# Summary of Montara Operations Environment Plan

# MV-90-PLN-I-00001.01

# Revision 0

| Rev No | Date | Approval | | |
|---|---|---|---|---|
| | | Owner | Reviewer | Approver |
| | | HSE Manager - Perth | Environment Lead | Country Manager |
| 0 | 12-Aug-19 | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

JADESTONE ENERGY (AUSTRALIA) PTY LTD
Level 6, 41 St Georges Terrace, Perth, Western Australia 6000 | PO Box 5388 Perth WA 6000
Telephone: +61 8 9486 6600 Website: www.jadestone-energy.com (ACN: 613 671 819)

| Revision | Author / Editor | Amendment |
|---|---|---|
| 0 | | Issued to NOPSEMA. Based on Montara Operations Environment Plan Permit |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

## Contents

**Tables**

## Figures



## Appendices

# ACRONYMS AND ABBREVIATIONS

| Abbreviation | Description |
|---|---|
| AFFF | Aqueous Film Forming Foam |
| ALARP | as low as reasonably practicable |
| AMP | Australian Marine Parks |
| AMSA | Australian Maritime Safety Authority |
| AQIS | Australian Quarantine and Inspection Service |
| API | American Petroleum Institute |
| APPEA | Australian Petroleum Production and Exploration Association |
| BIA | Biologically important areas |
| BOD | Biological oxygen demand |
| BOP | Blowout preventer |
| Bq/g | Becquerel per gram |
| CCR | Central control room |
| CHARM | Chemical Hazard and Risk Management |
| CMMS | Computerised Maintenance Management System |
| DAH | Dissolved aromatic hydrocarbons |
| DBCA | Department of Biodiversity, Conservation and Attractions |
| DEC | Department of Environment and Conservation (now DBCA) |
| DEWHA | Department of the Environment, Water, Heritage and the Arts (now DoEE) |
| DMIRS | Department of Mines, Industry Regulation and Safety (previously Department of Mines and Petroleum, DMP) |
| DoF | Department of Fisheries (now DPIRD) |
| DoEE | Department of the Environment and Energy |
| DPIRD | Department of Primary Industries and Regional Development (previously Department of Fisheries) |
| DSD | Department of Sustainable Development |
| DSEWPaC (now DoEE) | Department of Sustainability, Environment, Water, Population and Communities |
| EMBA | Environment that may be affected |
| ENVID | Environmental hazard identification (process) |
| EPBC Act | Environment Protection and Biodiversity Conservation Act 1999 |

| Abbreviation | Description |
|---|---|
| EP | Environment Plan |
| EP Act | Environmental Protection Act 1986 |
| EPO | Environmental performance outcome |
| EPS | Environmental performance standard |
| ESD | Emergency Shut-Down system |
| FPSO | Floating production storage and offtake (facility) |
| HP | High pressure |
| HSE | Health safety and environment |
| IMCRA | Integrated marine and coastal regionalisation of Australia |
| IMO | International Maritime Organisation |
| IMPS | Introduced marine pest species |
| IMR | Integrity, maintenance and repair |
| KEFs | Key Ecological Features |
| LP | Low pressure |
| LSA | Low specific activity |
| LWI | Light well intervention |
| MARPOL | Marine pollution (legislation) |
| mg/L | Milligrams per litre |
| MGPS | Marine growth protection system |
| MSDS | Material safety data sheet |
| 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 |
| OGP | Oil and gas producers (association) |

| Abbreviation | Description |
|---|---|
| OIM | Offshore Installation Manager |
| OIW | Oil-in-water |
| OPEP | Oil pollution emergency plan |
| OPGGS Act | Offshore Petroleum and Greenhouse Gas Storage Act 2006 |
| OPGGS (E) Regs | Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 |
| OPMF | Onslow Prawn Managed Fishery |
| OSCP | Oil Spill Contingency Plan |
| OSMP | Operational and scientific monitoring plan |
| PAH | Polycyclic aromatic hydrocarbons |
| PLONOR | Pose little or no risk |
| PPD | Personal protection device |
| ppm | parts per million |
| PSZ | Petroleum safety zone |
| PW | Produced water |
| RLWI | Riserless light well intervention |
| ROV | Remote Operated Vehicle |
| SBFTF | Southern Bluefin Tuna Fishery |
| SCAT | Shoreline Clean-up Assessment Technique |
| SCSSV | Surface controlled subsurface safety valve |
| SDS | Safety data sheet |
| SIL | Safety integrity level |
| SIMOPs | Simultaneous operations |
| SMP | Scientific monitoring program |
| SCSSV | Surface Controlled Subsurface Safety Valve |
| TPH | Total petroleum hydrocarbons |
| UPS | Universal power supply |
| VOC | Volatile organic compounds |
| WA | Western Australia |
| WHP | Wellhead platform |
| WSTF | Western Skipjack Tuna Fishery |

| Abbreviation | Description |
|---|---|
| WTBF | Western Tuna and Billfish Fishery |
| WOMP | Well Operations Management Plan |

# 1 OVERVIEW OF THE ACTIVITY

## 1.1 Introduction

Jadestone Energy Inc. (Jadestone Energy), as Titleholder, under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (referred to as the Environment Regulations), prepared an Environment Plan (EP) for the operation of the *Montara* facilities to allow for the continuation of production for a period of five years from the date of its acceptance by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA). The *Montara* Operations EP (MV-90-PLN-1-00001 Rev 2) was accepted by NOPSEMA on the 6th August 2019.

This EP Summary summarises the *Montara* Operations EP and has been prepared to meet the requirements of Regulations 11(3) and 11(4) under the Environment Regulations, as administered by NOPSEMA.

NOPSEMA's Guidance Note for Environment Plan summaries (N-4750-GL1566 Rev 2, April 2019) was referred to in the preparation of this summary EP.

## 1.2 Operator and titleholder details

The *Montara* Operations activity is in the production licenses AC/L7 (*Montara* field) and AC/L8 (Skua, Swift, and Swallow fields) in the Timor Sea. Jadestone Energy acquired the *Montara* operation from PTTEP Australasia (Ashmore Cartier) Pty Ltd to become the titleholder with operational control of the activity.

| | |
|---|---|
| Title holder | Jadestone Energy Inc (Jadestone Energy)<br><br>Level 8, 1 William Street<br>Perth, Western Australia, 6000.<br>ACN 613 671 819 |
| Contact | Mark Craig, Operations Manager<br><br>Phone: +61 8 9486 6600<br><br>Email: mark.craig@jadestone-energy.com.au |

## 1.3 Location

The activity is approximately 690 km east of Darwin in a water depth of approximately 80 m and produces oil from the *Montara*, Skua, Swift and Swallow fields (**Figure *1-1***).

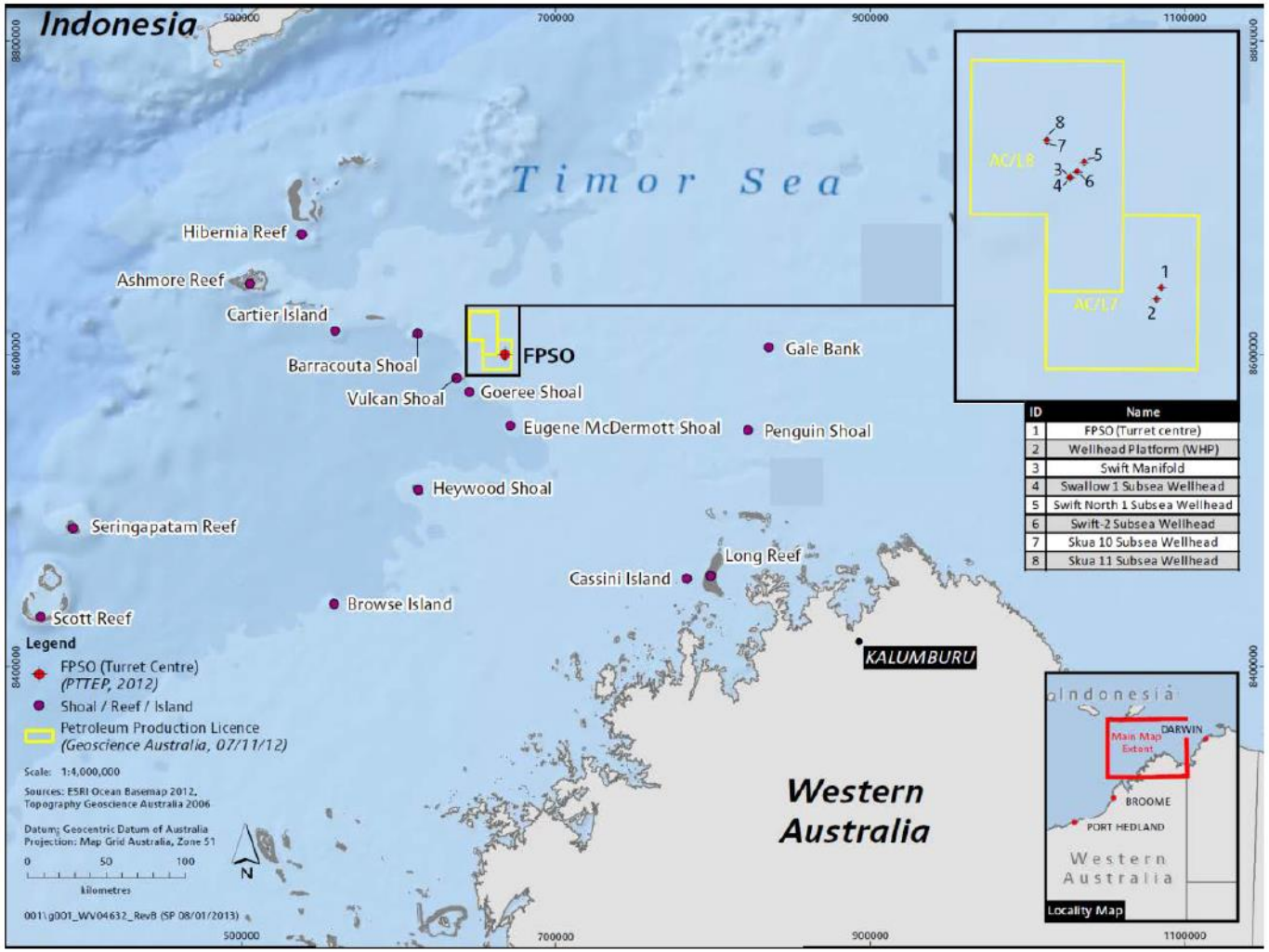



**Figure 1-1 Location of the *Montara* Operations activity**

The locations of key environmental sensitive receptors in closest proximity to the *Montara Venture* floating production storage and offtake (FPSO) facility are provided in Error! Reference source not found..

**Table 1-1 Proximity of sensitive receptors to the *Montara* Venture FPSO**

| Sensitive receptor | Approximate distance from *Montara* FPSO (km) |
|---|---|
| Goeree Shoal | 33 |
| Vulcan Shoal | 34 |
| Eugene McDermott Shoal | 46 |
| Barracouta Shoal | 57 |
| Cartier Island | 109 |
| Ashmore Reef | 168 |
| Mainland Australia | 208 |
| Rote Island (Indonesia) | 251 |
| West Timor | 265 |
| East Timor | 356 |

## 1.4 Structure and layout

The *Montara* Operations infrastructure includes:

- An unmanned well head platform (WHP)at the *Montara* field;
- Five subsea wells for development of the Skua, Swift and Swallow fields;
- Production flowline system comprising 6 flowlines and associated tie-in spools;
- Gas lift flowline system consisting of four flowlines and associated tie-in spools;
- Three infield control umbilicals and associated flying leads;
- A subsea manifold in the Swift field for comingling the production fluids and distributing the compressed gas and electro-hydraulic services to the subsea wells;
- A floating production, storage and offtake (FPSO) facility and its associated mooring system located approximately 1.5 km northeast of the WHP. Two flexible production risers and associated riser bases. One flexible gas lift riser and associated riser base. Two control umbilicals and associated riser bases. One gas compressor for the gas lift system;
- Support/supply vessels, work vessels and tugboats supporting third-party offtake tanker movements, facility logistics, maintenance and provisioning; and
- Helicopter support.

