan to be approved under the OPGGS (Environment) Regulations before an action can proceed.

Schedule 8 of the EPBC Regulations outlines the Australian IUCN Reserve Management Principles. Jadestone shall have regard to these principles.Matters of “National Environmental Significance” are:

- World Heritage Properties;
- National Heritage Places;
- Wetlands of International Importance;
- Listed Threatened Species and Communities;
- Listed Migratory Species;
- Nuclear Actions;

- Australian Marine Parks; and
- Great Barrier Reef Marine Park.

Australian Maritime Safety Authority Act 1990

This Act specifies that the Australian Maritime Safety Authority's (AMSA) role includes protection of the marine environment from pollution from ships and other environmental damage caused by shipping. AMSA is responsible for administering the Marine Orders in Commonwealth waters.

Biosecurity Amendment (Ballast Water and Other Measures) Act 2017

The Biosecurity Amendment is designed to prevent the introduction, establishment, and/or spread within Australia, of human, animal or plant pests and diseases.

Underwater Cultural Heritage Act 2018

The Act gives clarity to the present and ongoing jurisdictional arrangements for protecting and managing Australia's underwater cultural heritage in line with the 2010 Australian Underwater Cultural Heritage Intergovernmental Agreement.

The Act ensures Australia's underwater cultural inheritance is protected for future generations. It is aligned with the UNESCO 2001 Convention, facilitating Australia to be part of the global community's response to illegal salvaging, looting and trafficking of underwater cultural heritage.

Maritime Legislation Amendment (Prevention of Air Pollution from Ships) Act 2007

This Act implements the requirements of MARPOL 73/78 Annex VI for shipping in Commonwealth waters.

National Greenhouse and Energy Reporting Act 2007

This Act establishes the legislative framework for the NGER Scheme which is a national framework for reporting greenhouse gas emissions, greenhouse gas projects and energy consumption and production by corporations in Australia. Several legislative instruments sit under the NGER Act, providing greater detail about corporations' obligations.

Navigation Act 2012

This Act requires that ships carrying oil and chemical tankers conform to relevant Regulations in Annex I of the MARPOL convention for the Prevention of Pollution from Ships. Marine Orders are a body of delegated legislation made pursuant to the Navigation Act 2012 and the Protection of the Sea (Prevention of Pollution from Ships) Act 1983.

Ozone Protection and Synthetic Greenhouse Gas Management Act 1989

This Act regulates the import, export and manufacture of ozone depleting substances such as firefighting equipment and refrigerants.

Protection of the Sea (Harmful Antifouling Systems) Act 2006

This Act relates to the protection of the sea from the effects of harmful anti-fouling systems. It prohibits the use of harmful organotins in ant-fouling paints used on ships.

Protection of the Sea (Prevention of Pollution from Ships) Act 1983

This Act gives effect to the International Convention for the Prevention of Pollution from Ships 1973/78 (MARPOL 73/78/97 and Annexes). It provides for penalties of up to AUD 10 million for not complying with the MARPOL. Marine Orders are a body of delegated legislation made pursuant to the Navigation Act 2012 and the Protection of the Sea (Prevention of Pollution from Ships) Act 1983.

INTERNATIONAL LEGISLATION

Convention on Biological Diversity (1992)

The objectives of the convention are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources.

Convention Converning the Protection of the World Cultural and Natural Heritage

The World Heritage Convention aims to promote cooperation among nations to protect heritage around the world that is of such outstanding universal value that its conservation is important for current and future generations.

United Nations Framework Convention on Climate Change (1992)

The objective of the convention is to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous interference with the climate system. Australia ratified the convention in December 1992 and it came into force on 21 December 1993.

International Convention on Oil Pollution Preparedness, Response and Co-operation (1990) and Protocol (2000)

This convention sets up a system of oil pollution contingency plans and cooperation in fighting oil spills.

Vienna Convention on the Protection of the Ozone Layer (1985) and the Montreal Protocol; on Substances that Deplete the Ozone Layer (1987)

The Convention (ratified by Australia in 1987) and the Protocol (ratified in 1989) concern the phasing out of ozone depleting substances.

United Nations Convention on the Law of the Sea (UNCLOS) (1982)

Part XII of the convention sets up a general legal framework for marine environment protection. The convention imposes obligations on State Parties to prevent, reduce and control marine pollution from the various major pollution sources, including pollution from land, from the atmosphere, from vessels and from dumping (Articles 207 to 212). Subsequent articles provide a regime for the enforcement of national marine pollution laws in the many different situations that can arise. Australia signed the agreement relating to the implementation of Part XI of the Convention in 1982, and UNCLOS in 1994.

Bilateral Agreements on the Protection of Migratory Birds

Australia has negotiated bilateral agreements with Japan (Japan-Australia Migratory Birds Agreement [JAMBA], 1974), China (China-Australia Migratory Birds Agreement [CAMBA], 1986) and the Republic of Korea (Republic of Korea – Australia Migratory Birds Agreement [ROKAMBA], 2007) to protect species of migratory birds with international ranges.

In November 2006, the East Asian-Australasian Flyway Partnership (Flyway Partnership) was launched in order to recognise and conserve migratory waterbirds in the East Asian – Australasian Flyway for the benefit of people and biodiversity.

Convention on the Conservation of Migratory Species of Wild Animals (CMS or Bonn Convention) (1979)

This Convention was concluded in 1979 and came into force on 1 November 1983. The Convention arose from a recommendation of the United Nations Conference on the Human Environment (Stockholm, 1972), and aims to conserve terrestrial, marine and avian species over the whole of their migratory range. It commits "Range States" to take action to conserve migratory species, especially those under threat. It is an umbrella agreement under which subsidiary regional agreements are established.

International Convention for the Protection of Pollution from Ships (1973) and Protocol (1978)

This Convention and Protocol (together known as MARPOL) build on earlier conventions in the same area. MARPOL is concerned with operational discharges of pollutants from ships. It contains five Annexes, dealing respectively with oil, noxious liquid substances, harmful packaged substances, sewage and garbage. Detailed rules are laid out as to the extent to which (if at all) such substances can be released in different sea areas. The legislation giving effect to MARPOL in Australia is the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, the Navigation Act 2012 and several Parts of Marine Orders made under this legislation.

London (Dumping) Convention (1972)

Dumping at sea is regulated by the convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter 1972 (the 'London Convention'). Article 4 provides a general prohibition on dumping of wastes except as specified in the Convention. The convention has annexed to it two lists of substances, the 'black list' of substances which may not be dumped at all, and the 'grey list' of substances which may only be dumped under a specific permit.

International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (1969) and Protocol (1973)

The convention gives States Parties powers to intervene on ships on the high seas when their coastlines are threatened by an oil spill from that ship.

International Convention on Civil Liability for Oil Pollution Damage (1969) and Protocol (1973)

The convention and the associated International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage 1971 set up a system of compulsory insurance and strict liability up to a certain figure for damages suffered as the result of an oil spill accident.

International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM) (2004)

The convention was adopted in 2004 and came into force in 2017. It concerns the prevention of the spread of harmful aquatic organisms from one region to another, by establishing standards and procedures for the management and control of ships’ ballast water and sediments.

International Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS)

The convention prohibits the use of harmful organotins in anti-fouling paints used on ships and establishes a mechanism to prevent the potential future use of other harmful substances in anti-fouling systems.

OTHER APPLICABLE STANDARDS, CODES AND GUIDELINES

Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2018

These guidelines provide a Water Quality Management Framework which includes limits for common contaminants and water quality parameters in marine and fresh water.

Australian Ballast Water Management Requirements (DAWR 2017)

These guidelines state the mandatory ballast water requirements and provide information on ballast pump tests, ballast water reporting and ballast water exchange calculations.

Interim Recovery Plan for the Threatened Migratory Shorebirds visiting Western Australia (2015)

This Wildlife Conservation Plan for Migratory Shorebirds provides a framework to guide the conservation of migratory shorebirds and their habitat in Australia and, in recognition of their migratory habits, outlines national activities to support their appreciation and conservation throughout the East Asian-Australasian Flyway (EAAF).

National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (2018)

A guidance document issued by the Marine Pest Sectoral Committee which provides generic approach to a biofouling risk assessment and practical information on managing biofouling on hulls and niche areas.

Safe Work Australia (SWA) Classifying Hazardous Chemicals – National Guide (2018)

Provides the mandatory criteria for determining whether a substance is hazardous based on its health effects, and optional criteria for determining whether a substance is hazardous based on its ecotoxicological and physicochemical properties.

APPENDIX B – RISK REGISTER

RISK IDENTIFICATION				RISK ASSESSMENT/MITIGATON							MONITORING
				Inherent Risk				Managed Risk			
Risk ID	Risk Prompt	Risk Description & Potential Cause(s)	Potential Impact upon Objective(s)/ Strategy	C (1-5)	L (1-5)	Risk	Risk Treatment Action/ Controls	C (1-5)	L (1-5)	Risk	Responsibility/ Risk Owner
EPP-01	Physical presence - topsides	Presence of the CPF and CALM buoy and FSO	Behavioural impact to marine fauna through habitatuation and use of infrastructure for roosting, loafing, feeding resting point	1	N/A	**N/A**	No controls identified. Deterrence of marine fauna not actively pursued	1	N/A	**N/A**	
EPP-02	Physical presence - vessel and helo operations, subsea infrastructure	Anchoring by support and supply vessels, and vessel movement. Landing and take off of helicopters. Presence of infrastructure at seabed	Localised physical damage to benthic habitats and associated biota. Disturbance to fauna due to vessel and helo operations.	2	N/A	**N/A**	Vessels involved in maintenance or repair activities requiring anchoring will refer to **Jadestone's Operational Requirements for Offshore Marine Vessels**, which provides guidelines for anchor handling and avoiding sensitive seabed features. Helicopter operations will be managed according to **Jadestone's Helicopter Operations Procedure**. No controls identified for presence of infrastructure at seabed as the structure is existing not proposed.	1	N/A	**N/A**	Dave Uden - prepare Operational Requirements for Offshore Marine Vessels Procedure; Helicopter Operations Procedure
EPP-03	Artificial light	Impact on individuals from artificial lighting.	Disorientation, attraction or repulsion.	1	N/A	**N/A**	No controls identified. Lighting managed to safety requirements	1	N/A	**N/A**	
EPP-04	Noise	Helicopters, vessels (FSO, offtake tankers, and support vessels), topside process and operational equipment.	Disturbance leading to behavioural changes of fauna including lift off and reland from the facility.	1	N/A	**N/A**	No controls identified. Noise managed to health requirements	1	N/A	**N/A**	
EPP-05	Atmospheric Emissions	process and operational equipment and machinery, production gas and flaring, venting.	Temporary and localised decrease in air quality. Global contribution to greenhouse effect.	1	N/A	**N/A**	All engines, compressors and machinery are maintained on a regular basis and tuned to optical efficiency as per the Maintenance Management System. Compliance with Marine Orders – Part 97 (Marine Pollution Prevention – Air Pollution), Navigation Act 1912 (Division 12D) and Protection of the Sea Act 1983 (Part IIID) (e.g. use of low sulphur marine diesel). Support vessels will hold current International air pollution prevention certificate (IAPPC) in accordance with MARPOL 73/78 Annex VI and Marine Orders – Part 97 (Marine Pollution Prevention – Air Pollution) Clean burning flare will combust approximately >95% of gas. Cold venting (15-20mins to remove oxygen from the system following level 4 shutdown) only occurs 5-6 times per year. Propane bottles are tested and weighed 3 monthly to ensure there are no leakages. Blanket gas is pumped over the crude during offloading to minimise any fugitive VOC emissions.	1	N/A	**N/A**	Helen Astill - confirm risk control details
EPP-06	Discharge of Produced Formation Water (PFW)	Water produced during the oil/water separation process (PFW) is discharged to the sea from the CPF and FSO.	localised reduction in water quality with dissolved and particulate contaminants.	2	N/A	**N/A**	**Chemical selection procedure; Monitoring of Oil in Water Procedure; Adaptive Management Plan for PFW.**	1	N/A	**N/A**	Helen Astill - Chemical Selection Procedure, Oil Water Procedure, Adaptive Management Plan for PFW