The locations of the field infrastructure are provided in Table **1-2** below and illustrated in **Figure 1-2**.

**Table 1-2 *Montara* Operations Activity Infrastructure Coordinates (GDA 94, Zone 51)**

| Wells and infrastructure | Latitude (south) | Longitude (east) |
|---|---|---|
| *Montara Venture* FPSO (turret centre) | 12° 39’ 35.3” | 124° 32’ 41.1” |

| | | |
|---|---|---|
| Wellhead platform | 12º 40’ 20.5” | 124º 32’ 22.2” |
| Swallow 1 subsea well | 12º 32’ 29.5” | 124º 26’ 36.8” |
| Swift north 1 subsea | 12º 31’ 29.9” | 124º 27’ 33.7” |
| Swift 2 subsea well | 12º 32’ 3.6” | 124º 27’ 6.0” |
| Skua 10 subsea well | 12º 30’ 4.6” | 124º 25’ 5.4” |
| Skua 11 subsea well | 12º 30’ 4.6” | 124º 25’ 5.6” |
| *Montara* H5 well | 12º 40’ 20.5” | 124º 32’ 23.3” |
| *Montara* H4 well | 12º 40’ 20.5” | 124º 32’ 22.3” |
| *Montara* H3 ST-1 well | 12º 40’ 20.5” | 124º 32’ 22.2” |
| *Montara* H2 well | 12º 40’ 20.5” | 124º 32’ 22.2” |
| *Montara* G2 well | 12º 40’ 20.5” | 124º 32’ 22.3” |

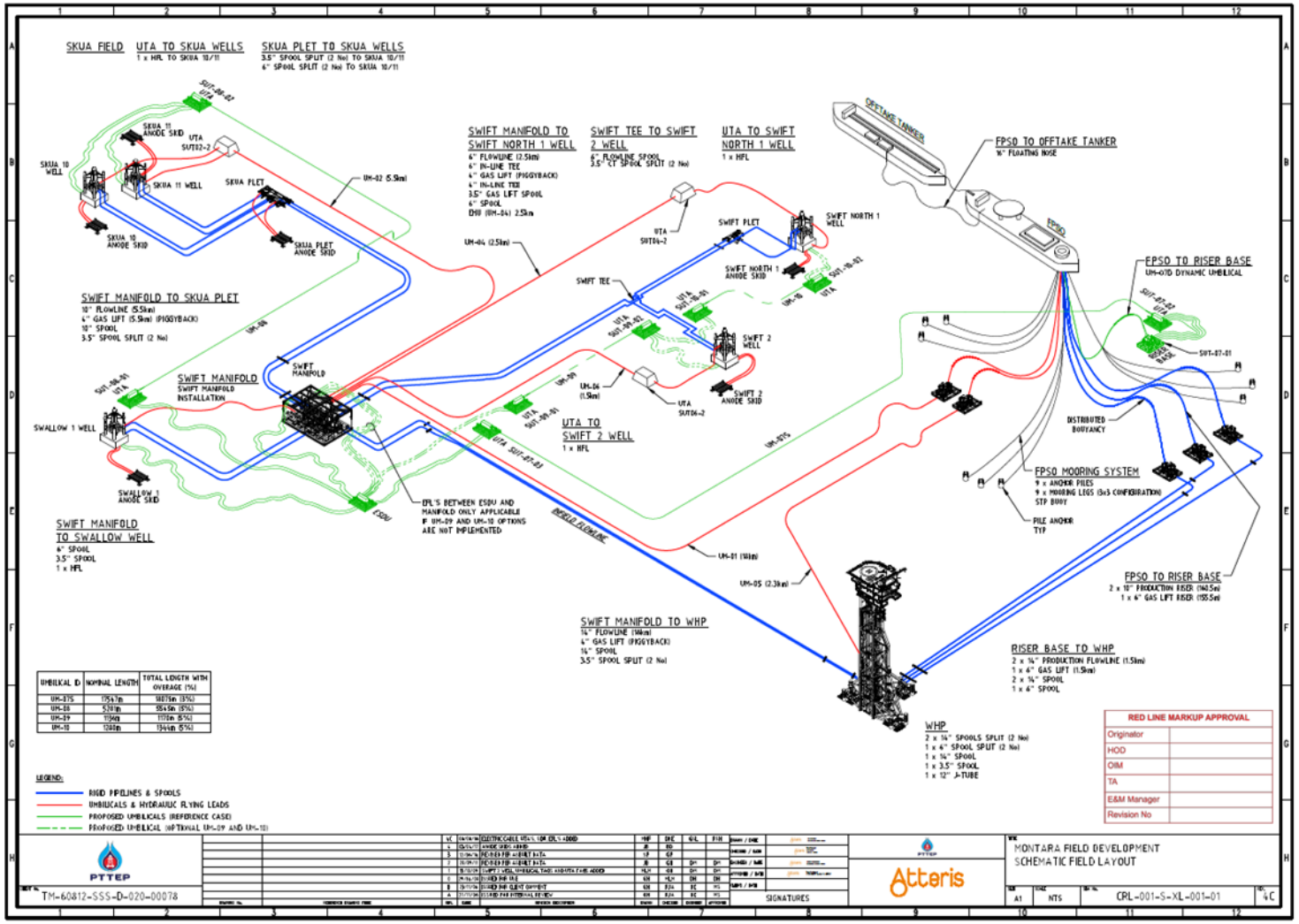



**Figure 1-2 Schematic of the *Montara* Operations field layout**

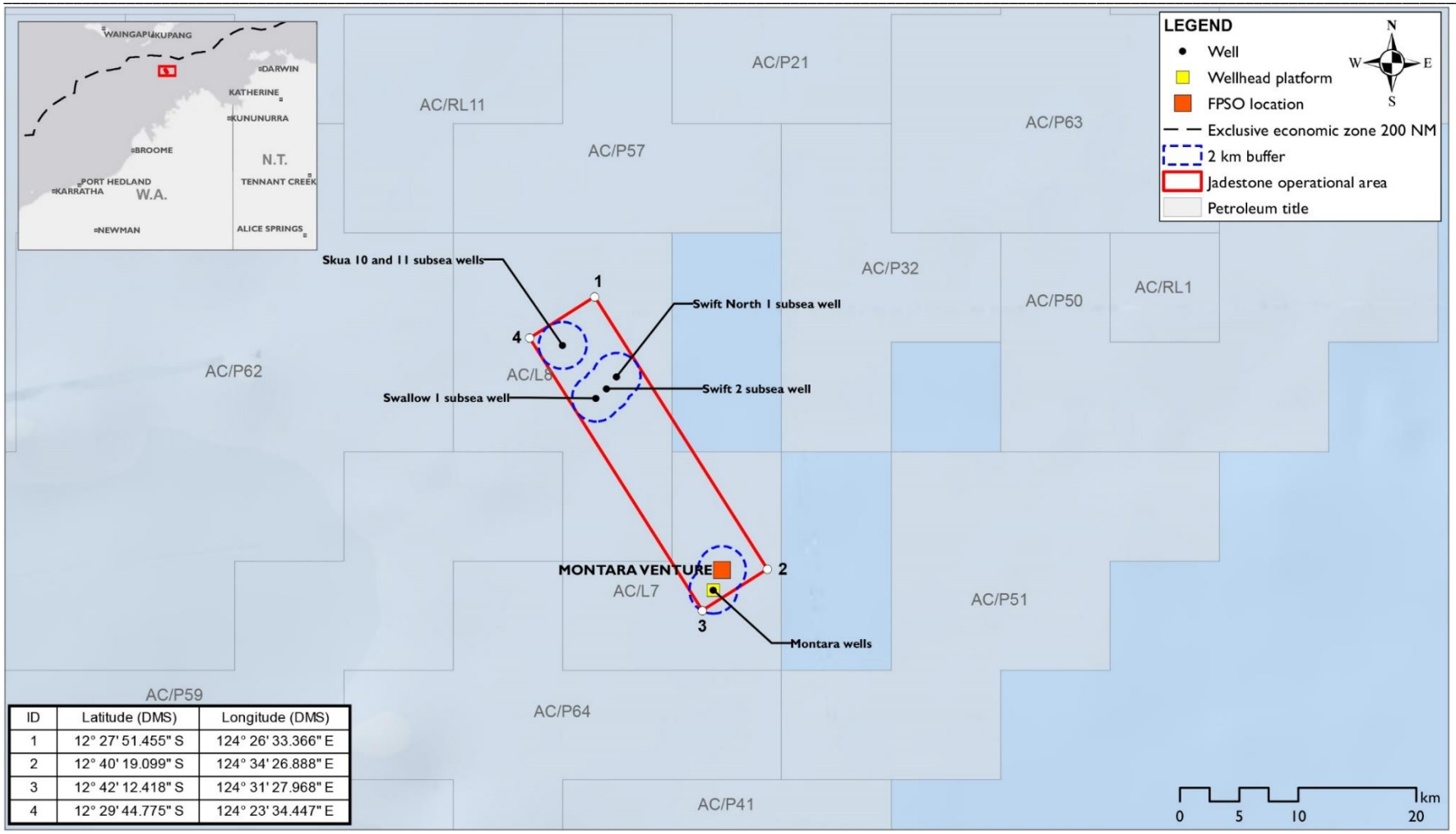
## 1.5 Scope and timing

The scope of the EP covers the following activities associated with the *Montara* Operations activity:

- Routine production, inspection, maintenance and repair (IMR) of the FSPO and WHP, wells and associated subsea infrastructure (including use of remotely operated vehicle (ROV) and diving activities);
- Support services including vessel and helicopter support; and
- Non-routine and unplanned activities and incidents associated with the above.
- The EP applies to activities undertaken within the Operational Area (Section 1.6) only as defined in the description of the activity (Section 2).
- Activities are designed to operate 24 hours per day, 365 days per year.

## 1.6 Operational Area

The Operational Area is defined as a 2 km boundary around all topsides and subsea infrastructure within production licenses AC/L7 and AC/L8 (Figure **1-3**).




| ID | Latitude (DMS) | Longitude (DMS) |
|---|---|---|
| 1 | 12° 27' 51.455" S | 124° 26' 33.366" E |
| 2 | 12° 40' 19.099" S | 124° 34' 26.888" E |
| 3 | 12° 42' 12.418" S | 124° 31' 27.968" E |
| 4 | 12° 29' 44.775" S | 124° 23' 34.447" E |

**Figure 1-3 Operational Area for the *Montara* Operations Activity**

# 2 DESCRIPTION OF THE ACTIVITY

## 2.1 Field infrastructure

### 2.1.1 Overview

Oil is extracted from production wells in each of the *Montara*, Skua, Swift and Swallow fields and is transported in flow lines to the *Montara Venture* FPSO facility via the *Montara* wellhead platform (WHP). No hydrocarbon processing is performed on the WHP. Hydrocarbon production fluids from the Swift, Swallow and Skua subsea wells are co-mingled subsea and arrive at the WHP to then be co-mingled with the *Montara* production fluids, or *Montara* can be segregated via one of the export flowlines. The co-mingled fluids are then exported to the FPSO via the two export flowlines.

### 2.1.2 Wells

The *Montara* Operations activity consists of both subsea and dry platform wells with associated subsea trees and dry platform trees. The subsurface completion consists of the wellbore drilled to penetrate the oil-bearing sands, and all equipment items installed within the wellbore are designed to allow well fluids to be produced in a safe and controlled manner. A fail safe (closed) Surface Controlled Subsurface Safety Valve (SCSSV) is installed in each well's tubing string at approximately 300m below the seabed to prevent uncontrolled flow in an emergency.

### 2.1.3 Manifold

Production fluids from the production wells co-mingle at the Swift manifold which incorporates multi-phase metering, chemical/ controls umbilicals, gas lift distribution and supports the subsea distribution unit for the subsea production control system. Valving is arranged to allow periodic individual well testing.

### 2.1.4 Flowlines and spools

The 10 flowlines and spools are carbon steel, with the exception of the connection to the FPSO where there is a transition to flexible flowlines. The flowlines are installed on the seabed untrenched, with the gas lift flowlines piggybacked onto the main production lines. All carbon steel flowlines are coated with 3LPP for external corrosion protection. The WHP to FPSO production flowlines are concrete-coated to achieve on-bottom stability.

Hydrocarbons produced from the wells are transported via flexible risers connected through the Submerged Turret Production Buoy. The flexible riser system consists of three risers, each configured in a steep wave configuration running through the Buoy to individual riser bases supported by buoyancy modules.

### 2.1.5 Umbilicals

The umbilicals supply instrument power, signal, hydraulic power and chemical injection from the FPSO to each of the subsea wells and the Swift manifold. A separate umbilical supplies these services in addition to electric power and fibre optic control/communication from the FPSO to the WHP.

The umbilicals consist of thermoplastic hoses, insulated cables, plastic fillers and steel armour wire wrapped in a polymer outer sheath. They are laid directly on the seabed and are not buried.

### 2.1.6 Well head platform

The wellhead platform (WHP) is unmanned and is visited as required for maintenance and operations purposes. A maximum of 10 persons on board can attend the WHP when in production and 20 during campaigns. The WHP is designed to act as a support structure for *Montara* wellheads and risers, including future allowances while:

- Collecting and co-mingling the output from the individual wells and facilitate well flow rate and control;
- Providing for gas re-injection and gas lift;
- Providing for remote control from the FPSO; and
- Providing for well testing and the ability to backflow re-injection gas through flowlines.

### 2.1.7 *Montara* FPSO

The *Montara Venture* FPSO is a 274.3m production vessel (IMO number 8714982) which includes the following:

- 1 x three-stage oil separation train
- Gas reinjection compressor
- Gas dehydration and re-generation
- Electrical power generation and distribution;
- Seawater cooling water lift pumps;
- Crude offloading facility
- Produced water treatment
- Fuel gas treatment
- Inert gas system
- Flare tower
- Chemical injection and storage
- Accommodation facilities
- Submerged turret production, hydraulic power unit systems

The FPSO is moored by a Single Point Mooring (SPM) system. The system comprises nine chain and wire mooring legs secured to the seabed by piles, a buoy and riser system and a fluid, gas, power and utility swivel system. Each mooring line is composed of chain and wire rope segments, which is connected to a Submerged Turret Production (STP) buoy at the turret level and to 9 driven anchor piles driven to a depth of approximately 23 metres. The turret for the FPSO has an inboard design to allow the vessel to freely weathervane at all times. The FPSO is designed to remain on station during all weather conditions and will be permanently moored with disconnection only anticipated should the FPSO require shipyard facilities. Operations on the turret will be limited to maintenance and repair activities. The turret will provide connections for all dynamic risers and umbilical line.

## 2.2 Operational activities

### 2.2.1 Commissioning

The recycle compressor will be reinstated and commissioned to recover hydrocarbons from gas currently going to flare.

Commissioning of infill wells will also be required; but will be part of the standard procedures as per the Safety Case and WOMP requirements.

As part of the engineering work required for these activities, an environmental impact assessment will be completed and evaluated against the in-force EP as part of the Management of Change process required with the engineering change. If further impacts or controls are determined from the impact assessment due to changed emissions and discharges, the EP will be revised and resubmitted to NOPSEMA for assessment.

### 2.2.2 Hydrocarbon processing

#### 2.2.2.1 Bulk Separation

On the FPSO, the production fluids are processed through a three-stage separation system into oil, gas and water. The oil stream is stabilised to meet specifications for storage, transport and sale. Separation of fluids and stabilisation of oil occur through of a high-pressure (HP) separator, medium pressure (MP) separator and low-pressure (LP) separator in series.

The bulk of the produced water (PW) and gas are separated from the oil during the separation process. Gas from the separator is routed to the reinjection gas compression system; oil is routed to the crude oil heater and PW routed to the PW degasser. Further gas and water is removed by the second and third stage separators. Oil from second stage separation is routed to the third stage separator where it is pumped or gravitated through crude oil rundown cooler and into the storage tank.

#### 2.2.2.2 Gas treatment

Associated gases are routed from the separation process to the reinjection gas compression system. This gas stream is compressed, dehydrated and cooled prior to use as fuel gas on the FPSO, and lift gas at each well, with the surplus reinjected into the *Montara* reservoir through the G2 reinjection well on the WHP. Gas for gas lift is exported from the FPSO via the gas swivel and gas lift flowline network. Dehydration is achieved via a glycol contactor located between the second and third stages of the three-stage reinjection compressor. Water recovered from gas dehydration is boiled off with stripping gas to LP flare at the glycol reboiler and still column.

#### 2.2.2.3 Produced water

Produced formation water (PW) associated with production fluids is routed from the separation process to the storage tanks. It is then pumped to the PW treatment system consisting of two hydrocyclone units, a degasser, discharge cooler, PW pumps and valving and pipework to route the water either directly overboard or diverted back to the PW storage tanks. Both streams incorporate a monitoring system for monitoring discharged oil-in-water levels.

The hydrocyclones are designed to reduce the oil content from a maximum oily water concentration of 2,000 mg/L to a treated water discharge concentration below 30 mg/L for discharge overboard. If the oil content of the treated PW is above the prescribed level, then the flow is diverted automatically back to the PW tanks and recirculated until the oil in water level in the treated water stream is sufficiently reduced to resume overboard discharge.

#### 2.2.2.4 Bilges

There are three bilge wells in the machinery space which collect oily water drainage from the various items of equipment in the space. These wells are monitored by high level alarms and are manually emptied to the

bilge holding tank using the bilge pump. The contents of the bilge holding tank are then pumped to the slop tank where it is treated for oil recovery and water handling.

#### 2.2.2.5 Slops water

Slops water consists of oily water from the open and closed drain system, bilge system and tank stripping and washing operations that is collected in the Slops Tanks on the FPSO.

The process plant is provided with three separate drains facilities - open hazardous drains, open non-hazardous drains and closed hazardous drains.

An open drain system is provided to collect drips and spills from various areas on the installation and direct the liquids to the slops tanks for treatment and disposal. Levels in the Slops Tanks are monitored remotely in the CCR utilising a continuous wave radar level measurement device fitted to each of the tanks with a high and high-high level alarm facility. Slops can be redirected to cargo storage tanks if required.

Open drains also collect rainwater and deck wash-down water, which may be contaminated with low levels of detergents, oil and grease, used machinery chemicals and general dirt from the deck.

Open non-hazardous drains flow directly to the main deck via the grated process decks, where they can be discharged overboard via the scuppers. The scuppers are normally unplugged for safety reasons to allow hydrocarbon spills (during a major accident event) outside of primary containment (and rainwater or seawater) to drain, thus minimising the potential for a pool to collect and ignite. For a minor spill, the scuppers may be plugged to allow for the containment and clean-up.

The closed hazardous drain system collects fluid from process vessels and elsewhere throughout the process including PW treatment, Flare Knockout, Fuel Gas Treatment and Oil Separation.

A hazardous closed drain header is provided for the main hydrocarbon containing vessels. This is routed to the LP flare drum.

Washing of crude oil cargo tanks generally occurs as part of an offloading operation. Periodic tank cleaning is typically undertaken on completion of crude oil washing to remove sludge for maintenance purposes or in preparation of tank inspections. Oil and water recovered from tank washing is circulated to the Slops Tanks.

The slops system consists of one “dirty” and one “clean” tank Both tanks use gravity to separate the oil from the water. When sufficient oil has collected in the slops tank, the cargo discharge or stripping pumps are used to pump the oil to the crude storage tanks. The water is transferred to the dirty slops tank for gravity separation and further transferred to the PW storage tanks for treatment and discharge via the PW treatment system.

#### 2.2.2.6 Volatisation of product and venting

A degree of volatisation of the crude oil product occurs while it is held in the FPSO’s storage tanks. These volatile organic compounds (VOCs) and light hydrocarbons are contained in the head space within each tank, the volume of which varies as crude oil is transferred into and out of the tanks. The build-up of VOCs, with the inherent risk of combustion, is minimised by the FPSO’s inert gas system which displaces the oxygen within the tanks.

The VOCs may be vented to atmosphere by displacement with inert gas. The rate of venting increases as product is transferred into a tank, reducing the volume of the head space therefore displacing VOCs.

#### 2.2.2.7 Crude oil storage and offloading

Stabilised crude is contained within the FPSO's ten dedicated crude storage tanks prior to offloading to export tankers. Capacities range from 11,570m$^3$ to 29,152m$^3$ with a total storage of 156,712m$^3$.

Levels in the tanks are monitored remotely in the CCR utilising a continuous wave radar level measurement device fitted to each of the cargo tanks with a level alarm facility.

Crude Oil Washing of cargo tanks generally takes place as part of an offloading operation to remove wax deposits and crude build-up. The washing medium is stabilised crude jettied at high pressure. The tanks are also cleaned periodically for maintenance and inspections purposes.

Crude oil is offloaded to a commercial offtake tanker moored in tandem configuration at the stern of the FPSO. The frequency of offtake depends on production rates.

#### 2.2.2.8 Flaring

Flaring is minimised as produced gas is used as fuel gas, gas lift or re-injected into the gas injection well. In the case of shutdown of the reinjection system, gas is temporarily diverted via flare knock-out (KO) drums to the flare system. Purge gas for the flare headers, required for safety reason and from the glycol system will also be routed to the flare.

Planned maintenance undertaken on the reinjection system and unplanned down-time will result in flaring volumes greater than during routine operations.

#### 2.2.2.9 Light well intervention

Light well intervention (LWI) activities may be necessary to maintain well integrity levels and to optimise production from the existing wells, estimated at four interventions over the five-year period.

While LWI activities do not make use of a drilling BOP, additional barriers including lubricators, check valves, wireline blowout preventers, stuffing boxes and riserless well control packages (subsea) are installed on the well to ensure that the two-barrier philosophy is maintained during the activity. These barriers can either be automatic or manually operated if required in the event of an emergency. These interventions can utilise slickline, braided line, electric line (utilising a tractor or as required), digital line or coiled tubing. The intervention may be performed from a vessel for subsea wells (Riserless Light Well Intervention – RLWI), or from the helideck in the circumstance of wells at the *Montara* Wellhead (WHP) Platform wells

Each well intervention campaign can cover one or more wells and can last up to 30 days per well.

#### 2.2.2.10 Chemicals and hazardous materials

Chemical injection is required at all the wells and topside facilities to typically provide scale inhibitors, corrosion inhibitors, hydrate inhibitors, biocides, emulsion breakers, water clarifiers and pour point depressants.

Chemicals will be stored and supplied from the FPSO to the wells via the combined chemical/ control umbilicals. The chemical injection system consists of topsides chemical injection skid packages on the FPSO for hydrate inhibitor, PPD, corrosion inhibitor, and scale inhibitor.

In addition to hydrocarbons associated with the processing and storage facilities, hazardous materials include diesel, lube oils, hydraulic oil, aviation fuel, acetylene, oxygen, nitrogen, hydrogen, radioactive

materials, paint and thinners, and proprietary cleaning agents as well as chemicals for chemical injection listed in the preceding section. Safety Data Sheets (SDSs) for all hazardous substances are maintained on a database aboard the FPSO as well as hard copies that are kept in the general office of the FPSO.

On the WHP, hazardous materials are stored in bunded laydown areas, again in accordance with the relevant SDSs.

## 2.3 Production hydrocarbons

*Montara* crude is a medium crude oi with a low viscosity (4.5 cP) and a medium density of 845 kg/m$^3$ (API 35.8) categorising it as a Group III oil in accordance with the International Tanker Owners Pollution Federation (ITOPF 2011).

The oil from Skua, Swift and Swallow fields that are comingled with *Montara* oil to varying degrees are considered Group II oils (International Tanker Owners Pollution Federation (ITOPF 2011) with low viscosities of 3.0, 3.8 and 3.2 centiPoise and medium densities of 42.7, 43 and 49.5 API, respectively.

## 2.4 Fuel oil

The FPSO is equipped with two diesel bunkering stations. Specific bunkering procedures are contained in Jadestone Energy's *Montara* Marine Facility Manual. The 6 bulk fuel oil/ diesel tanks are within the hull, with capacities ranging from 64 to 906m$^3$ (at 95% capacity).

Contingency plans are in place for dealing with emergencies including spills with the *Montara* Operations OPEP detailing the response to oil spills.