EPP-07	Discharge of waste streams	Sewage and sullage; putrescible waste; deck drainage, cooling water, brine.	Localised impact to marine waters.	2	N/A	**N/A**	**REFERENCE RELEVANT MARPOL SECTIONS**	1	N/A	**N/A**	Melissa Patt - cite relevant MARPOL sections for risk register
EPP-09	Interaction with other users - commercial and recreational fishing, shipping	Reduction of fishing areas by provision of the 500m exclusion zone; commute of supply and support vessels; presence of facility and assets	Loss of fishing area; inconvenience to fishing practices; potential impediment to expansion of nearby shipping lane.	1	N/A	N/A	As per the **Stakeholder Management Plan**, stakeholder consultation engages with relevant persons to advise on planned activities. The exclusion zone is as small as possible while meeting safety requirements **Operational Requirements for Offshore Marine Vessels**. AMSA and the Australian Hydrographic Service to reflect Stag operations in charts and shipping practices.	1	N/A	N/A	Dave Uden - prepare Operational Requirements for Offshore Marine Vessels Procedure; Helicopter Operations Procedure Ashley Crabbe - Stakeholder Management Plan
EPP-10	Hydrocarbon Spill Response	Poorly planned and coordinated response activities: monitoring and surveillance activities; application of chemical dispersants; poor deployment of response equipment and assets; shoreline cleanup; waste management; oiled wildlife.	Further pollution of the marine environment; further impact for fauna and flora and habitat; longer recovery times. Could result in preventable injury and death of fauna, and coastal and marine habitats.	5	N/A	**N/A**	**OPEP**	3	N/A	**N/A**	Mandy Walker - prepare OPEP
EPU-01	Physical presence - subsea infrastructure and operational activities	Unplanned disturbance to marine habitats and seabed due to movement in pipeline, anchor drag, dropped objects, ROV grounding. Vessel and helicopter operations.	Localised physical damage/ loss to benthic habitats and associated biota. Injury or death of individuals. Behavioural effects on marine fauna.	2	3	**M**	**Operational Requirements for Offshore Marine Vessels**, **Helicopter Operations Procedure**, which provide guidelines for anchor handling and avoiding sensitive seabed features. **Reference dropped object controls; ROV controls?**	2	2	**L**	Dave Uden - prepare Operational Requirements for Offshore Marine Vessels procedure
EPU-02	Physical presence - vessels	Biofouling, ballast water exchange	Introduction and establishment of marine pests	3	2	**M**	Supply and support vessels are sourced from the North West Shelf. Vessels will be required to adhere to quarantine and biofouling requirements if they have travelled from international waters, as defined in the **Operational Requirements for Offshore Marine Vessels**.	3	1	**L**	Dave Uden - prepare Operational Requirements for Offshore Marine Vessels procedure
EPU-03 (links to MO-02)	Interaction with other users	Commute of supply and support vessels; physical presence of the asset and facilities	Fishing gear snags or equipment damage. Navigational hazard and vessel collision resulting in an oil spill (XXL of hydrocarbon).	5	1	**M**	Stakeholder consultation, as per the **Stakeholder Management Plan**, advises relevant persons of planned activities in the area. Facility lighting meets workplace safety requirements and navigational safety requirements to satisfy AMSA Prevention of Collision Convention (Marine Order 30, Issue 7) and all vessels must adhere to the lighting management procedures as outlined in **Operational Requirements for Offshore Marine Vessels**. **OPEP**.	2	1	**L**	Dave Uden - prepare Operational Requirements for Offshore Marine Vessels procedure Ashlee Crabbe - prepare Stakeholder Engagement Plan Mandy Walker - prepare Oil Pollution Emergency Plan Dave Uden - calculate spill volume

EPU-04	Discharge of Solid Waste	Poor handling and storage of rubbish including-scrap metal, packaging, wood, cardboard, paper and empty containers.	Pollution of the marine environment resulting in injury or death to marine fauna individuals	2	4	**M**	**Waste Management Procedure**	2	3	**M**	Melissa Patt - prepare Waste Management Procedure
EPU-05	Chemical spills	Poor handling and storage of chemicals (up to XXL of chemical).	Localised impact to water quality that may result in injury or death to marine fauna individuals.	2	3	**M**	**Chemical Selection Procedure, Chemical Management Plan, Chemical Spill Plan**	2	2	**L**	Helen Astill - prepare Chemical Selection Procedure, Chemical Management Plan, Chemical Spill Plan Dave Uden - calculate spill volume
EPU-06	Hydrocarbon spills - operations	Handling and storage of hydrocarbons (XXL of MGO); overfilled tanks while offtake tanker being filled (xxL of Stag crude oil); transfer of diesel to CPF (XXL of MGO)	Impact to local marine waters; injury or death to marine fauna individuals	2	3	**M**	**Hydrocarbon storage and handling procedure; Offtake procedure**	2	2	**L**	Dave Uden - prepare hydrocarbon storage and handling procedure; offtake procedure Dave Uden - calculate spill volume
EPU-07 (links to MO-02)	Hydrocarbon spill - Vessel Collision	Rupture of fuel tank from vessel grounding or collision (XXXL of MGO; XXXL of Stag crude oil).	Impact to local marine waters; injury or death to marine fauna individuals	5	1	**M**	Stakeholder consultation, as per the **Stakeholder Management Plan**, advises relevant persons of planned activities in the area. Facility lighting meets workplace safety requirements and navigational safety requirements to satisfy AMSA Prevention of Collision Convention (Marine Order 30, Issue 7) and all vessels must adhere to the lighting management procedures as outlined in **Operational Requirements for Offshore Marine Vessels. OPEP**.	3	1	**L**	Mandy Walker - prepare Oil Pollution Emergency Plan Dave Uden - calculate spill volume; prepare Operational Requirements for Offshore Marine Vessels
EPU-08	Hydrocarbon spill - production	rupture or leak of subsea export pipeline (XXL of Stag crude oil); rupture or leak of floating import hose (XXL of Stag crude oil); rupture or leak of floating export hose (XXL of Stag crude oil)	Impact to local marine waters; injury or death to marine fauna individuals	3	3	**M**	**what procedures do we have to manage for the pipelines being shut in, and detection of leaks?**	2	2	**L**	Dave Uden - identify relevant shut in procedures for production; calculate spill volume

Risk Register Record 15th January 2021, Hamersley Boardroom, Perth WA. 9.30am-12pm

Attendees:

Helen Astill	**HSE Manager**
Leon Brown	**Acting Maintenance and Engineering Manager**
Kevin Grljusich	**Stag OIM**
Guy Hattersley	**Drilling Superintendent**
Owen Hobbs	**Country Manager AUS/NZ**
Jaya Kanniah	**Marine Operations**
Lucy Muir	**Approvals Consultant**
Melissa Patt	**Environment & Emergency Response Lead**
Robert Smith	**Operations Superintendent**
Andrew Woodhams	**Process Engineer**

EP Chapter	Consequence	Likelihood	Risk Ranking	Workshop notes 14/01/2021
Planned Events				
Light	1	N/a	N/a	No significant change due to removal of FSO. Less light emissions, consequence of negligible cannot be reduced any further, negligible impact remains
Noise	1	N/a	N/a	No significant change due to removal of FSO. Less noise emissions, consequence of negligible cannot be reduced any further, negligible impact remains

Atmospheric Emissions	1	N/a	N/a	No significant change due to removal of FSO. Less air emissions, consequence of negligible cannot be reduced any further, negligible impact remains
Discharge of Produced Water	1	N/a	N/a	No significant change due to removal of FSO. Consequence of negligible cannot be reduced any further due to less PW discharge as FSO removed from field, negligible impact remains
Discharge of liquid wastes	1	N/a	N/a	No significant change due to removal of FSO. Consequence of negligible cannot be reduced any further, due to less liquid waste discharge as FSO removed from field, negligible impact remains
Interaction with other users	1	N/a	N/a	No significant change due to removal of FSO. Consequence of negligible cannot be reduced any further, negligible impact remains
Interaction with fauna	1	N/a	N/a	No significant change due to removal of FSO. Consequence of negligible cannot be reduced any further, negligible impact remains
Physical footprint	1	N/a	N/a	No significant change due to removal of FSO. 500m zone still in place around infrastructure which the FSO was within when in field. Consequence of negligible cannot be reduced any further, negligible impact remains
Spill Response Activities	3	N/a	N/a	No significant change due to removal of FSO. Consequence does not change due to removal of FSO and the changes to spill scenarios as the spill response is similar to that in previous revision of the EP.
Unplanned Events				
IMS introduction	3	1	L	Consequence remains the same. With controls in place for the management of biofouling and ballast in accordance with JSE biosecurity manual, likelihood remains low for all vessels entering the field
Non-hazardous and hazardous solid waste	2	3	M	No change in the types of waste generated during normal operations that may be accidentally discharged, consequence and likelihood remain the same

Non-hydrocarbon hazardous liquids	2	2	L	No change in the types of liquids generated during normal operations that may be accidentally discharged, consequence and likelihood remain the same
Unplanned release of Stag crude oil	2	2	L	Reduction in volume, but the consequence and likelihood are unaltered as the potential impacts are still across a wide area and range of receptors and change in hydrocarbon exposure thresholds (low and moderate) compared to previous revisions of the EP
Unplanned release of diesel	3	1	L	Reduction in volume, but the consequence and likelihood are unaltered as the potential impacts are still across a wide area and range of receptors and change in hydrocarbon exposure thresholds (low and moderate) compared to previous revisions of EP
Dropped objects	2	2	L	No change in the types of objects that could be dropped, consequence and likelihood remain the same

APPENDIX C – EPBC MATTERS SEARCH REPORT

Australian Government
Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

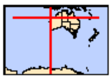
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 23/12/20 16:12:03

This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2015

Coordinates
Buffer: 0.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	1
National Heritage Places:	2
Wetlands of International Importance:	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	52
Listed Migratory Species:	89

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:	1
Commonwealth Heritage Places:	2
Listed Marine Species:	139
Whales and Other Cetaceans:	31
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	10

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	27
Regional Forest Agreements:	None
Invasive Species:	20
Nationally Important Wetlands:	2
Key Ecological Features (Marine)	7

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
Indigenous		
Dampier Archipelago (including Burrup Peninsula)	WA	Listed place

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Eighty-mile beach	Within Ramsar site

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

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 known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Malurus leucopterus edouardi White-winged Fairy-wren (Barrow Island), Barrow Island Black-and-white Fairy-wren [26194]	Vulnerable	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat likely to occur within area
Fish		
Milyeringa veritas Blind Gudgeon [66676]	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

Name	Status	Type of Presence
Bettongia lesueur Barrow and Boodie Islands subspecies Boodie, Burrowing Bettong (Barrow and Boodie Islands) [88021]	Vulnerable	Species or species habitat known to occur within area
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Isoodon auratus barrowensis Golden Bandicoot (Barrow Island) [66666]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes conspicillatus conspicillatus Spectacled Hare-wallaby (Barrow Island) [66661]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes hirsutus Central Australian subspecies Mala, Rufous Hare-Wallaby (Central Australia) [88019]	Endangered	Translocated population known to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Osphranter robustus isabellinus Barrow Island Wallaroo, Barrow Island Euro [89262]	Vulnerable	Species or species habitat likely to occur within area
Petrogale lateralis lateralis Black-flanked Rock-wallaby, Moororong, Black-footed Rock Wallaby [66647]	Endangered	Species or species habitat known to occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Ctenotus zastictus Hamelin Ctenotus [25570]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Lerista nevinae Nevin's Slider [85296]	Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Liasis olivaceus barroni Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Sharks		
Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Breeding known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna pacifica Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding likely to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sternula albifrons Little Tern [82849]		Breeding known to occur within area
Sula dactylatra Masked Booby [1021]		Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat likely to occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat known to occur within area
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat likely to occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Breeding known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
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		
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area

Name	Threatened	Type of Presence
Glareola maldivarum Oriental Pratincole [840]		Roosting known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting known to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Species or species habitat known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Thalasseus bergii Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Tringa totanus Common Redshank, Redshank [835]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Mermaid Reef - Rowley Shoals	WA	Listed place
Ningaloo Marine Area - Commonwealth Waters	WA	Listed place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
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 known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area

Name	Threatened	Type of Presence
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Roosting known to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Breeding known to occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Roosting known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Larus novaehollandiae Silver Gull [810]		Breeding known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting known to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding likely to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Species or species habitat known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		Breeding known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Sterna albifrons Little Tern [813]		Breeding known to occur within area
Sterna anaethetus Bridled Tern [814]		Breeding known to occur

Name	Threatened	Type of Presence
		within area
Sterna bengalensis Lesser Crested Tern [815]		Breeding known to occur within area
Sterna bergii Crested Tern [816]		Breeding known to occur within area
Sterna caspia Caspian Tern [59467]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sterna fuscata Sooty Tern [794]		Breeding known to occur within area
Sterna nereis Fairy Tern [796]		Breeding known to occur within area
Stiltia isabella Australian Pratincole [818]		Roosting known to occur within area
Sula dactylatra Masked Booby [1021]		Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Tringa totanus Common Redshank, Redshank [835]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area
Fish		
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area
Bhanotia fasciolata Corrugated Pipefish, Barbed Pipefish [66188]		Species or species habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish		Species or species

Name	Threatened	Type of Presence
[66189]		habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys latispinosus Muiron Island Pipefish [66196]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish [66717]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
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

Name	Threatened	Type of Presence
Trachyrhamphus longirostris		
Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon		
Dugong [28]		Breeding known to occur within area
Reptiles		
Acalyptophis peronii		
Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus apraefrontalis		
Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus duboisii		
Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii		
Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus laevis		
Olive Seasnake [1120]		Species or species habitat may occur within area
Aipysurus pooleorum		
Shark Bay Seasnake [66061]		Species or species habitat may occur within area
Aipysurus tenuis		
Brown-lined Seasnake [1121]		Species or species habitat may occur within area
Astrotia stokesii		
Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Breeding known to occur within area
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	Breeding known to occur within area
Hydrelaps darwiniensis		
Black-ringed Seasnake [1100]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Hydrophis czeblukovi Fine-spined Seasnake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis mcdowelli null [25926]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
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

Name	Status	Type of Presence
Indopacetus pacificus Longman's Beaked Whale [72]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon ginkgodens Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564]		Species or species habitat may occur within area
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 known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species

Name	Status	Type of Presence
		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
Argo-Rowley Terrace	Multiple Use Zone (IUCN VI)
Dampier	Habitat Protection Zone (IUCN IV)
Dampier	Multiple Use Zone (IUCN VI)
Dampier	National Park Zone (IUCN II)
Eighty Mile Beach	Multiple Use Zone (IUCN VI)
Gascoyne	Habitat Protection Zone (IUCN IV)
Gascoyne	Multiple Use Zone (IUCN VI)
Mermaid Reef	National Park Zone (IUCN II)
Montebello	Multiple Use Zone (IUCN VI)
Ningaloo	Recreational Use Zone (IUCN IV)