During bunkering, there shall be direct contact via agreed VHF channel between the transfer vessel and the FPSO. Should there be a spill, pumping will be stopped immediately, and the general alarm sounded. The vessel SOPEP, *Montara* Operations OPEP and *Montara* Incident Response Plan will be initiated.

The FPSO generally operates on fuel gas, however if due to maintenance or unplanned events the maximum diesel usage per month would require one to two supply boat bunker trips per month (depending on boat size).

## 2.5 Naturally occurring radioactive material

Naturally Occurring Radioactive Materials (NORMs) can sometimes be present in the piping and vessels of an oil processing facility. NORMs are in the category of low specific activity (LSA) radioactive materials which can emit a limited (non-fatal) amount of radiation. This EP addresses risk with NORMs in relation to removal and disposal ashore. NORMs are managed in accordance with the *Montara* Radiation Management Plan. This plan has been developed in accordance with the Northern Territory Radiation Protection Act, to outline the potential sources, storage, transportation, and emergency management requirements.

## 2.6 Maintenance

The facility is designed for continuous service with a design life of 20 years. The FPSO vessel, turret and mooring systems have been designed to allow all essential maintenance and mandatory inspections to be performed in the field whilst in continuous operation without dry-docking, with in-water survey in lieu of dry docking.

Jadestone Energy utilises Integrity Management from within the Computerised Maintenance Management System (CMMS) as defined by Performance Standards. All systems and equipment shall be maintained to meet the specified functions in accordance with these performance standards and process requirements.

Maintenance activities are detailed and recorded in the CMMS. Each maintenance activity has a priority based on its criticality identified during Safety Integrity Level (SIL) analysis, the Formal Safety Assessment and associated studies. A history of the maintenance for a piece of equipment can be recalled by the system at any time, and reminders are automatically generated by the system for periodic inspection, testing and maintenance. It is maintained via the intranet by the Operations team, and subject to audit and review. Maintenance Management System workshops were held to determine equipment priority level and captured in the CMMS.

The subsea infrastructure is designed to be maintenance free over the entire life of the field, however there are several sub-assemblies in the trees that may wear or fail in service that are replaceable.

Other activities completed on the subsea infrastructure during the life of field include repairs to damaged components, replacement of umbilicals, anode-retrofits, external inspection, measurement, non-destructive testing, rectification of scour or freespans, and cleaning of marine growth. Stabilization of freespans is by installing supports under the flowline at the mid-point of the span. using concrete mattresses, grout bags, concrete sleepers and inflatable grout pyramids.

If the span is in evidence and remains over length during inspection, an engineering assessment is conducted to determine the risk of damage. If the risk assessment determines that freespan rectification is required, the management of change process will ensue.

## 2.7 Utilities

### 2.7.1 Power generation and distribution

Main electrical power for the FPSO is provided by two gas turbine generators. The gas turbines are dual fuelled units, normally operating on fuel gas produced from the process train but can operate on diesel. Hydraulic power, chemical injection, electric power and fibre optic control/communication are supplied to the WHP via the subsea umbilical from the FPSO. The subsea umbilical cable will also provide fibre optic communications between the WHP and the FPSO.

Auxiliary power is provided by three diesel powered generators. An emergency generator supplies the emergency switchboard. The emergency generator start is fully automatic on loss of voltage on the essential switchboard. It can also be manually started in the emergency generator room.

In case of main power failure, the emergency diesel generator supplies power to services essential for safety. If main power and emergency power are unavailable, the 24 V DC UPS system supplies power to critical users requiring a no-break supply during the period of emergency or the loss of main power supply.

The WHP power generator is not required for normal operations, only for maintenance visits.

During operations, the WHP is powered by the FPSO via a subsea umbilical. In the event there is no power supply to WHP, the WHP generator is used for maintenance purposes.

### 2.7.2 Boilers

The two boilers that provide steam have been converted to dual fuel, operating normally on fuel gas with the option to use diesel. The boiler exhaust gas is the source of inert gas used to blanket the cargo tanks.

### 2.7.3 Compressed air systems

There are two compressed air systems on the FPSO which provide instrument air.

### 2.7.4 Nitrogen generation package

The nitrogen generation package provides nitrogen for the supply of inert gas to the flare and process facilities. Filtered instrument air is supplied to the nitrogen generator membrane separators. Using reverse osmosis, two streams of gas are produced; one 95–99% pure nitrogen and the other is oxygen rich and vented.

### 2.7.5 Fresh water generators

The two freshwater generators that provide potable water are fed seawater from the seawater system. Potable water is supplied to the accommodation for domestic services (via ultraviolet sterilizers and clarifiers). Potable water is also supplied to the essential diesel engine expansion tanks, emergency generator room, eye wash and safety shower systems and the utilities water system on deck. Freshwater can also be bunkered to augment the water generators if required.

### 2.7.6 Seawater lift pumps

Two seawater lift pumps provide seawater for cooling purposes. The seawater passes through two manually operated strainers to remove any marine solid particles. Marine growth in the caisson is controlled by sterilisation via electrolysis. The seawater is deoxygenated, sterilised by the release of chlorine from the salt solution and then circulated through a heat exchange prior to discharge back into the ocean.

### 2.7.7 Sewage, greywater and putrescible waste system

The FPSO sewerage system consists of a grey water collection system and a black water collection system from the accommodation (for a maximum of 78 people on board and 25–30 people during normal production operations).

The sewage treatment unit is self-contained, using aerobic sewage digestion coupled with treatment of the final effluent. Sewage is exposed to bacteria and aeration which breaks down the sewage before discharge overboard in accordance with MARPOL regulations. During planned maintenance periods on the sewage treatment system, sewage will be discharged from the system untreated into the marine environment for a limited amount of time (24–48 hours) at a frequency expected to be approximately 4–6 times annually.

Putrescible waste from the galley shall be discharged to sea after maceration to a particle size of less than 25 mm in accordance with MARPOL.

### 2.7.8 Solid waste management

Non-hazardous solid waste materials may include paper, rope, cardboard, sacking, timbers, scrap metal, domestic packaging (food and drink containers) and plastic.

Hazardous waste associated with the facilities may include fuel and lubricating oils, aerosol cans, batteries, acids/ caustics, chemicals associated with operation and maintenance processes, spent fluorescent tubes, paint and thinners and proprietary cleaning agents. All dangerous goods or materials will be assessed case by case.

Storage and handling of mixed class of dangerous goods in packages and intermediate bulk containers and corrosive substances will follow the guidelines set in AS/NZS 3833 and 3780 respectively. The transport of hazardous wastes is regulated using the Multimodal Dangerous Goods Form in accordance with MARPOL 73/78 Annex III Regulation 4, and in accordance with State and Territory legislative requirements.

## 2.8 Emergency shutdown

The *Montara* Emergency shutdown is staged and follows the *Montara* Emergency Shutdown System Philosophy. The types of shutdown include manual shut down, WHP shutdown, PSD process shutdown, total production shutdown, total facility shutdown and abandon field.

## 2.9 Support facilities

### 2.9.1 Aviation

Regular crew change and freight exchange are via fixed wing aircraft followed by a helicopter transfer to the facility. There are typically an average of two crew change flights per week plus additional flights on an as-required basis for visitors, maintenance campaigns, non-standard operational activities etc. A helicopter refuelling system is installed on the upper deck.

### 2.9.2 Supply vessels and support operations

Regular supply vessel runs to the facility typically occur once every two to three weeks. General cargo is offloaded by the mid-ships crane and galley stores via the aft crane. In conjunction with the visits to the FPSO, supply boats may visit the WHP to deliver maintenance supplies.

Support vessels are utilised for activities such as inspection, maintenance and remedial works including ROV inspection of subsea systems, as well as static tow during offtake. Underwater operations may be carried out using diving or ROV support vessels.

### 2.9.3 Underwater operations

The following types of underwater operations may be undertaken during the life of operation but are not limited to, the inspection of subsea equipment (including use of side scan sonar), metrology, non-destructive testing, hull survey, cleaning of the sea chests and anode-replacements.

# 3 DESCRIPTION OF THE ENVIRONMENT

## 3.1 Defining the EMBA

Jadestone Energy has evaluated the values and sensitivities within two geographical areas related to the *Montara* Operations activity:

- **The Operational Area** – the geographical area encompassing the environment that may be affected by the planned activities (Section **1.6**); and
- The **Environments that May Be Affected (EMBA)** – the geographical area encompassing the environment that may be affected by the unplanned events associated with the activities described (**Section 2**). The maximum extent of an oil spill due to a loss of well control (LOWC) resulting in a major blowout has been used to inform the oil spill response planning and oil spill risk assessment.

Appendix 1 describes the regional setting, physical and biological environments and social values.

# 4 ASSESSMENT - PLANNED ACTIVITIES

## 4.1 Light Emissions

### 4.1.1 Description of aspect

The FPSO, WHP and support vessels will generate light emissions comprising direct light spill on the ocean navigational and safety lighting, and continuous flaring from the FPSO (e.g. routine operations, process upset conditions).

### 4.1.2 Impact description

Some fish and zooplankton species are attracted to light sources while other species may prey upon higher than usual concentrations of zooplankton attracted to a vessel's light. The Operational Area does not contain any significant feeding, breeding or aggregation areas for fish so it is more likely there will individuals traversing the area than large groups of species.

While turtles use a variety of light cues for navigation especially hatchlings following their emergence from nests, the closest turtle nesting habitat to the Operational Area is Cartier Island (84 km distant) and nearest BIA for green turtle is 64 km away.

Migratory seabirds may be attracted to artificial lights. Given the Operational Area is outside a flyway, and the nearest migratory bird breeding/roosting site is Cartier Island (~ 84 km from the FPSO), only a small number of seabirds are expected to be affected whilst in transit resulting in possible behavioural disturbances (e.g. disorientation and attraction) to individuals.

### 4.1.3 Summary of environmental performance

| **Aspect** | **Light** |
|---|---|
| **Performance Outcome** | Activity lighting managed in accordance with OHS requirements |
| **Management Controls** | Performance standards |
| **Performance Standards Report ensures navigation aids and equipment meet regulatory and safety requirements** | Facility navigation lights are visible as per COLREGs requirements. |
| **Performance Standards Report ensures navigational lights are present and working** | Aircraft warning lights mark tall objects that may be an obstruction to a helicopter approach to the helideck.<br><br>Marine Navigational lights are positioned on infrastructure such that at least one light is visible to a vessel approaching from any direction. |

### 4.1.4 ALARP assessment

| Rejected Control | Justification |
|---|---|
| All activities completed in daylight hours only<br><br>Practical or cost effective - no | Daylight operations only will introduce unnecessary cost (i.e. 12 vs 24-hour ops.), whilst delivering little/ no environmental benefit. The operations cannot be shut down on a daily basis, and there would be a >100% increase in time taken to complete the activities resulting in significant costs and loss of production. Light from the FPSO, WHP and vessels does not illuminate beaches where receptors sensitive to light emissions may be present. |
| Replace external lights or reduce the lighting<br><br>Practical or cost effective - no | Lights are required to create illumination levels needed for safe working, emergencies and navigational requirements. 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<br><br>Practical or cost effective - no | Lighting has been positioned to achieve maximum illumination of work surfaces within asset structures. Considered costly and grossly disproportionate to any gain when considering distances from the Operational Area to turtle and seabird nesting areas. |
| Reduce usage of lighting in peak sensitive receptor windows<br><br>Practical or cost effective - no | To ensure lighting meets health and safety requirements, lighting is required throughout the day/ night for the duration of the activities. To isolate usage such that lights were not used during sensitive receptor windows would create a non-conformance with health and safety requirements. |
| Steam facilitating low opacity emissions<br><br>Practical - yes, cost effective - no. | A steam system would need to be supplied with steam 24 hr/day if it was required for combustion emission management (i.e. instantaneously operable). This would place an operational load on the. The boiler system may need to be redesigned to enable the steam supply function to the flare tip (the cost for re-engineering the boiler has not been considered in this assessment). |
| High pressure water cleaning to create white smoke<br><br>Practical - yes, cost effective - no. | The cost that would be incurred due to engineering design, construction and commissioning of a high-pressure water cleaning system at the flare tip. The cost for the improvement versus the benefit that would be achieved is not ALARP. |
| Increased flaring can result in better combustion at the flare tip due to the sonic design of flare<br><br>Practical - yes, cost effective - yes | More efficient combustion can reduce the opacity of emissions. Not adopted – the increased flaring would be contrary to the intent of the environmental performance outcome of planned flaring operations |