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Barrow Island	WA
Bedout Island	WA
Bessieres Island	WA
Boodie, Double Middle Islands	WA
Jarrkunpungu	WA
Kujungurru Warrarn	WA
Kujungurru Warrarn	WA
Lowendal Islands	WA
Montebello Islands	WA
Muiron Islands	WA
Murujuga	WA
North Sandy Island	WA
North Turtle Island	WA
Nyangumarta Warrarn	WA
Serrurier Island	WA
Unnamed WA36907	WA
Unnamed WA36909	WA
Unnamed WA36910	WA
Unnamed WA36913	WA
Unnamed WA36915	WA
Unnamed WA40828	WA
Unnamed WA40877	WA
Unnamed WA41080	WA
Unnamed WA44665	WA
Unnamed WA44667	WA
Unnamed WA44672	WA
Unnamed WA52366	WA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		

Name	Status	Type of Presence
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Mammals		
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Prosopis spp. Mesquite, Algaroba [68407]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area
Ramphotyphlops braminus Flowerpot Blind Snake, Brahminy Blind Snake, Cacing Besi [1258]		Species or species habitat likely to occur within area

Nationally Important Wetlands

[Resource Information]

Name	State
De Grey River	WA
Eighty Mile Beach System	WA

Key Ecological Features (Marine)

[Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Ancient coastline at 125 m depth contour	North-west
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
Mermaid Reef and Commonwealth waters	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

-17.977486 118.635826,-17.978315 118.638453,-18.119986 119.087479,-18.821949 119.490477,-19.304324 119.114604,-19.826297 119.416852,-19.943291 119.922537,-19.673305 120.856406,-19.751757 120.740737,-19.932596 120.257706,-20.054885 119.647414,-20.063466 119.103668,-20.120573 118.984694,-20.052033 118.934534,-20.011687 118.337671,-20.309664 118.081417,-20.397225 118.128644,-20.626843 117.871662,-20.674053 117.76805,-20.767648 117.380552,-20.634455 116.506745,-21.106031 115.656187,-21.203225 115.123378,-21.743197 114.544069,-21.660402 114.30382,-21.825993 113.91826,-22.124778 113.84851,-22.443361 113.511387,-23.456708 113.096765,-24.446657 112.298519,-25.137821 112.137708,-24.416059 112.164833,-23.674497 112.815829,-23.377513 112.831329,-23.456708 112.358582,-22.85554 112.594955,-22.794343 112.294644,-23.053529 111.84321,-22.83934 112.188083,-22.531556 111.978834,-22.27417 110.944215,-22.234572 111.205776,-22.500958 111.930397,-22.46136 112.327582,-22.041982 112.753829,-21.49715 112.684733,-21.714399 111.862584,-21.49661 112.013709,-20.618256 111.548711,-20.283473 111.723085,-20.15748 111.971084,-19.347522 112.408956,-19.599509 112.808079,-18.753553 112.808079,-18.775152 113.06189,-18.541164 113.43195,-18.062389 113.276951,-17.867999 113.712886,-18.290977 113.670261,-18.612213 113.911434,-18.452968 113.683824,-18.61316 113.745823,-18.641596 113.883569,-18.644813 113.899149,-18.793151 114.617693,-18.670757 114.916066,-18.308976 115.09044,-17.511617 114.854067,-18.03359 115.038128,-18.127185 115.450813,-17.864399 115.853811,-18.026391 116.969804,-17.482819 117.428989,-17.833801 117.26624,-18.049789 116.952367,-18.41517 117.210053,-18.361173 117.7603,-17.957994 118.574045,-17.535016 118.965418,-17.045441 119.628039,-17.420757 119.252709,-17.603412 118.973167,-17.977486 118.635826

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 – SUBSEA INTEGRITY AND MAINTENANCE ACTIVITIES

- Air Diving Operations
  - Tasks in accordance with the Subsea Inspection Procedure (GF-16-PR-U-00030)
    - Platform inspection, maintenance and repair
    - Platform marine growth cleaning
    - Platform debris removal
    - Platform splash zone corrosion protection installation
    - Pipeline and platform anode replacements
    - Riser/ Conductor inspection, maintenance and repair
    - Riser/ Conductor clamp repairs or replacement
    - Riser/ Conductor splash zone corrosion protection installation
    - Pipeline inspections, maintenance and repairs
    - Pipeline debris removal
    - Pipeline stabilisation and freespan reduction
    - Spool installation
    - Underbuoy hose change-outs
    - CALM Buoy and Mooring inspections, repair and maintenance
    - Valve operations
  - **Frequency**
    - Platform and diving frequencies are set 'as required' as per the Subsea Inspection Procedure (GF-16-PR-U-00030) and are based on findings during ROV Surveys and planned maintenance requirements.
    - The Underbuoy Hose Change Out is changed out at a minimum of every three (3) years as per the Oil Companies International Marine Forum (OCIMF) *Guidelines for the handling, storage, inspection and testing of hoses in field*. The OCIMF Guidelines state the service life can be extended based on an appropriate inspection, testing and maintenance program and historical evidence of hose performance.
  - **Vessels**
    - Air Diving Operations are to be supported by a suitable Diving Support Vessel (DSV) operating in DP mode or anchored in the field. DSV's will be in the range of 30 to 90m in size depending on the activity.
    - DSV's anchored will be supported by an Anchor Handling Vessel (AHV) or Supply Vessel
  - **Support**
    - In some instances, Rope Access will support diving operations
- **Saturation Diving**
  - Tasks in accordance with the Subsea Inspection Procedure (GF-16-PR-U-00030)
    - Platform inspection, maintenance and repair

- Platform marine growth cleaning
- Platform debris removal
- Pipeline and platform anode replacements
- Riser/ Conductor inspection, maintenance and repair
- Riser/ Conductor clamp repairs or replacement
- Pipeline inspections, maintenance and repairs
- Pipeline debris removal
- Pipeline stabilisation and freespan reduction
- Spool installation
- Underbuoy hose change-outs
- CALM Buoy Mooring inspections, repair and maintenance
- Valve operations

- **Frequency**
  - Platform and diving frequencies are set 'as required' as per the Subsea Inspection Procedure (GF-16-PR-U-00030) and are based on findings during ROV Surveys and planned maintenance requirements.
  - The Underbuoy Hose Change Out is changed out at a minimum of every three (3) years as per the Oil Companies International Marine Forum (OCIMF) *Guidelines for the handling, storage, inspection and testing of hoses in field*. The OCIMF Guidelines state the service life can be extended based on an appropriate inspection, testing and maintenance program and historical evidence of hose performance.
- **Vessels**
  - Saturation Diving Operations are to be supported by a suitable Diving Support Vessel (DSV) operating in DP mode or moored in a four-point mooring pattern. DSV's will be in the range of 50 to 90m in size depending on the activity.
- **ROV Operations**
- Tasks in accordance with the Subsea Inspection Procedure (GF-16-PR-U-00030)
  - Platform inspection, maintenance and repair
  - Platform marine growth cleaning
  - Platform debris removal
  - Riser/ Conductor inspection, maintenance and repair
  - Pipeline surveys
  - Pipeline debris removal
  - Pipeline stabilisation and freespan reduction
  - Platform site and pipeline route surveys
  - Pipeline and platform anode replacements
  - CALM Buoy and Mooring inspections, repair and maintenance
  - Platform and Pipeline post cyclone surveys

- **Frequency**
  - ROV survey frequency is set at every three (3) years as per the Subsea Inspection Procedure (GF-16-PR-U-00030) and annually in the event of a cyclone passing in the near vicinity.
- **Vessels**
  - ROV Operations will be conducted from a suitable vessel operating in DP mode or other. ROV support vessels will be in the range of 25 to 90m in size depending on the activity.

- **Rope Access Operations**
  - **Tasks**
    - Platform inspection, maintenance and repair
    - Platform marine growth cleaning
    - Riser/ Conductor inspection, maintenance and repair
    - Riser/ Conductor clamp repairs or replacement
    - Riser/ Conductor splash zone corrosion protection installation
  - **Vessels**
    - Standby vessel for rope access and overside operations.
- **Side Scan Sonar (SSS) and Autonomous Underwater Vehicle (AUV) Survey**
  - **Tasks**
    - Pipeline Surveys
    - Platform seabed surveys
    - Seabed Surveys
  - **Frequency**
    - SSS and AUV survey frequency is set at every three (3) years as per the Subsea Inspection Procedure (GF-16-PR-U-00030)
  - **Vessels**
    - SSS and AUV Operations will be conducted from a suitable vessel and generally are in the range of 25 to 50 m in size.

APPENDIX E – STAG FIELD STAKEHOLDER LOGAND CONSULTATION PLAN

Stakeholder	Stakeholder type	Engagement logistics	Engagement purpose	Stakeholder response	Jadestone response	Status and ongoing communications
Federal Government departments/ regulators						
Department of Defence (ADF Airspace, Australian Hydrographic Service (AHS) and Australian Navy)	Government	Consultation package, provided via email on November 29, 2016.	Ensure exclusion zone remains on existing nautical charts.	The AHS confirmed receipt of information and no comment was received. No comment received from other sections	N/A	Informed and updated
Department of Environment and Energy	Government	Consultation package, provided via email on November 29, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Department of Industry, Innovation and Science	Government	Consultation package, provided via email on November 29, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated

Stakeholder	Stakeholder type	Engagement logistics	Engagement purpose	Stakeholder response	Jadestone response	Status and ongoing communications
Federal Ministers						
Minister for Environment & Energy	Government	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Minister for Resources and Northern Australia	Government	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Minister for Industry, Innovation & Science	Government	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated

Stakeholder	Stakeholder type	Engagement logistics	Engagement purpose	Stakeholder response	Jadestone response	Status and ongoing communications
Federal Members of Parliament						
Member for Durack	Government	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
State Government departments * name at time of consultation						
WA Department of Mines and Petroleum	Government	Consultation package, provided via email on November 29, 2016.	Make aware of change of ownership and no change in risk profile	Responded with thanks November 30, 2016, requesting notification when EP accepted by the regulator and Jadestone is the operator of the asset.	No objection or concern has been raised by the Department in relation to operating activities. Jadestone notes the Department's request to be notified when EP accepted by NOPSEMA and action included in implementation section of EP to ensure this is done within three months of approval.	Informed and updated

Stakeholder	Stakeholder type	Engagement logistics	Engagement purpose	Stakeholder response	Jadestone response	Status and ongoing communications
WA Department of Fisheries	Government	Consultation package, provided via email on November 29, 2016.	Make aware of change of ownership and no change in risk profile	DoF acknowledged procedures and plans including Scientific Monitoring Plan would be Jadestone's responsibility, however DoF happy to provide advice during the development of these documents if desired. Request to remain in contact regarding the SMP. Previous advice from DoF regarding the Stag field would be referenced in this EP.	Key items raised by DoF in previous consultation regarding the Stag operational area are addressed as follows: • Biosecurity Section 8.1 • Commercial fisheries Section 5.9.1 • Pollution emergency plans and spill contingency plans DoF is listed as relevant person and will be advised of updates to the project, in addition to ongoing requests for advice.	Consulted and ongoing advice to be sought during development of plans.
Department Parks and Wildlife	Government	Consultation package, provided via email on November 29, 2016.	Make aware of change of ownership and no change in risk profile	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated

Stakeholder	Stakeholder type	Engagement logistics	Engagement purpose	Stakeholder response	Jadestone response	Status and ongoing communications
State Ministers						
Minister for Mines & Petroleum	Government agency/representative	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Minister for Fisheries	Government agency/representative	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Minister for Environment	Government agency/representative	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated

Stakeholder	Stakeholder type	Engagement logistics	Engagement purpose	Stakeholder response	Jadestone response	Status and ongoing communications
Minister for State Development; Transport	Government agency/representative	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Shadow Ministers						
Shadow Minister for State Development; Energy; Mines and Petroleum; Ports	Government agency/representative	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Member for Gosnells Shadow Minister for Environment	Government agency/representative	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated

Stakeholder	Stakeholder type	Engagement logistics	Engagement purpose	Stakeholder response	Jadestone response	Status and ongoing communications
State Members of Parliament						
Member for Pilbara	Government agency/representative	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Member for Mining and Pastoral	Government agency/representative	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Member for Mining and Pastoral	Government agency/representative	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not	Informed and updated

Stakeholder	Stakeholder type	Engagement logistics	Engagement purpose	Stakeholder response	Jadestone response	Status and ongoing communications
					expect a response to be provided.	
Member for Mining and Pastoral	Government agency/representative	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Member for Mining and Pastoral	Government agency/representative	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Member for Mining and Pastoral	Government agency/representative	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not	Informed and updated

Stakeholder	Stakeholder type	Engagement logistics	Engagement purpose	Stakeholder response	Jadestone response	Status and ongoing communications
					expect a response to be provided.	
Member for Mining and Pastoral	Government agency/representative	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Industry and other representative bodies						
Australian Fisheries Management Authority (AFMA)	Government agency/representative	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
BHP	Interested party	Consultation package, provided via email on November 29, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not	Informed and updated

Stakeholder	Stakeholder type	Engagement logistics	Engagement purpose	Stakeholder response	Jadestone response	Status and ongoing communications
					expect a response to be provided.	
Chevron	Interested party	Consultation package, provided via email on November 29, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Eni Australia	Interested party	Consultation package, provided via email on November 29, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Quadrant Energy	Interested party	Consultation package, provided via email on November 29, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not	Informed and updated