### 4.1.5 Acceptability Assessment summary

| | |
|---|---|
| **Policy & management system compliance** | Jadestone Energy's HSE Policy objectives are met. Section 7 demonstrates that Jadestone Energy's HSE Management System is capable of meeting environmental management requirements for the activities. |

| | |
|---|---|
| **Stakeholders & reputation** | Stakeholder consultation has been undertaken (see Section 6), and no stakeholder concerns have been raised with regards to impacts from lighting on sensitive receptors. |
| **Environmental context & ESD** | While there is direct light spill to sea surface immediately around the FPSO, WHP and support vessels, the impact assessment indicates that the light spill will not cause significant effects to adult turtles or birds that may transit the Operational Area. The potential impact is considered acceptable after consideration of:<br>• Potential impact pathways;<br>• Preservation of critical habitats;<br>• Assessment of key threats as described in species and Area Management / Recovery plans;<br>• Consideration of North-West Bioregional Plan; and<br>• Principles of ecologically sustainable development. |
| **Conservation and management advice** | 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 consistent with the Recovery Plan.<br>Jadestone Energy has had regard to the representative values of the protected areas within the adjacent EMBA, and the respective management plans and other published information. Impacts from light emissions will have a negligible impact on any of the social and ecological objectives and values, of any AMPs, or state marine parks. This is consistent with the objectives of the protected area management plans and considered acceptable. |

## 4.2 Noise emissions

### 4.2.1 Description of aspect

Noise will be generated during *Montara* Operations including from machinery, operational noise from wellheads and flowlines, vessels engines, helicopters and side scan sonar from ROVs.

### 4.2.2 Impact description

Continuous and impulsive noise above thresholds can result in behavioural changes (such as avoidance), masking of communications, interfering with prey/predator signals and damage to the auditory systems of marine fauna.

The noise assessment considered sound intensity levels measured from a similar FPSO, helicopter activities and related activities and compared them to natural noise sources and published thresholds for auditory damage and responses for fauna.

Cetaceans - Transient whales may pass through the Operational Area, but the Area does not contain any significant feeding, breeding or aggregation areas for marine mammals. The nearest BIA for cetaceans is the pygmy blue whale migration BIA, which is located 80 km from the Operational Area and is therefore not expected to be impacted by noise from the operations.

Reptiles - The Operational Area does not intersect any known turtle inter-nesting areas and is 84 km from nearest BIA and key turtle nesting sites (Cartier Island); hence any impacts are expected to be limited to transient individuals resulting in localised behavioural impacts.

Fish, rays and sharks - There are also no known key feeding/breeding areas occur within the Operational Area, however fish will likely transit the area, with only behavioural affects (e.g. changes to schooling behaviour and avoidance of noise sources) predicted.

Birds - It is not expected that noise generated from activities will greatly affect seabirds and shorebirds that may overfly or land on the facility. Therefore, any impacts are expected to be limited to behavioural impacts to individuals.

### 4.2.3 Summary of environmental performance

| **Aspect** | **Noise** |
|---|---|
| Performance Outcome | Controls implemented to minimise potential harmful impacts to marine fauna from noise |
| Management Controls | Performance standards |
| Support vessels will comply with EPBC Regulations 8.05 and 8.06 as per *Montara* Marine Facility Operating Manual | Support Vessel Masters will comply with relevant parts of EPBC Regulation (2000): Reg. 8.05 & 8.06 regarding:<br>• Minimising noise and maintaining speeds <6knots when within caution zones for cetacean and calves<br>• Stopping, turning off engines or disengaging gears or withdrawing at constant speed <6knots if a calf appears in the caution zone |
| Helicopters will comply with EPBC Regulations 8.07 as per Aviation Operations Procedure | Helicopters will comply with the following elements of EPBC Regulations 2000 Reg 8.07, except during take-off/ landing, during an emergency or when action is required to maintain safe operations regarding:<br>• No operation below 1,650 ft or within a horizontal radius of 500 m of a cetacean;<br>• A helicopter will not deliberately approach a cetacean from head-on.<br>Report any breaches of these standards, and any event involving injury to or death of marine fauna due to helicopter operations. |
| FPSO & WHP machinery is certified and maintained | FPSO & WHP machinery is maintained in accordance with CMMS. |

### 4.2.4 ALARP assessment

| **Rejected Control** | **Justification** |
|---|---|
| Remove machinery that emits noise<br>Practical and cost effective - no | Noise from the FPSO, vessels, ROVs, helicopters and machinery cannot be eliminated. Without these assets, the activities cannot be undertaken. |
| Replace noisy machinery with quieter machinery<br>Practical and cost effective - no | All equipment as listed is required; no opportunities for substitution were identified. |

| | |
|---|---|
| Provide additional muffling on machinery, or design to reduce noise<br><br>Practical and cost effective - 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 times/ areas of sensitivity<br><br>Practical and cost effective - no | The activities are located at distance from sensitive receptors and the coastline. Other fauna in the vicinity may experience short term behavioral effects only. |
| Additional activity specific noise emissions procedures for assets<br><br>Practical and cost effective - 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. |

### 4.2.5 Acceptability assessment

| | |
|---|---|
| **Policy & management system compliance** | Jadestone Energy's HSE Policy objectives are met. Section 7 demonstrates that Jadestone Energy's HSE Management System is capable of meeting environmental management requirements for the proposed drilling activities. |
| **Stakeholders & reputation** | Stakeholder consultation has been undertaken (see Section 6), and no stakeholder concerns have been raised with regards to impacts from noise on sensitive receptors. |
| **Environmental context & ESD** | While there are noise emissions expected, the impact and risk assessment process indicate that noise will not result in death, injury or significant behavioral effects to marine fauna<br><br>The potential impact is considered acceptable after consideration of:<br><br>• Potential impact pathways<br>• Preservation of critical habitats<br>• Assessment of key threats as described in species and Area Management/ Recovery plans<br>• Consideration of North-West Bioregional Plan; and<br>• Principles of ecologically sustainable development (ESD). |
| **Conservation and management advice** | Noise interference is identified as a threat in:<br><br>• The Recovery Plan for Marine Turtles in Australia (DoEE 2017a)<br>• Approved Conservation Advice for Humpback Whale (*M. novaeangliae*) (TSSC 2015a)<br>• The Conservation Management Plan (Recovery Plan) for the Blue Whale (*B. musculus*) (DoH 2005) (no longer in effect)<br><br>Jadestone Energy considered the representative values of the protected areas within the EMBA, and the respective management plans and other published information. Impacts from noise will have a negligible impact on any of the social and ecological objectives and values, of any AMPs, or state marine parks. This is consistent with the objectives of the protected area management plans and considered acceptable.<br><br>EPBC Regulation 8 and the Australian National Guidelines for Whale and Dolphin Watching 2005 (DEH 2006).<br><br>Noise is not identified as a risk in the Whale Shark Management Plan. |

## 4.3 Atmospheric emissions

### 4.3.1 Description of aspect

The main sources of atmospheric emissions during operational activities include flaring on the FPSO, power generation for machinery and vessel operations, venting from product storage and off take and fugitive emissions. The combustion of fuel to power vessel engines, generators and mobile and fixed plants and equipment result in emissions of greenhouse gases (GHG) and non-GHG (e.g. sulphur oxides, nitrous oxides).

### 4.3.2 Impacts

As *Montara* Facility operations occur in offshore waters, emissions will not impact on air quality in coastal towns or other sensitive locations. No impacts to social receptors are expected.

A reduction in air quality may have a temporary effect on transient bird species passing through the Operational Area. No avifauna BIAs overlap the Operational Area. The Operational Area is outside a flyway, and the nearest migratory bird breeding/ roosting site is Cartier Island which is located approximately 84 km from the FPSO. Hence only a small number of seabirds are expected to be affected by a reduction in air quality for a short period whilst in transit, possibly resulting in behavioural disturbances such as alterations of flight path.

### 4.3.3 Summary of environmental performance

| **Aspect** | **Atmospheric emissions** |
|---|---|
| **Performance Outcome** | No unplanned emissions to the atmosphere; Emissions to air meet regulatory requirements |
| **Management Controls** | Performance standards |
| **CMMS requires equipment certification and maintenance** | All engines, compressors and machinery on the FPSO and WHP are maintained via the CMMS |
| **International Air Pollution Prevention (IAPP) Certificate valid** | FPSO and vessels will maintain a current International Air Pollution Prevention Certificate or equivalent which confirms that the following measures during the activity are in place - prevent ozone-depleting substance emissions; and reduce NOx and SOx |
| **FPSO and vessels compliant with Marine Order 97** | FPSO and vessels (as appropriate to vessel class) will comply with Marine Order 97 (Marine pollution prevention – air pollution), which requires vessels to have a valid IAPP Certificate (for vessels > 400 tonnage) and use of low sulphur diesel, when possible |

### 4.3.4 ALARP Assessment

| **Rejected control** | **Justification** |
|---|---|
| All emissions producing equipment is removed<br><br>Practical -no, cost effective – 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<br><br>Practical -no, cost effective – N/A | All equipment as listed is required; no opportunities for substitution were identified. |

| | |
|---|---|
| Equipment is re-designed/ replaced with equipment designed to reduce emissions.<br><br>The facility is modified to reduce air emissions e.g. new well for reinjection, scrubbers<br><br>Practical - yes, cost effective – no | Risk and impact reduction are achieved through planned maintenance ensuring clean and efficient running of engines. |

### 4.3.5 Acceptability assessment

| | |
|---|---|
| **Policy & management system compliance** | Jadestone Energy's HSE Policy objectives are met. Section 7 demonstrates that Jadestone Energy's HSE Management System is capable of meeting environmental management requirements for the activities. |
| **Stakeholders & reputation** | 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. |
| **Environmental context & ESD** | While there are atmospheric emissions to the airshed immediately around the facility and vessels, the impact and risk assessment process indicates that emissions will not result in significant effects to the environment or receptors.<br><br>The potential impact is considered acceptable after consideration of:<br><br>• Potential impact pathways;<br>• Preservation of critical habitats;<br>• Assessment of key threats as described in species and Area Management/ Recovery plans;<br>• Consideration of North-West Bioregional Plan; and<br>• Principles of ecologically sustainable development. |
| **Conservation and management Plans** | No Management Plans identified air emissions such as those described above as being a threat to marine fauna or habitats.<br><br>Jadestone Energy has had regard to the representative values of the protected areas within the EMBA, and the respective management plans and other published information. Impacts from atmospheric emissions will have a negligible impact on any of the social and ecological objectives and values, of any AMPs, or state marine parks. This is consistent with the objectives of the protected area management plans and considered acceptable. |

## 4.4 Liquid discharges

### 4.4.1 Description of aspect

Liquid discharges generated from the FPSO and vessels and routinely discharged to the marine environment include slops water, cooling water, desalination brine, treated sewage and greywater and putrescible food waste.

Deck drainage consists primarily of stormwater and deck wash-down water, typically containing low levels of detergents, oil and grease, spilt chemicals, used machinery chemicals and dirt from the deck. Oily water from bilges will be collected and treated via an oil-water separator in accordance with MARPOL requirements. Once separated, the oil and grease will be stored ahead of transfer ashore for recycling, and the treated water discharged to sea.

Cooling water is used as a heat exchange medium to cool machinery; the water is then discharged at a temperature above ambient. Cooling water may be treated with biocide to prevent biofouling of pipes.

The typical volume of treated sewage and greywater from the *Montara* FPSO is estimated to be <35 m3/d and putrescible waste of 60 kg/d (derived from existing PTTEP AA *Montara* Operations), occurring daily all

year. During planned maintenance periods on the sewage treatment system, sewage will be discharged from the system untreated into the marine environment for a limited amount of time (24–48 hours) approximately 4–6 times annually. Support vessels operating within the permit areas routinely discharge sewage, greywater and putrescible wastes.

### 4.4.2 Impacts

#### 4.4.2.1 Deck drainage and bilge water

Given that oil and grease residues in oily water drainage will be in low concentrations, the potential for impacts 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 marine ecology.

#### 4.4.2.2 Cooling water and desalination brine

Cooling water discharges will result in a localised and temporary increase in the ambient water temperature. Discharge of cooling water has the potential to cause changes in marine ecology through elevated temperatures and trace chemical concentrations of biocides such as copper and aluminium ions which will disperse rapidly on discharge to concentrations below levels of environmental concern.

A water quality monitoring program conducted in 2017 confirmed at 100 m from the point of discharge, there has not been greater than 3°C above the ambient water temperature.

Residual brine typically has a salinity of 40,000 ppm in comparison to seawater which has a salinity of 35,000 ppm. Being denser than seawater, the brine will sink and rapidly disperse in the currents. The salinity will be further reduced due to combining of the brine with the return seawater from the *Montara* FPSO cooling water system prior to discharge. Given the relatively low volume, low increase in salinity and the deep, open water surrounding the Operational Area, impacts on fauna from increased salinity is expected to be low.

Fish and plankton are relatively small organisms that may experience increased body temperature and altered physiological processes. Given that the area of raised water temperature will be highly localised, significant impacts on a larger ecosystem or population level to fish or plankton are not expected to occur.

Given the hydrodynamically active open water environment surrounding the *Montara* Operations, it is expected that the surface discharges of cooling water and desalination brine will rapidly disperse, cool and dilute in the surrounding waters (Black et al. 1994)., therefore temperature, biocides and increased salinity loading leading to changes to water quality or behavioural changes in marine species would be negligible. Therefore, only receptors in close proximity to the discharge point have the potential to be impacted.

#### 4.4.2.3 Sewage, greywater and putrescible food waste

The potential impacts include a change in BOD and behavioural responses of marine fauna to discharges as an alternative food source. Changes in phytoplankton or zooplankton abundance and composition is expected to be localised, returning to background conditions within tens to a few hundred metres of the discharge. 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). Effects on environmental receptors up the food chain are therefore not expected beyond the immediate vicinity of the discharge in deep open waters.

Some fish and oceanic seabirds may be attracted to 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. Given the small quantities and intermittent nature of disposal however, any attraction is likely to be minor and is not expected to result in adverse impacts at an ecosystem or population level.

No important foraging or nesting BIA for marine turtles, fish or marine mammals overlaps the Operational Area. However, the northern boundary of the whale shark foraging BIA does overlap providing potential for whale sharks to be present. The presence of marine fauna is expected to be limited to individuals transiting through the area, including whale sharks due to the size of the whale shark foraging BIA.

### 4.4.3 Summary of environmental performance

| **Aspect** | **Operational discharges** |
|---|---|
| **Performance Outcome** | No unplanned operational discharges within the Operational Area; Operational discharges to sea are in accordance with legislative requirements |
| **Management Controls** | Performance standard |
| **Deck drainage and bilge water** | |
| Oily water discharge from FPSO | Oily water on the FPSO discharged via PW treatment system (Section 4.6) |
| Oily water filtering and monitoring equipment fitted and maintained | 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 |
| Oily sludge is contained | Oily residue (sludge) is not discharged to sea but is contained and transferred to shore for disposal |
| **Cooling water** | |
| Water cooled equipment on FPSO is maintained | Water cooled equipment/machinery and heat exchangers maintained in accordance with the CMMS |
| Production chemicals dosed to the production processing system regularly monitored | Production chemicals to be added to the system at a dosage rate as prescribed in the chemical approval request |
| **Desalination brine** | |
| PW systems are maintained | Potable water systems maintained in accordance with the CMMS |
| **Sewage and greywater** | |
| FPSO sewage treatment plant meets operational needs and is maintained | Pursuant to MARPOL, FPSO has a current International Sewage Pollution Prevention Certificate or equivalent which confirms that required measures to reduce impacts from sewage disposal are in place |
| **Putrescible waste** | |
| Garbage record book maintained | Vessel's garbage record book maintained to record quantities of food waste in accordance with MARPOL |

### 4.4.4 ALARP assessment

| Rejected Control | Justification of rejection |
|---|---|
| Wastes stored onboard and transferred to shore for onshore treatment and disposal<br><br>Practicable and cost effective - No | Costs associated with complete reengineering 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 and low potential impact from discharges. In addition, transfers increase the risks of spills/ leaks and safety risks to personnel during transfer operations. |
| Re-engineer equipment to retain wastes onboard<br><br>Practicable and cost effective - 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. |

### 4.4.5 Acceptability assessment

| | |
|---|---|
| **Policy & management system compliance** | Jadestone Energy's HSE Policy objectives are met. Section 7 demonstrates that Jadestone Energy's HSE Management System is capable of meeting environmental management requirements for this activity. |
| **Stakeholders & reputation** | 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. |
| **Industry best practice** | The APPEA Code of Environmental Practice (APPEA 2008) objectives are met with regard to offshore production operations. |
| **Environmental context & ESD** | While there are liquid waste discharges to sea surface immediately around the *Montara* facilities, the impact and risk assessment process indicates that discharges will not result in significant effects to marine fauna.<br><br>The potential impact is considered acceptable after consideration of:<br><br>• Potential impact pathways;<br>• Preservation of critical habitats;<br>• Assessment of key threats as described in species and Area Management/ Recovery plans;<br>• Consideration of North-West Bioregional Plan; and<br>• Principles of ecologically sustainable development. |
| **Conservation and management advice** | No Management Plans identified operational discharges such as those described above as being a threat to marine fauna or habitats.<br><br>Jadestone Energy has had regard to the representative values of the protected areas within the EMBA, and the respective management plans and other published information. Impacts from liquid discharges will have a negligible impact on any of the social and ecological objectives and values, of any AMPs, or state marine parks. This is consistent with the objectives of the protected area management plans and considered acceptable. |

## 4.5 Chemical discharges

### 4.5.1 Description of aspect

Chemicals planned for discharge in the Operational Area include fire fighting foam, chemicals and chemically treated water from maintenance and well intervention activities and subsea control fluids.

### 4.5.2 Impacts

Changes to ambient water quality within the direct vicinity of the facilities and support vessels through chemical loading can lead to toxic effects on marine fauna in the vicinity.

#### 4.5.2.1 Firefighting foam

The worst-case impact may include a local biochemical oxygen demand or local toxic effects or irritation from exposure to toxic compounds. On discharge, the small volumes of treated water and chemicals will rapidly disperse, and any potential impacts would be confined to a highly localised area immediately surrounding the release location. There is no emergent habitat that could be impacted by a surface discharge and the benthic habitat is predominately bare sand, with a very sparse assemblage infauna.

#### 4.5.2.2 Subsea control fluids, LWI discharges, and maintenance discharges

The potential impacts of hydraulic fluid discharges near the seabed are a localised reduction in water quality and potential toxicity to benthic marine fauna associated with seabed sediments or attracted/attached to subsea infrastructure.

The Offshore Chemical Notification Scheme (OCNS) system uses the ecotoxicity data for offshore chemical products to assess the potential environmental risk in the marine environment. The least environmentally hazardous grade is Gold (CHARM assessed), and E (through a non-CHARM assessment). The OCNS system requires bioaccumulation and biodegradation data, and aquatic toxicity data from three trophic levels (algae, crustacean and fish) to predict the potential ecosystem risk and, in turn, rank the product by Hazard Quotient.

The subsea control fluid, decalcifier/descaler, hydrate management and brine products used at the *Montara* facilities for these activities have an OCNS rating of E. To achieve this ranking, the chemicals have the least environmental impact in terms of ecotoxicity, biodegradation and bioaccumulation, and indicates negligible impacts to the marine environment result from the discharge of the fluid.

Benthic communities within the Operational Area are primarily associated with soft sediment habitats of relatively low sensitivity and wide regional representation. No important foraging or nesting BIA for marine turtles or marine mammals overlaps the area. The northern boundary of the whale shark foraging BIA does overlap the Area providing potential for whale sharks to be present. The presence of marine fauna is expected to be limited to individuals transiting through the area, including whale sharks due to the size of the whale shark foraging BIA. There is also only a small overlap of active commercial fisheries with the Operational Area.

### 4.5.3 Summary of environmental performance

| **Aspect** | **Operational discharges** |
|---|---|
| **Performance Outcome** | No unplanned chemical discharges within the Operational Area |
| **Management Controls** | Performance standard |
| **Firefighting Foam** | |
| Performance Standards Report ensures automatic fire protection system is followed | Performance standards implemented for fire-fighting foam to ensure fire protection system is maintained and operated in accordance with *Montara's* Automatic Fire Protection System |
| **Subsea Control Fluids & Chemicals for Maintenance** | |
| Chemical Selection Evaluation and Approval Procedure | 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 |

### 4.5.4 ALARP assessment

| **Rejected control** | **Justification** |
|---|---|
| Zero discharge of fire-fighting foam, subsea control fluids and chemicals<br><br>Practicable and cost effective - no | Costs associated with complete reengineering such that drainage is all contained from areas where fire-fighting foam is present and disposed of onshore; followed by onshore treatment and disposal costs would be disproportionate to the environmental benefit gained given the rapid dilution in offshore water and low potential impact from discharges. In addition, transfers increase the risks of spills/leaks and safety risks to personnel during transfer operations.<br><br>Subsea control fluids discharged through valve actuation cannot be practically avoided. |
| Reduce toxicity of discharges<br><br>Practicable and cost effective - 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 given lack of sensitive receptors in area. |

### 4.5.5 Acceptability assessment

| | |
|---|---|
| **Policy & management system compliance** | Jadestone Energy's HSE Policy objectives are met. Section 7 demonstrates that Jadestone Energy's HSE Management System is capable of meeting environmental management requirements for this activity. |
| **Stakeholders & reputation** | Stakeholder consultation has been undertaken (see Section 6), and no stakeholder concerns have been raised regarding impacts from chemical discharges on sensitive receptors. |
| **Environmental context & ESD** | While there are chemical discharges to sea surface and subsea in the vicinity of infrastructure immediately around the *Montara* facilities, the impact and risk assessment process indicates that discharges will not result in significant effects to marine fauna.<br><br>The potential impact is considered acceptable after consideration of:<br><br>• Potential impact pathways;<br>• Preservation of critical habitats;<br>• Assessment of key threats as described in species and Area Management/Recovery plans;<br>• Consideration of North-West Bioregional Plan; and<br>• Principles of ecologically sustainable development. |
| **Conservation and management advice** | No Management Plans identified operational discharges such as those described above as being a threat to marine fauna or habitats.<br><br>Jadestone Energy has had regard to the representative values of the protected areas within the EMBA, and the respective management plans and other published information. Impacts from chemical discharges will have a negligible impact on any of the social and ecological objectives and values, of any AMPs, or state marine parks. This is consistent with the objectives of the protected area management plans and considered acceptable. |

## 4.6 Produced water discharge

### 4.6.1 Description of aspect

Produced water (PW) contains a mixture of dissolved hydrocarbons and suspended oil droplets, naturally occurring radioactive materials (NORMs), inorganic salts, metals, low residual concentrations of a small number of chemical additives (e.g. corrosion inhibitor, biocides and scale inhibitors and hydrate inhibitors).

At the end of the PW treatment process, two PW hydrocyclones (2 x 50%) separate oil-in-water down to a level that meet overboard discharge specifications. PW is then discharged overboard or is returned to PW tanks for further treatment. Manual liquid sampling points are provided on each hydrocyclone reject oil outlet lines and PW outlet lines. PW is discharged overboard in batches at sea surface adjacent to the cooling water discharge.

The oil-in-water content is continuously measured by the oil-in-water meter. High oil-in-water protection content diverts flow of off-specification water from overboard discharge to the PW tanks for further processing. Manual liquid sampling points are provided upstream of the oil-in-water meter on both hydrocyclone underflow lines to allow calibration and verification of the oil-in-water meter measurements. A log of the discharge is maintained to conform to statutory requirements.

The main contaminants of concern in discharged PW are oil in water (OIW) including aromatic hydrocarbons, trace metals and NORMs. Measurement of oil in water concentrations within the PW discharged is made using the inline spectrophotometer and verified with a hand-held spec unit.