Stakeholder	Stakeholder type	Engagement logistics	Engagement purpose	Stakeholder response	Jadestone response	Status and ongoing communications
					expect a response to be provided.	
Vermillion	Interested party	Consultation package, provided via email on November 29, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Fishing bodies						
A Raptis and Sons	Potentially affected party - unplanned	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Austral Fisheries	Potentially affected party - unplanned	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not	Informed and updated

Stakeholder	Stakeholder type	Engagement logistics	Engagement purpose	Stakeholder response	Jadestone response	Status and ongoing communications
					expect a response to be provided.	
Australian South Bluefin Tuna Industry Association (ASBTIA)	Interested party	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Commonwealth Fisheries Association (CFA)	Interested party	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Marine Tourism WA	Interested party	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not	Informed and updated

Stakeholder	Stakeholder type	Engagement logistics	Engagement purpose	Stakeholder response	Jadestone response	Status and ongoing communications
					expect a response to be provided.	
MG Kailis Group	Potentially affected party - unplanned	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Ocean Wild Tuna	Potentially affected party - unplanned	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Pearl Producers Association	Potentially affected party - unplanned	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not	Informed and updated

Stakeholder	Stakeholder type	Engagement logistics	Engagement purpose	Stakeholder response	Jadestone response	Status and ongoing communications
					expect a response to be provided.	
Recfishwest	Interested party	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
W.A. Seafoods Direct	Potentially affected party - unplanned	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Western Australian Fishing Industry Council (WAFIC)	Interested party	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	WAFIC accepts 500m restricted zone around the facility for safety reasons, with additional cautionary zone as charted where vessels should 'avoid navigating, anchoring or fishing' however are	WAFIC will be advised to raise broader NWS feedback with regulatory agencies.	Consulted and updated

Stakeholder	Stakeholder type	Engagement logistics	Engagement purpose	Stakeholder response	Jadestone response	Status and ongoing communications
				not excluded from the area. WAFIC have a larger concern regarding exclusion of fishers from zones on the NWS.		
WestMore Seafoods & Shark Bay Seafoods	Potentially affected party - unplanned	Consultation package, provided via email on November 28, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Regional stakeholders						
Pilbara Port Authority	Government agency/representative	Consultation package, provided via email on November 29, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated

Stakeholder	Stakeholder type	Engagement logistics	Engagement purpose	Stakeholder response	Jadestone response	Status and ongoing communications
Dampier Port Authority	Government agency/representative	Consultation package, provided via email on November 29, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
City of Karratha	Interested parties	Consultation package, provided via email on November 29, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Karratha Chamber of Commerce and Industry	Interested parties	Consultation package, provided via email on November 29, 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated

Stakeholder	Stakeholder type	Engagement logistics	Engagement purpose	Stakeholder response	Jadestone response	Status and ongoing communications
Commercial Fisheries						
Mackerel Managed Fishery (State) (Representative individual licence holders)	Potentially affected parties - unplanned	Consultation package, provided via email on 6 Dec 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Pearl Oyster Fishery (State) (Representative individual licence holders)	Potentially affected parties - unplanned	Consultation package, provided via email on 6 Dec 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Onslow Prawn Managed Fishery (State) (Representative individual licence holders)	Potentially affected parties - unplanned	Consultation package, provided via email on 6 Dec 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated

Stakeholder	Stakeholder type	Engagement logistics	Engagement purpose	Stakeholder response	Jadestone response	Status and ongoing communications
Beche-de-mer Fishery (State) (Representative individual licence holders)	Potentially affected parties - unplanned	Consultation package, provided via email on 6 Dec 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Marine Aquarium Managed Fishery (State) (Representative individual licence holders)	Potentially affected parties - unplanned	Consultation package, provided via email on 6 Dec 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Specimen Shell Managed Fishery (State) (Representative individual licence holders)	Potentially affected parties - unplanned	Consultation package, provided via email on 6 Dec 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated

Stakeholder	Stakeholder type	Engagement logistics	Engagement purpose	Stakeholder response	Jadestone response	Status and ongoing communications
Pilbara Trawl Managed Fishery (State) (Representative individual licence holders)	Potentially affected parties - unplanned	Consultation package, provided via email on 6 Dec 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Pilbara Trap Managed Fishery (State) (Representative individual licence holders)	Potentially affected parties - unplanned	Consultation package, provided via email on 6 Dec 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Pilbara Line Fishery (State) (Representative individual licence holders)	Potentially affected parties - unplanned	Consultation package, provided via email on 6 Dec 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated

Stakeholder	Stakeholder type	Engagement logistics	Engagement purpose	Stakeholder response	Jadestone response	Status and ongoing communications
Pilbara Developing Crab Fishery (State) (Representative individual licence holders)	Potentially affected parties - unplanned	Consultation package, provided via email on 6 Dec 2016.	Make aware of change of ownership and no change in risk profile.	No objection or concern has been raised in relation to operating activities.	This stakeholder has not provided a response to consultation and given the nature of the facility, on assessment Jadestone does not expect a response to be provided.	Informed and updated
Oil spill response						
Western Australian Department of Transport	Response organisation	Meeting on 27 February 2017. Draft OPEP provided for comment 27 February 2017. Consultation package provided via email on November 29, 2016. Further update to change in spill scenarios provided 7 Jan 2021	Establish response arrangements	DoT noted separate IMT arrangements for cross jurisdiction spills. DoT requested OPEP for review,	Jadestone will continue to work with DoT regarding spill response arrangements, as outlined in the activity OPEP. JSE to provide OPEP upon submission of document to NOPSEMA for DoT to review.	Formal collaborative relationship established
Australian Maritime Safety Authority (AMSA)	Response organisation	AMOSC were provided a draft copy of the Stag Facility OPEP by email on 22 November, 2016. Consultation package provided via email on November 29, 2016.	To establish MOU for response arrangements	Noted Stag Facilities long history in the area. Noted 3 nm cautionary zone and shipping fairway 5.7km to the South of the facility, which is predominantly	Shipping traffic advice from AMSA is noted and referenced in Section 5.9.4. MOU in place with AMSA outlining access arrangements	Formal collaborative relationship established

Stakeholder	Stakeholder type	Engagement logistics	Engagement purpose	Stakeholder response	Jadestone response	Status and ongoing communications
		AMOSC MoU application process underway; awaiting finalisation by AMOSC upon transfer of title to Jadestone. Master Services Agreement in place with AMOSC as primary responder for oil pollution events as an interim measure prior to Jadestone holding AMOSC membership. Jadestone discussed proposed changes from FSO to oil tanker with AMSA in July 2020.		support vessel traffic for the oil and gas industry. Arrangements need to be in place regarding access to national plan resources including chemical dispersants and the FWADC.	to national plan resources.	
Australian Marine Oil Spill Centre (AMOSC)	Response organisation	Enquiries regarding FWADC capabilities made by email during preparation of the OPEP. Consultation package, including introduction to Jadestone Energy, provided via email on November 29, 2016. AMSA MoU application process underway;	To gain AMOSC membership and set up MOU	No objection or concern has been raised by AMOSC in relation to operating activities. AMOSC advised they are able to support the response requirements identified for the activity however membership will not be finalised until first board meeting of 2017. Noted requirement for	MOU now in place with AMOSC. No additional comments from AMOSC provided	Formal collaborative relationship established

Stakeholder	Stakeholder type	Engagement logistics	Engagement purpose	Stakeholder response	Jadestone response	Status and ongoing communications
		awaiting finalisation by AMSA. [now finalised] Further update to change in spill scenarios provided 7 Jan 2021		Jadestone to have a service arrangement with AMOSC as an interim measure.		
Department of Agriculture, Water and the Environment (DAWE) – Biosecurity (marine pests)	Government agency/representative	Email issued 7 Jan 2021 informing of change in use of FSO	Inform of changes to third party vessel and inform of biosecurity management	No response to date	Stakeholder has not yet provided a response, Jadestone expects a response to the proposed change in operations to be received and will remain in correspondence with DAWE.	JSE will continue to work with DAWE regarding biosecurity management of vessels entering the operational area.

Appendix F – Analyte list for biannual characterisation of produced water

Contaminant group	Analyte	Units
Hydrocarbons	Oil in water	mg/L
	Oil and grease	mg/L
	Total petroleum hydrocarbons	mg/L
Aromatic hydrocarbons	Benzene	mg/L
	Toluene	mg/L
	Ethylbenzene	mg/L
	Xylene	mg/L
	Total PAHs	mg/L
	Naphthalene	mg/L
	Phenanthrene	mg/L
	C_6–C_9	mg/L
	C_{10}–C_{14}	mg/L
	C_{15}–C_{28}	mg/L
	C_{29}–C_{36}	mg/L
	$>C_{36}$	mg/L
Trace metals	Arsenic	mg/L
	Barium	mg/L
	Cadmium	mg/L
	Chromium	mg/L
	Hexavalent Chromium	mg/L
	Copper	mg/L
	Iron	mg/L
	Lead	mg/L
	Manganese	mg/L
	Mercury	mg/L
	Nickel	mg/L
	Silver	mg/L
	Strontium	mg/L
	Zinc	mg/L
Nutrients	Total Organic Carbon	mg/L
	Ammonia	mg/L
	Nitrate	mg/L
	Total Kjeldahl Nitrogen	mg/L

Contaminant group	Analyte	Units
	Total Nitrogen	mg/L
	Tertiary Amines	mg/L
	Total Phosphorous	mg/L
	Total Dissolved Solids	mg/L
	Total Suspended Solids	mg/L
	Chemical Oxygen Demand	mg/L
Naturally occurring radioactive material	Ra^{226}, Ra^{228}	Bq/L
PSD		µm

APPENDIX G – STAG CRUDE OIL ASSAY (INTERTEK, 2008)

Sample ID	2063		1	Cut Points					
Crude ID	STAG CPF EXPORT			2	3	4	5	6	7
Client ID	APACHE ENERGY LIMITED		Whole	LPG	IBP - 230C	230 - 360C	360 - 540C	360C +	540C +
Date	19 September 2008								
Test	Method	Unit							
Mass Yield	D2892/D5236	%mass		Nil	4.9	48.2	36.4	47.0	10.8
Volume Yield		%volume		Nil	5.2	49.4	35.4	45.4	10.0
Density @15°C	D5002/D4052	kg/L	0.9428		0.8788	0.9175	0.9670	0.9754	0.9937
Specific Gravity @60/60°F		-	0.9433		0.8793	0.9180	0.9676	0.9760	0.9943
API Gravity		API	18.5		29.4	22.6	14.7	13.5	10.8
Aniline Point	D611	°C			519	54.5	62.3	68.8	
Aniline Gravity Product	Calc	-			3685	2940	2119	2103	
Arsenic	ICPMS	mg/kg	2.3						
Ash	D482	%mass	0.0004					0.0070	
Asphaltenes	IP143	%mass	0.14					0.40	
Carbon Residue - Micro	D4530	%mass	105					2.48	
Cetane Index - Procedure A	D4737	-				33.2			
Cetane Index - Procedure B	D4737	-				33.0			
Characterisation Factor	UOP375	-	113					115	
Cloud Point	D2500	°C				<-45.0			
Colour - ASTM	D1500	-				L0.5			
Copper Corrosion (3hrs @ 50C)	D130	-				1A			
FIA - Aromatics	D1319	%volume			18				
Flash Point	D93	°C	1110						
Freeze Point	D5972	°C			<-70.0				
Heat of Combustion - Gross	D4868	MJ/kg	43.98					43.5	
Heat of Combustion - Net	D4868	MJ/kg	4148					411	
Hydrocarbon - Mono-Aromatics	IP391	%mass				23.4			
Hydrocarbon - Di-Aromatics	IP391	%mass				4.8			
Hydrocarbon - Polycyclic-Aromatics	IP391	%mass				5.0			
Kinematic Viscosity @-20°C	D445	cSt			1132				
Kinematic Viscosity @20°C	D445	cSt	122.5		3.476				
Kinematic Viscosity @40°C	D445	cSt	37.26		2.282	7.342			
Kinematic Viscosity @50°C	D445	cSt					200.2	675.2	
Kinematic Viscosity @100°C	D445	cSt					14.69	33.54	
Mercury Content	UOP938	wt ppb	<1						
Metal - Nickel	ICP-OES	wt ppm	4.0					7.2	314
Metal - Vanadium	ICP-OES	wt ppm	<10					<1	<1
Nitrogen - Basic	UOP269	wt ppm	299					158	
Nitrogen - Total	D4629	wt ppm	516				830	1284	3421
PIONA (Benzene)	D6730	%volume			NA				
Pour Point	D5950/D5853	°C	-33			<-39.0	-3.0	0.0	48.0
Reid Vapour Pressure	D323	kPa	<1						
Reid Vapour Pressure	D323	psi	<0.15						
Sediment by Extraction	D4737	%wt	<0.01						
Smoke Point	D1322	mm			16.5				
Sulphur - Mercaptan	D3227	wt ppm							
Sulphur - Total	IP336	%mass	0.14		<0.030	0.057	0.20	0.22	0.31
Total Acid Number	D664	mg KOH/g	0.50			0.08	0.80	0.9	
Water Content	D4006	%volume	0.150						
Wax Content	UOP46	%mass	<5						

APPENDIX H – HYDROCARBON THRESHOLDS

Hydrocarbon thresholds

Hydrocarbon impact pathways and thresholds

The modelling method described is able to track hydrocarbon concentrations of floating oil, entrained oil and dissolved aromatic hydrocarbons below biologically significant impact levels. Consequently, threshold concentrations are specified for the model to control what contact is recorded for surface (floating oil) and subsurface locations (entrained oil and dissolved aromatic hydrocarbons) to ensure that recorded contacts are for biologically meaningful concentrations.

The determination of biologically meaningful impact levels is complex since the degree of impact will depend on the sensitivity of the biota contacted, the duration of the contact (exposure) and the toxicity of the hydrocarbon mixture making the contact. The toxicity of a hydrocarbon will change over time, due to weathering processes altering the composition of the hydrocarbon. To ensure conservatism in the environmental impact assessment process, the threshold concentrations applied to the model are selected to adopt the most sensitive receptors that may be exposed, the longest likely exposure times and the more toxic hydrocarbons.

Impact pathways and impact threshold concentrations are detailed below for surface (floating) oil, entrained oil and dissolved aromatic hydrocarbons (DAHs).

Surface (floating) oil

The impact threshold concentration for exposure to surface (floating) oil is derived from levels likely to cause adverse impacts to marine/ coastal fauna and habitats. Marine/ coastal fauna, habitats and socio-economic receptors may be impacted by floating oil in the following way:

- Marine mammals, reptiles and birds can be exposed to oil when at the water surface. For marine mammals and reptiles this can occur when surfacing within a slick to breathe while for birds this includes contact from diving into a slick or floating on the sea surface while feeding or resting. For marine fauna surfacing in floating oil contact to sensitive areas may occur (e.g. eyes, mouth and respiratory system) creating irritation and potentially cell damage. Volatile compounds evaporating form surface oil may be inhaled by marine mammals and reptiles, particularly when the oil is fresh and relatively unweathered. Inhalation of these compounds may cause damage to internal respiratory structures. It is generally considered that marine mammals with smooth skin (e.g. cetaceans) are less susceptible to coating of oil than those covered with hair given hair has a greater potential to trap and retain oil causing longer exposure times. Birds are particularly susceptible to impact from floating oil in that feathers retain oil, particularly when the oil is 'sticky' (e.g. heavy crudes). The coating of oil on birds may hinder flight and feeding, reduce the ability of the bird to thermoregulate (control body temperature) and irritate/damage sensitive surfaces such as eyes, ears and nasal structures. Secondary impacts can occur through the ingestion of oil as birds attempt to preen contaminated feathers. Ingestion may lead to oil absorption and further toxic impacts;
- Surface oil can coat emergent habitats such as coral or rocky reefs and intertidal and shoreline areas around islands or along coastlines. Habitats that can be affected include rocky shorelines, sandy beaches, mangrove communities and intertidal areas which may support seagrass, algae and coral reef communities. The physical coating of mangroves, in particular their root system, can prevent gas exchange and/or cause toxicity at the cellular level. Mangrove response to oil contact includes deforestation, yellowing of leaves and mortality. Other chronic responses include reduced growth, reduced reproductive output and success and genetic mutation. Intertidal areas may be contacted at low tides where emergent habitat is coated by oil. Seagrass, algae and sessile fauna such as hard corals, soft corals and sponges may be smothered as well as small low mobility fauna that live in close association with these and other benthic habitats or within/on sediments. Smothering of intertidal photosynthetic organisms such as seagrass, algae and hard coral may reduce their capacity for photosynthesis (energy production) or lead to a

toxic response at the cellular level. For seagrass and algae this could lead to plant death, shedding of leaves/thalli, reduced growth, reduced reproductive output/success and genetic mutation. Similarly, for hard corals, bleaching, colony death, reduced growth and reduced reproductive capacity may occur. Such impacts may be exacerbated if these organisms are already under stress from marginal environmental conditions or if impacts occur during critical life-history stages (e.g. spawning periods). Small fauna smothered by oil may be hindered in their ability to move and feed or may suffer a toxic response from mortality to reduced growth rate or reproductive success. The coating of habitats can lead to secondary impacts to marine/coastal fauna. For example, marine turtles and shorebirds may be contacted by oil when using nesting beaches or when roosting/feeding along shorelines, respectively. Marine/coastal fauna may also ingest oil when feeding on coated habitats, e.g. dugongs or turtles ingesting coated seagrass/algae and shorebirds ingesting coated intertidal organisms such as molluscs and crabs; and

- Surface oil may impact on socio-economic receptors such as the oil and gas industry, commercial shipping, fisheries/aquaculture and tourism. The presence of floating oil may pose a human health risk from volatile compounds depending on the nature and freshness of the oil (i.e. fresh light oils and condensates posing the greatest risk) while oil spill response activities targeting floating oil may preclude or disrupt activities by other users in the area both offshore and at oil affected shorelines. This could have an economic impact on affected industries. In addition, floating and stranded oil may be highly visible to the general public and have a resultant negative effect on tourism in affected areas. Real or perceived deterioration of nearshore and coastal habitats may also have long lasting effect on the tourism value of an area and of fisheries activities that may rely on those areas to support healthy fish stocks.

There is a paucity of data on floating oil concentrations with respect to impacts to marine organisms. The impact of floating oil on birds is better understood than other receptors. Estimates for the minimum oil thickness that will harm seabirds (through ingestion from preening of contaminated feathers or loss of thermal protection of their feathers) range from at 10 g/m_2 (O'Hara and Morandin, 2010) to 25 g/m^2 (Koops *et al.*, 2004). A conservative threshold of 10 g/m^2 has been applied to impacts from floating diesel and crude oil. This hydrocarbon threshold is also considered appropriate for turtles, sea snakes and marine mammals (NRDAMCME, 1997) and has also been applied herein to determine impacts of surface oils to emergent habitat such as coral reefs.

A 1g/m^2 threshold was also modelled which may appear as a rainbow sheen and may be indicative of socio-economic impacts.

Entrained oil

Entrained oil is oil that is dispersed within the water column as oil droplets. For oil spills released at surface, entrained oil is created in the top few meters of the water column through mixing of surface oil by wave action. For oil spills released subsea (e.g. pipelines leaks, well blowouts) entrained oil may be distributed deeper within the water column.

The concentrations of entrained droplets output by SIMAP represent hydrocarbons that are not bioavailable. The soluble and semi-soluble fractions dissolve from the droplets over time, and a potential effects analysis based on the dissolved hydrocarbons characterizes their risk.

Because PAHs are the most toxic components of oil and crude oils typically contain about 1% PAHs by mass (French-McCay 2002; Forth et al. 2017), the sublethal concentration threshold (PNEC) expressed as total hydrocarbon concentration (THC, not TPH) based on the most toxic components would be ~100 µg/L (100 ppb) for fresh oil. However, as oil weathers, PAHs are lost to volatilization and degradation. Thus, the whole-oil threshold of 100 ppb is appropriate for fresh oil and conservative (highly protective of aquatic resources) for weathered oil. An exposure concentration of 1,000 ppb (1 ppm or 1 mg/L) of (total) oil hydrocarbons was deemed a low level of concern for sensitive life stages in marine organisms by Kraly et al. (2001). The 1 mg/L concentration is at the low end of the range where sub-lethal impacts from acute exposure have been observed (NRC, 2005). Based on the review of toxicity studies by Bejarano et al. (2017), a THC lethal threshold of 3–28 mg/L (or 3–30 mg/L with rounding, given uncertainties) would be appropriate for a range of oils and states of weathering for species from all geographical areas globally.

Based on this information, a contact threshold of 100 ppb was considered a conservative contact threshold for the assessment of impacts from entrained oil.

Dissolved Aromatic Hydrocarbons

Dissolved hydrocarbons are taken up into organisms directly through external surfaces and gills, as well as through the digestive tract. Thus, soluble and semi-soluble hydrocarbons are bioavailable, whereas insoluble compounds in oil are not bioavailable to aquatic organisms. Laboratory studies have shown that the dissolved hydrocarbons exert the most effects on aquatic biota (Carls et al. 2008; Nordtug et al. 2011; Redman 2015). The volatilization rates of hydrocarbons from surface slicks are faster than the dissolution rates. Thus, dissolution from oil droplets in the water column is the main source of concentrations dissolved in the water.

The most toxic components of oil to water-column and benthic organisms are lower-molecular-weight compounds, which are both volatile and soluble in water (generally in the water accommodated fraction – WAF). The polynuclear aromatic hydrocarbons (PAHs) exert the most toxic effects because they are semi-soluble and not highly volatile, so they persist in the environment long enough for significant exposure to occur (Anderson et al., 1974, 1987; Neff and Anderson, 1981; Malins and Hodgins, 1981; McAuliffe, 1987; NRC 2003, 2005). The monoaromatic hydrocarbons (MAHs), including BTEX (benzene, toluene, ethylbenzene, and xylenes), and the soluble alkanes also contribute to toxicity, but these compounds are highly volatile, so exposures of aquatic biota are minimal or negligible except when light oils are discharged at depth where volatilization does not occur (French-McCay 2002).

French McCay (2018) provides an outline of the measured total PAH concentrations within the water accommodated fraction of medium crude oils as being 74.9 to 282 μ/l.

Within the soluble and semi-soluble hydrocarbons, toxicity is inversely related to solubility, typically quantified by the octanol-water partition coefficient (Kow), a measure of hydrophobicity (Nirmalakhandan and Speece 1988; Hodson et al. 1988; Blum and Speece 1990; McCarty 1986; McCarty et al. 1992a, b; Mackay et al. 1992; McCarty and Mackay 1993; Verhaar et al. 1992, 1999; Swartz et al. 1995; French-McCay 2002; McGrath et al 2009).

Due to the toxic nature of MAHs and low molecular weight PAHs, and the ability for these to be transferred across cellular structures, DAHs contribute to the acute toxicity of an oil. The proportion of BTEX, and other DAHs that are readily dissolved or evaporated, diminish over time. DAH concentration is therefore higher around fresh oil than weathered oil. The toxicity of DAHs to an organism is dependent on both the concentration of the oil and the amount of time an organism is exposed to a given concentration.

The range of LC50s varies from ~10 mg/L (ppb) for 3-ring PAHs (which are semi-soluble) to ~10-100 mg/L (ppm) for the highly soluble BTEX compounds (French-McCay 2002). Thus, the toxicity of an oil hydrocarbon mixture is strongly related to the chemical composition, which varies as the oil weathers since the soluble and semi-soluble hydrocarbons are all volatile to varying degree. Aurand and Coelho (2005) suggest that, based on the wide variation of toxicity data, a threshold of 1,000 ppb will represent a reasonable level for protection of more sensitive life stages of organisms residing in the water column.

For most oil spills, exposures of water column biota to concentrations above potential thresholds of concern are typically on time scales of minutes to hours, even for spills lasting weeks or months because of the varying movements of the oil in the water, dilution and losses to biodegradation and volatilization. Furthermore, the concentrations vary in time over the short exposure periods (McAuliffe et al. 1980, 1981; McAuliffe 1987; Lunel 1994; French McCay 2002, 2004; Bejarano et al. 2014). Thus, the use of LC50s for >48 hours of exposure, or chronic endpoints for longer exposure times, as thresholds for oil spills is highly conservative. Acute aquatic toxicity thresholds would be sufficiently conservative for oil spills in open water systems (as opposed to ponds or other contained systems). There is no need for an ACR correction for evaluating acute toxicity to aquatic biota from oil spills in open waters.

Based on this information, a contact threshold of 70 ppb was considered a conservative contact threshold for the assessment of impacts from dissolved aromatic hydrocarbons.

APPENDIX I – ECOTOXICOLOGY ASSESSMENT OF STAG CPF PW

https://jadestoneo365.sharepoint.com/sites/edmsau/Perth/_layouts/15/DocIdRedir.aspx?ID=JADESTONE-1389807935-52324

APPENDIX J – PROTECTION PRIORITY VALUES AND SPILL MODELLING SUMMARY

Key: NM = Not Modelled; NC = Not Contacted. Also note the worst case is represented for each value but could be from different seasons.