A full toxicity assessment of PW was undertaken in 2017.The toxicity tests included a range of tropical and temperate Australian marine species and were selected based on their ecological relevance, known sensitivity to contaminants, availability of robust test protocols and known reproducibility and sensitivity as tests species for assessing produced water in marine environments.

As all eight toxicity tests used were chronic, the general fit of the species sensitivity distributions (SSDs) determined provided a good general fit of the SSD curve to the toxicity data and thereby improved the reliability of the safe dilution estimate of PW required in the receiving environment to achieve environmental performance requirements.

The guideline values derived from the SSD included a concentration that is protective of 95% of species, and a concentration which is protective of 99% of species. Based on the ecotoxicity testing the level of dilution required in the receiving environment to meet water quality management criteria (ANZECC/ARMCANZ 2000) could be determined. Modelling was then undertaken for a range of conditions (e.g. current strength) to investigate the distance from the release site at which the plume temperature and contaminants comply with the 95 and 99% protection criteria.

### 4.6.2 Impacts

Potential impacts are discussed in section 5.6.6 alongside a determination of their acceptability.

### 4.6.3 Summary of environmental performance

| **Hazard** | **Discharge of produced water (PW)** | | |
|---|---|---|---|
| **Performance Outcome** | **PW discharges achieve the national marine water quality guidelines for protection of 99% of species as defined by ANZECC/ ARMCANZ (2000) at the boundary of the area of impact** | | |
| | **Planned operations** | **Contingency operations** | **Adaptive Management** |
| **Management Control** | **Performance standard** | **Performance standard** | **Performance standard** |
| **Monitoring** | | | |
| Daily discharge of PW is monitored and recorded automatically by the inline spec as per Produced Water System | Daily discharge rate from the FPSO does not exceed the volumes set in procedures manual. | If total daily volume approaches the pre-set volumes, check daily total oil load does not exceed the set load | If an increase in total daily discharge load is required, undertake MoC to determine if changes to impacts are provided for in the EP or a revision is required |
| | Batch average OIW concentration <15 mg/L | Inline spec of PW OIW concentration >30 mg/L overboard discharge ceases | |
| | | If discharge is diverted inboard PW returns to first holding tank | |
| | If inline spec is not operational, manual sampling to be done every three hours | If manual sample show a concentration > 15 mg/L increase manual monitoring frequency to every two hours | |
| HACH handheld turbidity meter operating manual | Weekly monitoring finds a turbidity < NTU set in the procedure manual | If turbidity of the weekly sample > the set NTU, sample daily for one week | If the average of the daily NTU measurements are > the set NTU, analysed a sample for particle size distribution |
| **Calibration & assurance** | | | |
| Equipment is successfully calibrated as per Jadestone Energy procedures | Prior to batch start-up, inline spec is calibrated within tolerance requirements | If inline spec does not successfully calibrate, manually sample every 3 hrs if OIW <15 mg/L, and every 2 hrs if OIW >15 mg/L | |
| | Accuracy of hand-held meter checked weekly | If check unsuccessful, calibrate handheld meter according to manufacturer's specs | Raise a work order to repair/ replace handheld meter as required |

| | | | |
|---|---|---|---|
| | 6 monthly calibration of inline spec | If calibration unsuccessful, reattempt calibration of the inline spec | Raise a work order to repair/ replace inline spec as required |
| | Annual 3rd party calibration | | |
| **Maintenance** | | | |
| Equipment maintained as per PW System | Inline OIW spec serviced weekly by production technician | | |
| | Inline OIW analyser serviced by vendor every 6 months | Raise a work order and have Vendor repair/ replace | |
| **Measurement** | | | |
| *Montara* PW Monitoring & Management Framework | Annual characterisation of contaminants in PW checks contaminant concentrations are acceptable by applying the set dilution rate to concentrations and are < 99% ANZECC/ARMCANZ 2000 trigger values | If contaminant concentration/s will not be sufficiently diluted to required background levels undertake WET testing of relevant effluent stream | If WET testing shows PW does not meet the set dilution requirements, undertake MoC to determine if changes to risks and impacts 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. |
| | Annual in situ marine water quality monitoring - check contaminant concentrations against ANZECC/ ARMCANZ 2000 trigger values | If one or more samples are above the trigger values, determine if difference is significant | If results indicate a mixing zone greater than in the in-force EP by more than an agreed amount, undertake WET testing within 3 months |
| | Three-yearly in situ marine sediment quality monitoring checks contaminant concentrations against ANZECC/ ARMCANZ SQ guidelines | If one or more samples are above the trigger values determine if difference is significant | Conduct modelling to determine if predicted extent of impact is outside the mixing zone within the in-force EP |
| | WET testing every three years of PW discharge | If WET testing results >2017 results, re-run mixing zone modelling | If mixing zone area is predicted to increase, undertake MoC process to determine if changes to risks and impacts are provided for in the EP or revise the EP for NOPSEMA for acceptance. |
| **Production & processing** | | | |

| | | | |
|---|---|---|---|
| Chemical Selection and Approval Procedure details requirements of risk assessment for production chemicals | Production chemicals to be assessed and approved for use before application according to the process outlined in the Procedure. | | |
| Production chemicals dosage regularly monitored | Production chemicals added at a dosage rate as prescribed in the chemical approval request | | |
| MoC 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 | | If a new reservoir section is added, the impact assessment process for PW must be repeated |
| | | | If a change to the production processing equipment occurs, impact assessment process for PW must be repeated |

### 4.6.4 ALARP assessment

| Control considered | Justification |
|---|---|
| Contain all PW and transfer to shore for onshore treatment and disposal<br><br>Practicable - no<br><br>Cost effective - no | The daily discharge volume would require multiple trips to shore. Containment would require storage on tanker for approx. 2 weeks, mooring system would be required, offtake tanker or swap for another one. Increases risk of vessel collision incident with increased frequency of vessel trips. SIMOPS additional vessel in field, additional costs for treatment and disposal onshore |
| Reinjection of produced water to the reservoir<br><br>Practicable-yes<br><br>Cost effective - no | Drilling of a well to allow reinjection of produced water to the reservoir would cost in the order of $15 to 20 million. Given the expected environmental impacts associated with discharge of produced water, the environmental benefit that would be gained from reinjection of produced water would not be commensurate to the cost required. |
| Process polishing<br><br>Practicable-yes<br><br>Cost effective - no | Additional modifications to the treatment system include a coalescer package and additional automation to allow monitoring of OIW during continuous over-boarding. Design expectation is to reduce OIW relative to current readings. While improvements in produced water quality can be achieved at this time purchasing and installation costs in disproportionate to the benefit that would be achieved. |
| Administrative - Adopted<br><br>Practicable - n/a<br><br>Cost effective – n/a | The primary means of reducing the risk of environmental impacts from the composition of these chemicals is through the implementation of Jadestone Energy's Chemical Selection Evaluation and Approval Procedure 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. |
| Administrative - Adopted<br><br>Practicable-N/A<br><br>Cost effective – 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. |

### 4.6.5 Acceptability assessment and impact description

| Impact aspect | Acceptable level of impact | Assessment |
|---|---|---|
| ***Water*** | | |
| Consideration: the key contaminants of concern in PW 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 PW, particularly polycyclic aromatic hydrocarbons. 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 | Water quality concentrations for hydrocarbons, metals and nutrients meet the 99% species protection guidelines for contaminants (ANZECC/ARMCANZ 2000) after accounting for the pre-set required dilution rate. For noting, the 99% species protection limits provide for the management of bioaccumulation/ biomagnification processes. | Components of the plankton that could be impacted include micro-invertebrates; eggs; larvae of invertebrates; fish and larger pelagic invertebrates around the Facility.<br><br>Attached assemblages have an increased frequency and duration of exposure to the discharge stream given their fixed placement. 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 artificial structures and become exposed again), and duration given they are not held at one point in the environment.<br><br>Pathways of exposure to the contaminants within the PW 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 small enough to remain buoyant.<br><br>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 and metals is most likely to occur in sessile invertebrates attached to the FPSO hull close to the discharge location experiencing repeated exposure.<br><br>The area of impact for the water column environment is predicted to be small scale and is therefore unlikely to be significant at population or ecosystem scales. |
| Dissolved metals may create impacts to marine organisms if present at high enough concentrations and some metals have the potential to bioaccumulate | | |

| Impact aspect | Acceptable level of impact | Assessment |
|---|---|---|
| Elevated nutrient levels can lead to increased bacterial and phytoplankton production | | Increased water column biomass associated with the availability of dissolved nutrients will be highly localised (within tens of metres). The influence on nutrient levels within the water column is predicted to dissipate local to the discharge point and does not exceed ANZECC/ARMCANZ (2000) 99% species protection concentrations beyond this point |
| Within PW 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). | NORMs concentrations in water meet the 0.1 Bq/L recreation guidelines (ANZECC/ ARMCANZ 2000) for gross alpha and gross beta concentrations after accounting for the pre-set dilution rate. | The environmental risk around radioisotopes is due to ionising radiation which is high in energy and can break chemical bonds of exposed atoms. In some cases where the ionising energy is high enough, DNA may be damaged leading to mutations.<br><br>Within PW the radioisotopes of primary concern are $^{226}$Ra and $^{228}$Ra, which are more likely to be dissolved within PW than other NORMs, and which have the relatively longest half-lives of 1,601 and 5.7 years, respectively. 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. 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 discharges were of insignificant risk to the health of marine life or humans.<br><br>Jadestone Energy completed water quality analysis of NORMs to evaluate water quality for radioactivity against the ANZECC/ ARMCANZ (2000) recommended guidelines.<br><br>Results for filtered and total samples together with the dilution factor, shows that the radiation activity levels within PW discharged from the FPSO meets the ANZECC/ ARMCANZ (2000) recommended guideline by the boundary of the area of impact. |
| Summary: monitoring and measurement of the PW 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 the pre-set 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. | | |
| ***Fauna and habitat values (incl. recovery plans and conservation advices)*** | | |
| Consideration: The Area of Impact for the discharge of the produced water from the FPSO coincides with fauna or habitats that support fauna with conservation status. | | |
| The facility and PW discharge environment overlaps with the whale shark and pygmy blue whale BIAs. | PW discharges do not contravene management objectives of fauna and habitat values as identified | 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). Whale sharks spend the majority of their time in deeper waters, and would avoid the surface PW plume, however it may have a small indirect effect on their food source - plankton. The predicted small scale of the area of impact |

| Impact aspect | Acceptable level of impact | Assessment |
|---|---|---|
| | in bioregional plans, including recovery plans and conservation advices | however suggests that exposure impacts (sub-lethal or lethal) is not likely to significantly impact whale shark food sources.<br><br>Blue whale migration is thought to follow deep oceanic routes, but little is known about their precise routes. Observations suggest most pygmy blue whales pass along the shelf edge out to 1,000 m water depths. The Operational Area does not include any recognised blue whale migratory routes or known feeding, breeding or resting areas. However, low numbers of blue whales migrating to and from Indonesian waters may occasionally pass through, most likely during the southern migration (October to November).<br><br>The conservation management plan for pygmy blue whales identifies the threats of acute and chronic chemical discharge, whaling, climate variability and blue whale change, noise interference and vessel disturbance. The discharge of PW is not considered likely to have any impact on the species or habitat used by the species. |
| Summary: evaluation of the Area of Impact and quality considerations of the PW 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. | | |

| Impact aspect | Acceptable level of impact | Assessment |
|---|---|---|
| **Commercial fishing values** | | |
| Consideration: The Area of Impact for the discharge of the produced water from the FPSO 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.<br><br>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. | Water quality concentrations for hydrocarbons meet the 99% species protection guidelines for contaminants (ANZECC/ ARMCANZ 2000) after accounting for the pre-set required dilution rate. | Effects may be experienced by pelagic fish within the PW area of impact. Pelagic fish are commonly associated with offshore structures and therefore higher abundances are likely to occur around the FPSO than in surrounding open water.<br><br>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 PW. While PAH concentrations may be elevated in fishes attracted to the FPSO, 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).<br><br>No fishing is permitted within the 500 m restricted zone around the FPSO and other subsea infrastructure. Given that the area of impact for PW discharge lies within this PSZ, no impact to fish targeted by nearby fisheries is predicted.<br><br>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 transit 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 PW discharge did not identify that commercial fishing activities are or will be compromised by the discharge stream, or threatened target species, showing that the discharge is acceptable to conservation objectives relevant to the area. | | |

| Impact aspect | Acceptable level of impact | Assessment |
|---|---|---|
| ***Ecologically sustainable development (ESD)*** | | |
| Consideration: Jadestone Energy must ensure that discharge of PW from the FPSO does not contravene or perform in conflict with the intent of the principles of ESD | | |
| 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 Energy risk assessment process and 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 PW to the environment from the FPSO was assessed as a category 1, 'slight effect; recovery in days to weeks; injury to organism'. |
| (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 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. 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-- 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 FPSO 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. See above - *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 consider safety, the environment and the economics of the activity prior to approval and implementation. By taking multiple lines of risk into account, Jadestone Energy 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 the FPSO 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. | | |

## 4.7 Physical presence

### 4.7.1 Description of aspect

A permanent 500 m Petroleum Safety Zone (PSZ) is present around the facilities to ensure restricted and controlled vessel access near the facilities. The physical presence of the *Montara* operation, associated infrastructure and PSZ preclude other users (e.g. commercial/recreational fishers, commercial shipping).