Protection Priority	Key Values	Relevant Key Periods (Vulnerability)	Oil Spill Modelling Parameter		Scenario Result	
					Subsea Crude ($86.5m^3$)	Surface Diesel ($250m^3$)
Dampier Archipelago	**Physical Habitats** Coral reefs -approximately 120 species of coral - significant (>70% coverage) are on slopes of eastern half of archipelago -high sponge diversity Seagrass -largest areas between Keast and Legendre Is, and West Intercourse Is and Cape Preston -takes forms of interspersed seagrass/macroalgal beds rather than extensive meadows Macroalgae -macro-algae dominate shallow (<10m) submerged limestone reefs and grow on stable rubble and boulder surfaces -approx. 200 species -counts for 70% of marine habitat Mangroves - throughout area but EPA regionally significant at West Intercourse and Enderby Is Intertidal mud/sand flats -wide sandflats and mudflats Sandy Beaches -present and used for turtle and seabird nesting Contact from floating oil is likely to impact emergent coral and sandy beaches resulting in smothering of coral and stranded oil on	Turtle nesting and breeding Nov-Mar with peak in late Dec/early Jan. Humpback whale annual migration July to September	Probability of films arriving at receptors at $>1g/m^2$	%	<1	<1
			Probability of contact by floating oil at $>10g/m^2$	%	<1	<1
			Probability of contact by entrained oil at >100ppb	(%)	<1	<1
			Probability of contact by dissolved aromatics at >70 ppb	(%)	<1	<1
			Maximum accumulated volume on shorelines with concentrations exceeding 100 g/m^2	m^3	19	NC
			Minimum time to shoreline contact by floating oil at >100 g/m^2	days	7	NC
			Maximum concentration of entrained oil in the worst replicate	ppb	44	40

Protection Priority	Key Values	Relevant Key Periods (Vulnerability)	Oil Spill Modelling Parameter		Scenario Result	
					Subsea Crude (86.5m³)	Surface Diesel (250m³)
	beaches, although tidal movements will mobilise oil and add to dispersion of oil. Contact from entrained oil may impact submerged corals/seagrasses/macroalgae resulting in smothering and/or contact toxic impacts; although constant tidal and current motions will re-mobilise oil and create further dilution **Marine Fauna** Invertebrates -abundant, molluscs Finfish and Rays -high fish biodiversity approx. 650 species, dwarf sawfish EPBC protected - outer islands of the Archipelago are inhabited predominantly by coral reef fishes whereas inner areas close to the mainland are occupied by mangrove and silty-bottom dwellers -inter-island passages have rich soft bottom fauna Birds -16 species of seabirds, some protected under EPBC, JAMBA and CAMBA species with significant breeding on Goodwyn, Keast Islands, Nelson Rocks -migratory seabird resting, foraging and breeding areas on beaches and mudflats -breeding occurs predominantly in winter months -nesting can occur on sandy beaches and dunes Marine reptiles Turtles - nesting and foraging		Maximum concentration of dissolved aromatics in the worst replicate	ppb	7	5

Protection Priority	Key Values	Relevant Key Periods (Vulnerability)	Oil Spill Modelling Parameter		Scenario Result	
					Subsea Crude (86.5m³)	Surface Diesel (250m³)
	(Hawksbill - largest known nesting for NW pop is NW of Rosemary Is and Delambre, nesting all year) (Flatbacks - nest on Legendre, Huay, Delambre) (Green – significant rookery in NWS) (Olive Ridley – known to forage) (Loggerhead – nesting and foraging) Seasnakes - possible transient presence Marine mammals - Eight species (dugong, whales, dolphins) - migratory pathway for protected humpback whale in July-Sept. Contact from floating oil is likely to impact marine fauna by smothering (causing skin/eye irritation and affect ability to thermo-regulate), oil coating from movement across shorelines and inhalation of oil if surfacing to breathe. In addition, ingestion may occur from preening/cleaning body and/or eating tainted food resulting in internal toxicity. Contact from entrained oil may impact marine fauna by causing skin or eye irritation/toxicity as fauna move through water, or internal toxicity from ingesting oil tainted food or breathing oil entrained water (fish). Although constant tidal and current motions will re-mobilise oil and create further dilution and fauna are mobile **Protected Area** - Commonwealth Marine Reserve The habitat and marine fauna which may be contacted by oil (as described above) will then impact upon the CMR values **Socio-economic and heritage values**					

Protection Priority	Key Values	Relevant Key Periods (Vulnerability)	Oil Spill Modelling Parameter		Scenario Result	
					Subsea Crude (86.5m^3)	Surface Diesel (250m^3)
	-National Heritage Listed -Aboriginal rock art on shorelines, Burrup Peninsula -42 islands within 45km radius of Dampier -25 islands are nature reserves -Recreational fishing (high values by community) -Camping beaches, social amenities -High use port for shipping and industry and shipping fairway -Aquaculture -Aquarium fishery -tourism around water based activities and nature (whale watching and turtles) Shipwreck sites Oil contacting will impact upon these values, in particular, tourism, industry, indigenous values and fishing activities being impacted from visible floating oil and tainted fish					
Barrow Island Inc. surrounds	Bandicoot Bay - conservation area created to protect benthic fauna and seabirds. Class A Nature Reserve *Note that there is No Contact by Dissolved Oil above the threshold* **Physical Habitats** Coral reefs - Biggada Reef Seagrass - No significant meadows, some present in shallow areas	Green turtle nesting: All year round (peak Dec-Jan) Hawksbill turtle nesting: Oct-Jan Flatback turtles: Dec-Jan	Probability of films arriving at receptors at >1g/m^2	%	1	<1
			Probability of contact by floating oil at >10g/m^2	%	<1	<1
			Probability of contact by entrained oil at >100ppb	(%)	1	2

Protection Priority	Key Values	Relevant Key Periods (Vulnerability)	Oil Spill Modelling Parameter		Scenario Result: Subsea Crude (86.5m^3)	Scenario Result: Surface Diesel (250m^3)
	Macroalgae - Dominant benthic habitat on hard substrates (~40%) Mangroves - Some restricted areas of stunted growth mangroves Sandy beaches - Important beaches for turtle nesting (Green & Flatback) Rocky shorelines - Cliffs up to 30 m high - Some intertidal limestone platforms provide food for shorebirds Intertidal mud/sandflats - largest intertidal sand/mudflat community in the reserves, high in invertebrate diversity - important feeding area for migratory birds KEF Contact from floating oil is likely to impact the shoreline and result in accumulated stranded oil at discrete locations. Mangroves and intertidal areas may be impacted by being smothered, although continuous tidal movements will mobilise oil and add to dispersion. Contact from entrained oil may impact shoreline through accumulation and may impact submerged corals/seagrasses/macroalgae resulting in smothering and/or contact toxic impacts; although constant tidal and current motions will re-mobilise oil and create further dilution. **Marine Fauna** Invertebrates - High invertebrate density on mud/sand flats	Loggerhead nesting: Dec-Jan Birds: Sept-Feb	Probability of contact by dissolved aromatics at >70 ppb	(%)	<1	<1
			Maximum accumulated volume on shorelines with concentrations exceeding 100 g/m^2	m^3	2	NC
			Minimum time to shoreline contact by floating oil at >100 g/m^2	Days	26	NC
			Maximum concentration of entrained oil in the worst replicate	ppb	2	544
			Maximum concentration of dissolved aromatics in the worst replicate	ppb	343	30

Protection Priority	Key Values	Relevant Key Periods (Vulnerability)	Oil Spill Modelling Parameter		Scenario Result: Subsea Crude (86.5m³)	Scenario Result: Surface Diesel (250m³)
	- Diversity typical of NWS and Indo-Pacific region - Filter feeding communities dominant >10m depths Turtles - Regionally and nationally sig Green (western side) and flatback turtle (eastern side) nesting beaches, - Foraging and nesting areas around Barrow Island for green, flatback and hawksbill; mating flatback turtles; - John Wayne Beach, logger heads + hawksbill (low density) - Turtle Bay is an important turtle aggregation and feeding area Seabirds - Migratory birds (important habitat) (important bird area) 10th of top 147 bird sites, - Highest pop of migratory birds in BI Nature reserve (south-south east island) and in tidal mudflats e.g. Bandicoot Bay - Along the East Asian-Australasian Flyway migration route of migratory sea and shorebirds - Double island important bird nesting (shearwaters, sea eagles) Fish/sharks - Intertidal flats provide foraging habitat for sharks/rays at high tide - High species richness and diversity of fish fauna >400 species Marine mammals Fish - Similar species found throughout Indo-west Pacific region - Blind gudgeon found at Barrow Island (in caves/groundwater) Seabirds					

Protection Priority	Key Values	Relevant Key Periods (Vulnerability)	Oil Spill Modelling Parameter		Scenario Result: Subsea Crude (86.5m³)	Scenario Result: Surface Diesel (250m³)
	- Foraging area for Migratory and seabirds Marine mammals - Whale and dolphin species may occasionally visit the Barrow/Montebello islands region Contact from floating oil is likely to impact marine fauna by smothering (causing skin/eye irritation and affect ability to thermo-regulate), oil coating from movement across shorelines and inhalation of oil if surfacing to breathe. In addition, ingestion may occur from preening/cleaning body and/or eating tainted food resulting in internal toxicity. Contact from entrained oil may impact marine fauna by causing skin or eye irritation/toxicity as fauna move through water, or internal toxicity from ingesting oil tainted food or breathing oil entrained water (fish). Although constant tidal and current motions will re-mobilise oil and create further dilution and fauna are mobile **Socio-Economic and Heritage values** National heritage - Barrow Island and Montebello-Barrow Islands CMR - Barrow Island marine park is zoned a sanctuary zone. Commonwealth Marine Reserve and Barrow Island MMA and Montebello Islands MP (Multiple Use) The habitat and marine fauna which may be contacted by oil (as described above) will then impact upon the marine park values Commercial fishing - Pearling leaseholders in the area, some zones prohibit pearling - A number of State managed fisheries occur in the area Tourism					

Protection Priority	Key Values	Relevant Key Periods (Vulnerability)	Oil Spill Modelling Parameter		Scenario Result: Subsea Crude ($86.5m^3$)	Scenario Result: Surface Diesel ($250m^3$)
	- Nature based tourism (charter vessels, diving snorkelling) - Limited visitors given remote location - Shore based fishing - Marine park allows passive recreational activities (diving, snorkelling, boating) - Very important for recreational fishing - Significant for recreational fishing and charter boat tourism Cultural Heritage - No recorded seabed Aboriginal sites Recreational Fishing - Significant for recreational fishing and charter boat tourism Industry - Oil and gas facility and pipelines, RO Plant and operations Oil contacting will impact upon these values from visible floating oil and stranded oil					
Montebello Islands, inc. CMR	Montebello Islands are important for turtle nesting and seabirds. Montebello CMR is in place to protect foraging areas for migratory seabirds, whale sharks and marine turtles; includes part of the migratory pathway of the humpback whale. - The reserve includes shallow shelf environments with depths ranging from 15 metres to 150 metres and provides protection for shelf and slope habitats, as well as pinnacle and terrace seafloor features	Pygmy blue whale migration: Apr-Aug	Probability of films arriving at receptors at $>1g/m^2$	%	8	<1
			Probability of contact by floating oil at $>10g/m^2$	%	1	<1
			Probability of contact by entrained oil at >100ppb	(%)	2	40

Protection Priority	Key Values	Relevant Key Periods (Vulnerability)	Oil Spill Modelling Parameter		Scenario Result	
					Subsea Crude (86.5m^3)	Surface Diesel (250m^3)
	- Examples of the seafloor habitats and communities of the Northwest Shelf Province provincial bioregions as well as the Pilbara (offshore) meso-scale bioregion - One key ecological feature for the region: ancient Coastline (a unique seafloor feature that provides areas of enhanced biological productivity) is represented in this reserve - Important for recreational fishing Contact from entrained and dissolved oil may impact submerged habitats resulting in smothering and/or contact toxic impacts; although constant tidal and current motions will re-mobilise oil and create further dilution **Physical Habitats** Reefs Algae (40%) Mangroves (globally unique as offshore) Fish habitat Intertidal sand flat communities Contact from floating oil is likely to impact the shoreline and result in accumulated stranded oil at discrete locations. Mangroves and intertidal areas may be impacted by being smothered, although continuous tidal movements will mobilise oil and add to dispersion. Contact from entrained oil may impact shoreline through accumulation and may impact submerged corals/seagrasses/macroalgae resulting in smothering and/or contact toxic impacts; although constant tidal and current motions will re-mobilise oil and create further dilution **Marine Fauna** Turtles		Probability of contact by dissolved aromatics at >70 ppb	(%)	<1	2
			Maximum accumulated volume on shorelines with concentrations exceeding 100 g/m^2	m^3	33	NC
			Minimum time to shoreline contact by floating oil at >100 g/m^2	Days	NC	NC
			Maximum concentration of entrained oil in the worst replicate	ppb	1,288	5,973
			Maximum concentration of dissolved aromatics in the worst replicate	ppb	34	168

Protection Priority	Key Values	Relevant Key Periods (Vulnerability)	Oil Spill Modelling Parameter		Scenario Result	
					Subsea Crude (86.5m³)	Surface Diesel (250m³)
	- Logger head, green significant rookery, hawksbill, flatback - Northwest and Eastern Trimouille Islands (Hawksbill), western reef and Southern Bay at Northwest Island (Green) Seabirds - Migratory and threatened seabirds - 14 species - Significant nesting, foraging and resting areas Invertebrates - Filter feeding communities dominant >10m depths Fish - Similar species found throughout Indo-west Pacific region Marine mammals - Whale and dolphin species may occasionally visit the Barrow/Montebello islands region - Only the humpback whale is a regular visitor to these areas (foraging) - Pygmy blue whale northern migration (Apr - Aug) - Dugongs regularly seen in shallow waters Marine Reptiles - Foraging area for marine turtles Contact from floating oil is likely to impact marine fauna by smothering (causing skin/eye irritation and affect ability to thermo-regulate), oil coating from movement across shorelines and inhalation of oil if surfacing to breathe. In addition, ingestion may occur from preening/cleaning body and/or eating tainted food resulting in internal toxicity. Contact from entrained oil may impact marine fauna by causing skin or eye irritation/toxicity as fauna move through water, or internal toxicity from ingesting oil tainted					

Protection Priority	Key Values	Relevant Key Periods (Vulnerability)	Oil Spill Modelling Parameter		Scenario Result	
					Subsea Crude (86.5m³)	Surface Diesel (250m³)
	food or breathing oil entrained water (fish). Although constant tidal and current motions will re-mobilise oil and create further dilution and fauna are mobile **Socio-Economic and Heritage values** Pearling (inactive/pearling zones) Significant for recreational fishing and charter boat tourism Marine park allows passive recreational activities (diving, snorkelling, boating) Social amenities and other tourism European history/maritime heritage Nominated place (National heritage) Commonwealth Marine Reserve and and Montebello Islands MP (Multiple Use) Cultural heritage: No recorded Aboriginal sites Oil contacting will impact upon these values from visible floating oil and stranded oil					
Lowendal Islands	**Physical Habitats** - Important shallow lagoons with seagrass for dugongs - Deep water benthic (soft sediment) habitats - Dugong and batman reef (eastern side IS), - Mangroves are considered globally unique as they are offshore - Macro algal reefs (40%) Contact from floating oil is likely to impact the shoreline and result in accumulated stranded oil at discrete locations. Mangroves and	Green turtle nesting: All year round (peak Dec-Jan) Hawksbill turtle nesting: Oct-Jan Flatback turtles: Dec-Jan	Probability of films arriving at receptors at >1g/m²	%	<1	<1
			Probability of contact by floating oil at 10g/m²	%	<1	<1
			Probability of contact by entrained oil at >100ppb	(%)	<1	2

Protection Priority	Key Values	Relevant Key Periods (Vulnerability)	Oil Spill Modelling Parameter		Scenario Result	
					Subsea Crude (86.5m³)	Surface Diesel (250m³)
	intertidal areas may be impacted by being smothered, although continuous tidal movements will mobilise oil and add to dispersion. Contact from entrained oil may impact shoreline through accumulation and may impact submerged corals/ seagrasses/ macroalgae resulting in smothering and/or contact toxic impacts; although constant tidal and current motions will re-mobilise oil and create further dilution **Marine Fauna** Turtles - Important hawksbill (Beacon, Parakeelya, Kaia and Pipeline), Loggerhead and green turtle nesting (minor) Varanus pipeline, Harriet and Andersons), - Nesting is reported to occur throughout the year in WA, peaking between October and January - Significant Flatback rookery, nesting season for Flatback turtles peaks in December and January with subsequent peak hatchling emergence in February and March Seabirds - Approximately 89 species of avifauna, 12 -14 species of migratory and seabirds Marine mammals - Seagrass beds around the Lowendal islands thought to provide valuable food source for dugongs Contact from floating oil is likely to impact marine fauna by smothering (causing skin/eye irritation and affect ability to thermo-regulate), oil coating from movement across shorelines and inhalation of oil if surfacing to breathe. In addition, ingestion may occur from preening/cleaning body and/or eating tainted food resulting in internal toxicity. Contact from entrained oil may impact	Loggerhead nesting: Dec-Jan Birds: Sept-Feb	Probability of contact by dissolved aromatics at >70 ppb	(%)	<1	<1
			Maximum accumulated volume on shorelines with concentrations exceeding 100 g/m²	m³	7	NC
			Minimum time to shoreline contact by floating oil at >100 g/m²	days	26	NC
			Maximum concentration of entrained oil in the worst replicate	ppb	<1	424
			Maximum concentration of dissolved aromatics in the worst replicate	ppb	2	16

Protection Priority	Key Values	Relevant Key Periods (Vulnerability)	Oil Spill Modelling Parameter		Scenario Result	
					Subsea Crude (86.5m³)	Surface Diesel (250m³)
	marine fauna by causing skin or eye irritation/toxicity as fauna move through water, or internal toxicity from ingesting oil tainted food or breathing oil entrained water (fish). Although constant tidal and current motions will re-mobilise oil and create further dilution and fauna are mobile **Protected Areas** - The Barrow Island Marine Management Area most of the waters around Barrow Island, the Lowendal Islands and the Barrow Island Marine Park. [See Barrow Island and Montebellos for information] The habitat and marine fauna which may be contacted by oil (as described above) will then impact upon the MMA and marine park values **Socio-economic and Heritage values** - Social amenities and other tourism, Very significant for recreational fishing and charter boat tourism Oil contacting will impact upon these values from visible floating oil and stranded oil					
Greater North Coast/Eighty Mile Beach; inc. CMR and Ramsar Site	Eighty Mile Beach management plan recognises oil spills as a potential pressure on emergent features: mangroves and saltmarsh, intertidal sand and mudflats (DPaW, 2014). CMR in place to protect communities and seafloor habitats, Eighty Mile Beach marine park also in place. **Physical Habitat** Coral reefs - Subtidal filter feeding communities present, likely provide foraging habitat for flatback turtles	Birds: Aug-Nov Nesting Turtles: Nov-Dec Hatchling turtles: Feb-Mar	Probability of films arriving at receptors at >1g/m²	%	1	<1
			Probability of contact by floating oil at 10g/m²	%	<1	<1
			Probability of contact by entrained oil at >100ppb	(%)	<1	<1

Protection Priority	Key Values	Relevant Key Periods (Vulnerability)	Oil Spill Modelling Parameter		Scenario Result	
					Subsea Crude (86.5m³)	Surface Diesel (250m³)
	- High diversity intertidal and subtidal coral reef communities Seagrasses - Seasonally present but sparsely distributed - Dugongs regularly found feeding on seagrass meadows here Macroalgae - Provide habitat and feeding opportunities for fish, invertebrates and dugong Mangroves - Limited stretch along coastline and in Mandora Saltmarsh area. minor stands 10-20 km close to tidal creeks. Intertidal mud/sand flats - 225km intertidal mudflats provide important food source for many of the bird species from the infauna present - Mandora Saltmarsh area contains rare group of wetlands Sandy Beaches - Sandy shores occupy the landward edge of the intertidal zone (approx. 220km), provide important turtle nesting habitat and some tourism (see below). Rocky shorelines - Not identified in emergent area Contact from floating oil is likely to impact the shoreline and result in accumulated stranded oil at discrete locations. Mangroves and intertidal areas may be impacted by being smothered, although continuous tidal movements will mobilise oil and add to dispersion. Contact from entrained oil may impact shoreline through accumulation, although constant tidal and current motions will re-mobilise oil and create further dilution.		Probability of contact by dissolved aromatics at >70 ppb	(%)	<1	<1
			Maximum accumulated volume on shorelines with concentrations exceeding 100 g/m²	m³	7	NC
			Minimum time to shoreline contact by floating oil at >10 g/m²	DAYS	NC	NC
			Maximum concentration of entrained oil in the worst replicate	ppb	<1	15
			Maximum concentration of dissolved aromatics in the worst replicate	ppb	<1	<1

Protection Priority	Key Values	Relevant Key Periods (Vulnerability)	Oil Spill Modelling Parameter		Scenario Result: Subsea Crude (86.5m³)	Scenario Result: Surface Diesel (250m³)
	Contact from entrained and dissolved oil (although well below threshold levels) may impact submerged habitats resulting in smothering and/or contact toxic impacts; although constant tidal and current motions will re-mobilise oil and create further dilution **Marine Fauna** Invertebrates - Large number and diversity of invertebrates within the intertidal mudflat areas - Oil can reduce invertebrate abundance or alter the intertidal invertebrate community that provides food for non-breeding shorebirds Fish and sharks - Fish populations dependent on habitat and substrate type - Several fish species targeted by recreational commercial fisheries - Sawfish foraging, nursing and pupping; diversity of sharks and rays (including protected species) - Diversity of fish species provide recreational and commercial fishing opportunities Birds - Ramsar site - 97 wetland bird species, 42 of which are listed under CAMBA, JAMBA and ROKAMBA - 500,000 birds use the area as a migration terminus annually, key period is Aug-Nov when contact with oil spill could result in impacts at a population level Marine reptiles					

Protection Priority	Key Values	Relevant Key Periods (Vulnerability)	Oil Spill Modelling Parameter		Scenario Result	
					Subsea Crude (86.5m³)	Surface Diesel (250m³)
	- Flatback turtles nest at scattered locations along shoreline. - Green , hawksbill, loggerhead, olive ridley and leatherback may frequent the waters all year round Marine Mammals - Humpback whale migration pathway though the CMR - Dugongs and other cetaceans inhabit or migrate through the CMR/marine park although unlikely to be larger whale species due to water depths Contact from floating oil is likely to impact marine fauna by smothering (causing skin/eye irritation and affect ability to thermo-regulate) and oil contact from movement across the shoreline. In addition, ingestion may occur from preening/cleaning body and/or eating oil covered food resulting in internal toxicity. Contact from entrained oil may impact marine fauna by causing skin irritation/toxicity as fauna move through water, or internal toxicity from ingesting oil tainted food. Although constant tidal and current motions will re-mobilise oil and create further dilution and fauna are mobile **Protected Area** - Listed Ramsar site. The site comprises of two separate areas: 220km of beach and associated intertidal mudflats from Cape Missiessy to Cape Keraudren ("the beach") and Mandora Salt Marsh 40km to the east (inland). Oil unlikely to contact Mandora Salt Marsh, however 'the beach' area consists of sandy beach, mangroves and intertidal mudflats which may be contacted by oil (as described above) impacting upon the Ramsar values **Socio-economic and heritage values**					

Protection Priority	Key Values	Relevant Key Periods (Vulnerability)	Oil Spill Modelling Parameter		Scenario Result	
					Subsea Crude (86.5m³)	Surface Diesel (250m³)
	- Tourism activities include camping nearby, nature appreciation, nature based, fishing and wildlife viewing from vessels. Some vessel based fishing (mostly shore based recreational fishing in Eighty Mile Beach area) and four wheel driving - Indigenous values: wetlands are significant to 3 local groups, several aboriginal heritage sites present. The adjacent CMR contains land and sea important to traditional indigenous owners, 4 special purpose zones included in marine park Oil contacting shorelines will impact upon these values, in particular, tourism and fishing activities from visible stranded oil and tainted fish - Heritage value: two shipwrecks and one plane wreck present that could be contacted by entrained oil - Pearl Producers Association have previously indicated this is area is important as a seed stock. Diving for pearl oysters is limited to the 35m depth contour (adjacent to the marine park) - Commercial fishing: a number are licensed to operate in the CMR The habitat and marine fauna which may be contacted by oil (as described above) will then impact upon the CMR and socio-economic values					

APPENDIX K – AMSA MOU

MEMORANDUM OF UNDERSTANDING

BETWEEN THE

AUSTRALIAN MARITIME SAFETY AUTHORITY ('AMSA')

AND

JADESTONE ENERGY, ACN 613 671 819 ('THE TITLEHOLDER')

ON

SUPPORT FOR OIL SPILL PREPAREDNESS AND RESPONSE

BACKGROUND

1. Under the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* ('the Regulations'), the Titleholder is required to have an accepted *Environment Plan* ('*EP*').
2. The *EP* must include an *Oil Pollution Emergency Plan*, and this must provide for consultation with relevant persons.
3. For those petroleum titles subject to a joint venture, the Titleholder has been nominated under section 775B(2) of the *Offshore Petroleum and Greenhouse Storage Act 2006* ('OPGGS Act') as the party who is authorised to take eligible voluntary actions on behalf of the titleholders and under regulation 11A.04(2) of the *Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011* as the party to whom notices can be given.
4. In order for NOPSEMA to accept the *EP* under the Regulations, the *EP* must demonstrate that the Titleholder has carried out the consultation required by the Regulations.
5. This Memorandum of Understanding ('MOU') is the result of consultation between the Titleholder and AMSA, and sets out their understanding of their respective roles and responsibilities when responding to ship-sourced marine pollution incidents and non-ship-sourced marine pollution incidents.
6. This MOU supersedes any previous agreement or understandings between AMSA and the Titleholder about oil spill preparedness and response.
7. This MOU does not create or give rise to any rights or obligations for either participant.

RESPONSE TO SHIP-SOURCED MARINE POLLUTION INCIDENTS

8. AMSA and the Titleholder acknowledge that AMSA retains Combat Agency responsibility for all ship-sourced marine pollution incidents. AMSA will respond in accordance with its *Marine Pollution Response Plan* as approved by the AMSA Executive.
9. The Titleholder agrees to provide all available support to AMSA in AMSA's performance of its Combat Agency responsibilities.

10. If the Titleholder is required by the OPGGS Act or the Regulations, or both, to develop an *Oil Pollution Emergency Plan* for ship-sourced incidents, the following words will be contained within the appropriate section of that plan:
    - The Australian Maritime Safety Authority (AMSA) is the designated Combat Agency for oil spills from vessels within the Commonwealth jurisdiction. Upon notification of an incident involving a ship, AMSA will assume control of the incident and respond in accordance with AMSA's *Marine Pollution Response Plan*.
    - AMSA's *Marine Pollution Response Plan* is the operational response plan for the management of ship-sourced incidents.
    - AMSA is to be notified immediately of all ship-sourced incidents through RCC Australia on +61 2 62306811.
11. The Titleholder acknowledges that in addition to marine pollution incidents, AMSA has specific national interest responsibilities with regard to the management of maritime casualties (as defined within the *National Plan for Maritime Environmental Emergencies* and *International Convention on the High Seas in Cases of Oil Pollution Casualties*) and specifically with regard to the application of the *Protection of the Sea (Powers of Intervention) Act 1981*. AMSA and the Titleholder agree to work cooperatively to manage maritime casualty incidents in accordance with the arrangements within the *National Plan for Maritime Environmental Emergencies*.

RESPONSE TO NON-SHIP-SOURCED MARINE POLLUTION INCIDENTS

12. All *Oil Pollution Emergency Plans* prepared by the Titleholder that wish to draw on the support of AMSA and the *National Plan for Maritime Environmental Emergencies* will contain the following words within that plan:
    - The Australian Maritime Safety Authority ('AMSA') will coordinate the resources of the National Plan for Maritime Environmental Emergencies on the formal request of the appointed Incident Controller. Notification of AMSA will be through RCC Australia on +61 2 62306811.
13. The Titleholder agrees that access to the National Plan arrangements and support is contingent upon AMSA acknowledging receipt of the most recent version of *the Oil Pollution Emergency Plan* that has been accepted by the relevant Regulator(s).
14. The Titleholder agrees to formally include an advisor or liaison officer from AMSA within the Incident Management Team defined within the *Oil Pollution Emergency Plan* to facilitate the effective and efficient coordination of National Plan resources.
15. The Titleholder agrees to notify AMSA immediately of any marine pollution incident in the interests of facilitating the most efficient and effective response to the incident.
16. AMSA agrees, in the event of a significant non-ship-sourced marine pollution incident requiring regional or national level support, to provide services and resources under its direct control, including (but not limited to):
    - Technical and response advice;
    - Response equipment, through the AMSA National Equipment Stockpiles;
    - Response contractors and services, including Fixed Wing Aerial Dispersant Capability and oil and chemical spill modelling; and
    - Response personnel, including management and operational staff.

17. AMSA agrees, in the event of a significant non-ship-sourced marine pollution incident, to support the Titleholder or a third party appointed by the Titleholder in its role as Combat Agency. This support will be provided in accordance with the cooperative arrangements detailed within the *National Plan for Maritime Environmental Emergencies*, and may include the coordination of National Plan response equipment and resources, response and advisory services and personnel.
18. AMSA agrees to respond in accordance with the *Incident Action Plan* approved by the appointed Incident Controller. The only exception will be where AMSA believes that an operation presents unacceptable risks to the health and safety of personnel and resources coordinated or controlled by AMSA. In these circumstances AMSA will seek to resolve these issues at the earliest opportunity with the Incident Controller in accordance with normal incident action planning processes.

COST RECOVERY

19. The Titleholder acknowledges that the *Australian Maritime Safety Authority Act 1990* authorises AMSA to charge for some of its activities.
20. The Titleholder agrees to reimburse AMSA for all costs incurred in responding to incidents for which the Titleholder has responsibilities under the OPGGS Act and the Regulations.
21. AMSA agrees that in the case of ship-sourced marine pollution incidents, AMSA will seek to recover all possible costs from the ship owner and their respective insurers before seeking reimbursement from the Titleholder.

ONGOING CONSULTATION AND COOPERATION

22. AMSA and the Titleholder will nominate contact points for the ongoing management of this MOU.
23. AMSA and the Titleholder agree to maintain a cooperative approach to preparing and responding to marine pollution incidents, including the open exchange of information and technical advice.
24. AMSA will facilitate an annual workshop to provide an open forum to exchange information on best practice and review and update operational procedure.

RESOLUTION OF DISPUTES

25. Any dispute which arises under or in relation to this MOU will be resolved by consultation and negotiation between the participants and will not be referred to any third party.

REVIEW & AMENDMENT

26. This MOU may be reviewed and amended if agreed in writing and signed by the participants.

COMMENCEMENT & EXPIRY

27. This MOU commences on the date both participants have signed the document and expires 5 years from commencement

TERMINATION

28. This MOU may be terminated at any time by either participant upon giving the other four weeks' notice in writing.

Signed as a non-legally binding understanding

....	....	Julian Mitchell ~~Toby Stone~~	a General Manager
Signature	**Date**		**Response**
....	26/06/17	**Name**	**General Manager**
Signature	**Date**	**Mark Robertson**	

APPENDIX L – AMOSC MSC

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APPENDIX M – MANAGEMENT OF CHANGE PROCEDURE (JS-90-PR-G-00017) APPENDIX 5: ENVIRONMENT PLAN (EP) MOC

APPENDIX 5 – Environment Plan (EP) MOC

Environment Plan (EP) MOC			
MOC Ref.		**Date Raised:**	

Note: To comply with the OPGGS Regulations the EP MOC process must consider the change in the context of the demonstration of impacts and risks to levels that are acceptable and ALARP, and whether the change may alter the basis upon which the EP was accepted.

1. INITIATION			
Document Name			
Document No.		**Rev.**	
1.1 **Brief description of specific change(s) or proposed change(s)** *List multiple changes if it relates to the same EP. The Activity can refer to operational details, management control and performance standards, etc.*			
1.2 **Is the proposed change already included in the EP/approval document?**			
1.2.1 The proposed change covered by existing the approved document (i.e. further assessment of the change is not required).	☐	*Go to Section 4 for sign off*	
References to relevant sections of document:			
1.2.2 The proposed change differs from arrangements described in the approved document.	☐	*Complete Sections 2 and 3*	

2.	**CHANGE & RISK ASSESSMENT**		
2.1	**Risk Assessment**		
2.1.1	Personnel involved in the risk assessment:		
Either copy the details below or attach separate document. The completed risk assessment needs to justify some of the check boxes in this Section. Refer to Environmental Hazard Identification and Assessment Procedure (JS-70-PR-I-00036).			
2.2	**Check against Regulatory requirements**		
	Requirement	**YES**	**NO**
2.2.1	Does the change constitute a significant modification or new stage of the activity that is not provided for in the current EP?	☐	☐
2.2.2	Does the change result in one of the following:		
	a. The occurrence of any significant new environmental impact or risk, or significant increase in an existing environmental impact or risk, not provided for in the EP in force for the activity;	☐	☐
	b. The occurrence of a series of new environmental impacts or risks, or a series of increases in existing environmental impacts or risks, which, taken together, amount to the occurrence of:		
	i. A significant new environmental impact or risk or	☐	☐
	ii. a significant increase in an existing environmental impact or risk	☐	☐
	that is not provided for in the EP in force for the activity?		
2.2.3	Is the change or proposed change contrary or incompatible with existing EP?	☐	☐
2.2.4	Are all the new or existing risks reduced to ALARP? Ensure ALARP demonstration remains in place if a management control is changed or deleted, or if the activity is modified. Reduction of risks to ALARP means the cost of further risk reduction is grossly disproportionate to the benefit gained	☐	☐

If YES to any of the above, then a proposed revision of the EP must be submitted for assessment by NOPSEMA.
Justification for selections made in 2.2.1 to 2.2.4:

3. IMPLEMENTATION		
3.1 Document Revision Requirement		
3.1.1 Revise and re-submit approval document to Regulator		☐
<u>OR</u>		
3.1.2 Conduct internal 'minor' revision of the approval document and issue for use.		☐
3.2 **Other considerations**		
	YES	**NO**
3.2.1 Can we commence or continue on the work (if it has already started)? *(If NO, discuss & assess impact with General Manager and obtain sign off)*	☐	☐
3.2.2 Does this change require Legal review? *(If YES, obtain Legal review and sign off)*	☐	☐
3.2.3 Does this change require deviation from BMS, EPBC Act, licence or other approval? *(If YES, assess impact on current activity and determine whether further discussion with relevant Regulator or re-approval will be required)*	☐	☐
3.2.4 Does this change require Spill Scenario re-modelling? *(If YES, capture this in the task table below)*	☐	☐
3.2.5 If there is a change to the spill scenario, does this require review of Financial Assurance under the OPGGS Act (ref. Financial Assurance Calculation, GF-70-REP-I-00002)? *(If YES, obtain Finance Manager review and sign off)*	☐	☐

3.2.6 Does this change require further stakeholder consultation? *(If YES, capture this in the task table below)*	☐	☐

3.3 **List any critical MoC implementation tasks below (if applicable):**		
MoC Tasks	**Responsible**	**Due date**

4. APPROVALS			
Title	**Name:**	**Signature:**	**Date:**
Engineering Coordinator			
HSE Manager			
Operations Superintendent			

APPENDIX N – ENVIRONMENTAL RISK ASSESSMENT OF CHEMICALS FOR OPERATIONAL ACTIVITIES (EXTRACT FROM CHEMICAL SELECTION EVALUATION AND APPROVAL PROCEDURE (JS-70-PR-I-00033))

APPENDIX 8 – ENVIRONMENTAL RISK ASSESSMENT OF CHEMICAL FOR OPERATIONAL ACTIVITIES

Environmental Risk Assessment of Chemical for Operational Activities

Chemical Name:

Supplier:

Prepared by:

Document Owner(s)	Activity/ Facility

Report Version Control

Version	Date	Author	Change Description

___________________________ ___________________________________

Environmental scientist Signature **OIM Signature**

Date: __________________ **Date:** _______________________

STEP 1	CHEMICAL INFORMATION		
Propose a new chemical for use	Yes	No	Attach Safety Data Sheet (SDS) and ecotoxicity report summary
Is all information required to perform an environmental risk assessment of a chemical available? (Refer to checklist in Appendix 3)	☐	☐	
➢ If the answer to the above question is YES > Go to STEP 2			
➢ If the answer to the above question is NO > Seek ecotoxicity data from the supplier. If ecotoxicity data is not available and cannot be sourced from a literature search, the proposed chemical cannot be used, seek an alternative chemical.			
STEP 2	CHEMICAL DISCLOSURE REPORT		
Down-hole chemical use	Yes	No	Provide all information required for full chemical disclosure
Is the fate of the chemical down-hole in state waters?	☐	☐	
➢ If the answer to the above question is YES > complete Chemical Disclosure Reporting Form (http://www.dmp.wa.gov.au/documents/ENV-PEB-166.docx), submit chemical to DMP for approval. If chemical is approved by DMP, accept chemical for use. If chemical is rejected by DMP, find a substitute chemical.			
➢ If the answer to the above question is NO > Go to STEP 3			
STEP 3	CHEMICAL USAGE AND VOLUME		
Planned discharge or potential for unplanned release (>80 L) to the marine environment	Yes	No	Indicate end-fate of the chemical
Is any discharge planned or potential risk of an unplanned release (>80L) to the marine environment or land?	☐	☐	
➢ If the answer to the above question is YES > Go to STEP 4			
➢ If the answer to the above question is NO > Detailed environmental risk assessment of chemical is not required, evaluate chemical on New Chemical Introduction Form.			
STEP 4	OCNS CLASSIFICATION CHECK		
OSPAR Pose Little or NO Risk to the Environment (PLONOR) List	Yes	No	List the PLONOR substances
Is the chemical or all constituents of the chemical on the OSPAR PLONOR List (approved list can be found at www.ospar.org/)?	☐	☐	
➢ If the answer to the above question is YES > Accept chemical for use.			
➢ If the answer to the above question is NO > Go to STEP 5			
STEP 5	OCNS CLASSIFICATION CHECK		

OCNS Hazard Quotient (HQ) (CHARM model)	Yes	No	Indicate CHARM HQ Colour-Band (GOLD, SILVER, WHITE, BLUE, ORANGE or PURPLE)
Is Product OCNS risk classified on the CEFAS CHARM database? (http://www.cefas.defra.gov.uk/industry-information/offshore-chemical-notification-scheme.aspx)	☐	☐	
➢ If the answer to the above question is YES and the chemical is colour-banded GOLD or SILVER > Chemical is environmentally acceptable, no requirement for detailed risk assessment. If the answer to the above question is YES and the chemical is colour- banded WHITE, BLUE, ORANGE or PURPLE> Go to STEP 9			
➢ If the answer to the above question is NO > Go to STEP 6			
STEP 6	OCNS CLASSIFICATION CHECK		
OCNS Hazard Grouping (non-CHARM method)	Yes	No	Indicate OCNS Final non-CHARM Grouping (E, D, C, B or A)
Is the chemical OCNS risk classified on the CEFAS non-CHARM chemical grouping database? (http://www.cefas.defra.gov.uk/industry-information/offshore-chemical-notification-scheme.aspx)	☐	☐	
➢ If the answer to the above question is YES and the product is grouped E or D > Chemical is environmentally acceptable, no requirement for detailed risk assessment. If the answer to the above question is YES and the product is rated C, B or A > go to STEP 9			
➢ If the answer to the above question is NO > Go to STEP 7			
STEP 7	ENVIRONMENTAL RISK ASSESSMENT OF CHEMICAL		
Ecotoxicity data required for environmental risk assessment of chemical	Yes	No	Provide ecotoxicity data summary (use CHARM model software or for the non- CHARM method, use the OCNS Grouping Tables)
Is sufficient ecotoxicity data available for the chemical or its chemical ingredients in order to determine the hazard level (using the OCNS CHARM Model or non- CHARM method, if applicable) and subsequent risk to the receiving marine environment? (Refer to Appendix 7)	☐	☐	
➢ If the answer to the above question is YES > go to STEP 9.			
➢ If the answer to the above question is NO > go to STEP 8.			
STEP 8	ENVIRONMENTAL RISK ASSESSMENT OF CHEMICAL		
Ecotoxicity data of a comparable chemical required for environmental risk assessment	Yes	No	Provide ecotoxicity data summary for comparable chemical

Is ecotoxicity data available for a comparable chemical or for the product's chemical ingredients (i.e. no less than 95% similar in composition including all hazardous components)?	☐	☐	
➢ If the answer to the above question is YES > go to STEP 9.			
➢ If the answer to the above question is NO > Seek an alternative chemical. If the answer to the above is NO and there is no alternative chemical available, laboratory testing should be implemented by the supplier (Refer to ecotoxicity testing recommendations in Appendix 6).			
STEP 9	ENVIRONMENTAL RISK ASSESSMENT OF CHEMICAL		
Risk justification for chemical use	Yes	No	Provide environmental risk assessment summary
If a pseudo-OCNS rating can be applied to the chemical, provide assessment summary and risk justification. If a pseudo-OCNS rating cannot be applied, is this chemical acceptable for use in the marine environment based on the normal dose rate (i.e. concentration and quantity per day), end-fate (i.e. discharge) and available ecotoxicity information? If there is no alternative to using a non-CHARM A, B or C rated chemical, or a CHARM rated purple, orange, blue or white colour-band chemical, provide a technical justification for use.	☐	☐	
➢ If the answer to the above question is YES > Accept chemical for use.			
➢ If the answer to the above question is NO > Reject the chemical and find an alternative chemical.			
Overall Risk: High Medium Low			
Comments:			