The physical presence of infrastructure may alter marine fauna behaviour and creates habitat for organisms that are attracted to and/ or attach to hard substrates.

### 4.7.2 Impacts

**Fishing**: Any overlap with active fisheries is relatively small - only the Northern Demersal Scalefish Managed Fishery having recent catch returns for the Operations Area or its immediate vicinity. The PSZ represents a very small part of the Northern Demersal Scalefish Managed Fishery licenced area, with numerous alternatives available. There is the potential for interactions between fishing activities and support vessels.

**Shipping:** The *Montara* facilities is located northwest of the nearest designated shipping route with heavy vessels utilising the Osborne passage in the northern part of the permit areas, however it is not anticipated there will be high commercial shipping traffic in the Operational Area or immediate surrounds Any detour by shipping traffic that may occur is considered negligible in comparison to the area available for navigation.

**Seabirds:** Migratory seabirds may experience localised and short-term effects through behavioural changes; such as resting or roosting on platforms (*Montara* FPSO and WHP), or changed feeding patterns such as attraction to fish near the infrastructure, affecting the size and composition of the seabird community in the local area or resulting in occasional bird strike.

**Protected species:** Slight deviations by migrating marine fauna including whale sharks and pygmy blue whales may result in order to avoid the structures and vessels.

**Benthic fauna**: Impacts associated with the provision of artificial habitat from *Montara* infrastructure are increased local biological productivity and diversity, Given the small scale of the artificial habitat created, the potential impacts are expected to be highly localised.

### 4.7.3 Summary of environmental performance

| | |
|---|---|
| **Aspect** | Physical presence |
| **Performance Outcome** | Recreational and commercial fishers, and shipping traffic, are aware of the Operational Area and associated activities |
| **Management control** | Performance standard |
| **FPSO and WHP navigational and communication equipment installed, maintained and operated in accordance with Performance Standard Report** | The *Montara* facility and associated infrastructure are charted on AHS nautical charts with gazetted PSZ |
| | Navigation and communication equipment on the FPSO comply with Safety of Life at Sea (SOLAS) requirements |
| | ARPA with integrated AIS system are located on the FPSO |

| | |
|---|---|
| **Aspect** | Physical presence |
| **Performance Outcome** | Recreational and commercial fishers, and shipping traffic, are aware of the Operational Area and associated activities |
| **Management control** | Performance standard |
| | A Marine VHF Radio is located and functioning in the central control room |
| **Jadestone Energy Stakeholder Engagement Plan details consultation requirements to ensure other marine users are aware of the activity** | Consultation undertaken with relevant stakeholders as Section 6 |

### 4.7.4 ALARP assessment

| **Rejected control** | **Justification** |
|---|---|
| Removal of facility and vessels<br><br>Practicable and cost effective - no | Operation of the facility would not be possible without the infrastructure or without vessels to replenish supplies required for safe operations. |
| Re-engineer to remove requirement for topsides altogether<br><br>Practicable and cost effective - 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. |
| Reduce or remove vessel and helicopter use during key sensitive periods<br><br>Practicable and cost effective - no | Reducing or removing vessel and helicopter activities is not a viable option as these activities are necessary for the safe and efficient operation of the facility.<br><br>*Montara* facility is located outside of shipping fairways and is not positioned in highly prized fishing habitat. |
| Additional activity specific navigational or communications requirements<br><br>Practicable and cost effective - no | The 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 *Montara* facility are undertaken. Additional procedures would provide no further benefit. |
| Additional support vessels on location to inform third party vessels in the vicinity of the facility<br><br>Practicable and cost effective - no | The additional cost of 24/7 vessel presence in field is considered grossly disproportionate to the benefit gained given the facility is marked on hydrographic charts and is visible above water. The radio room on the FPSO is manned 24/7 allowing contact to be made with 3rd part vessels in the vicinity as required. If radio cannot raise the vessel, calls are made to the Home Affairs Office for their control. |

### 4.7.5 Acceptability assessment

| | |
|---|---|
| **Policy & management system compliance** | Jadestone Energy's HSE Policy objectives are met. Section 7 demonstrates that Jadestone Energy'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 physical presence as denoted by the PSZ and preclusions within it. |

| | |
|---|---|
| **Environmental context** | While the *Montara* 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.<br><br>The potential impact is considered acceptable after consideration of:<br>• Potential impact pathways;<br>• Preservation of critical habitats;<br>• Assessment of key threats as described in species and Area Management/ Recovery plans;<br>• Consideration of North-West Bioregional Plan; and<br>• Principles of ecologically sustainable development. |
| **Conservation and management advice** | No Management Plans identified physical presence as described above as being a threat to marine fauna or habitats.<br><br>Jadestone Energy has had regard to the representative values of the protected areas within the EMBA, and the respective management plans and other published information. Impacts from physical presence will have a negligible impact on any of the social and ecological objectives and values, of any AMPs, or state marine parks. This is consistent with the objectives of the protected area management plans and considered acceptable. |

## 4.8 Seabed disturbance

### 4.8.1 Description of impact

If the installation of additional or replacement subsea infrastructure (e.g. tie in spools, freespans, umbilicals, wet parked equipment) is required, this will further disturb the seabed in the immediate area of existing infrastructure. There may be some minor seabed disturbance from routine inspection, maintenance and repair (IMR) activities and well intervention activities, some of which require vessel anchoring in the Operational Area.

### 4.8.2 Impacts

The potential impacts associated with seabed disturbance from IMR activities and light well interventions are direct disturbance to benthic habitats and communities and temporary and localised increase in water column turbidity as a direct result of sediment disturbance. The scale of habitat loss and seabed disturbance limited to tens of metres either side of existing infrastructure in comparison to the vast size of soft substrata habitats spanning the NWMR and NMP. 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 Operational Area.

### 4.8.3 Summary of environmental performance

| | |
|---|---|
| **Aspect** | Seabed disturbance |
| **Performance Outcome** | No unintentional disturbance to the seabed and marine environment in the Operational Area<br><br>Seabed disturbance limited to planned activities and defined locations |
| **Management Control** | Performance standards |
| **Change Management Procedure** | Prior to starting integrity, maintenance or repair work on subsea infrastructure, a survey using ROV/ autonomous underwater vehicle/ diving will be undertaken which include visual surveys of the seabed within the footprint of the work area. |
| **Designated anchoring area in Operational Area** | Vessel operations within the Operational Area to comply with *Montara* Marine Facility Manual including anchoring within designated area. |

### 4.8.4 ALARP assessment

| **Rejected control** | **Justification** |
|---|---|
| No additional infrastructure<br><br>Practicable and cost effective: no | Future production of the facility would not be possible without additional infrastructure or without vessels to replenish supplies. Required for safe operations. |
| No maintenance of subsea infrastructure<br><br>Practicable and cost effective: no | Safe operation of the facility could not occur without regular IMR or LWI intervention activities. |

### 4.8.5 Acceptability assessment

| | |
|---|---|
| **Policy & management system compliance** | Jadestone Energy's HSE Policy objectives are met. Section 7 demonstrates that Jadestone Energy's HSE Management System is capable of meeting environmental management requirements for this activity. |
| **Stakeholder & reputation** | Stakeholder consultation has been undertaken (Section 6), and no stakeholder concerns have been raised with regards to seabed disturbance. |
| **Environmental context & ESD** | Disturbance is localised to immediately under or near to the footprint of *Montara* Facility and subsea infrastructure within the Operational Area. The impacted benthic habitats and associated biota are well represented in the region.<br><br>The potential impact is considered acceptable after consideration of:<br>• Potential impact pathways<br>• Preservation of critical habitats<br>• Assessment of key threats as described in species and Area Management/ Recovery plans<br>• Consideration of North-West Bioregional Plan; and<br>• Principles of ecologically sustainable development (ESD). |
| **Conservation and management advice** | There are no relevant management plans for – Seabed disturbance.<br><br>Jadestone Energy has had regard to the representative values of the protected areas within the EMBA, and the respective management plans and other published information. Impacts from seabed disturbance will have a negligible impact on any of the social and ecological objectives and values, of any AMPs, or state marine parks. This is consistent with the objectives of the protected area management plans and considered acceptable. |

## 4.9 Spill response activities

### 4.9.1 Description of aspect

In summary, the response activities include:

- Source control;
- Monitoring, evaluation and surveillance;
- Protection and deflection;
- Containment and recovery;
- Shoreline clean-up;
- Dispersant application; and
- Oiled wildlife response.

The *Montara* Operations Oil Pollution Emergency Plan (OPEP) provides detail on how these strategies will be implemented. Spill response activities will involve:

- Use of vessels and aircraft
- Onshore operations
- Use of equipment on coastal areas during clean-up of shorelines (e.g. pumps);
- Use of fuels to power vessel engines, generators and mobile equipment
- Operational discharges
- Dispersant operations
- Movement and operation of vessels, personnel and equipment on shoreline areas and protected areas;
- Oiled wildlife response activities

The spill response activities considered are described in terms of environmental benefits and costs in **Table 4-1**

**Table 4-1 Spill response strategies considered for the mitigation of hydrocarbon spills**

| Strategy | Description | Environmental Benefits | Decision |
|---|---|---|---|
| Source control | Implementation of the FPSO SOPEP | Reduce the volume of oil entering the marine environment | Adopt |
| | Implementation of Emergency Pipeline Repair Plan | Reduce the volume of oil entering the marine environment | Adopt |
| | Implementation of LOWC Source Control Plan | Reduce the volume of oil entering the marine environment | Adopt |
| | Subsea dispersants applied close to the release point minimises the amount of oil from reaching the sea surface. This technique helps to break up the oil droplets so that they are dispersed, diluted and biodegraded more rapidly in the water column, and is beneficial in reducing the amount of volatile organic compounds at the sea surface near the well site. | This strategy is only suitable for a loss of well control release.<br><br>Subsea dispersant application can reduce the amount of surface hydrocarbons drifting towards sensitive receptors, by increasing the availability of oil droplets for biodegradation. Subsea dispersant requires smaller volumes of dispersant to treat the oil as compared to surface dispersant application.<br><br>Subsea dispersant application only undertaken when there is a net environmental benefit. Applicability is limited to the conditions and locations described in the OPEP. | Adopt |
| Operational Monitoring | Surveillance actions are used to monitor and evaluate the fate and trajectory of spills, determine the effectiveness of response strategies and identify and report on any potential/actual contacts to flora/fauna/ sensitive receptor. Surveillance results can assist in escalating or de-escalating response strategies. | There are various measures (vessel/ aerial surveillance, tracking buoys, oil spill modelling, fluorometry, SCAT) within this response strategy which may be suitable. Their use, in combination or individually, will be determined based on the spill distribution and other considerations such as access to locations, environmental and metocean conditions.<br><br>This strategy is a primary response to ensure sufficient information to gain situational awareness and make informed decisions on response planning, execution and termination. | Adopt |

| Strategy | Description | Environmental Benefits | Decision |
|---|---|---|---|
| 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.<br><br>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. | Surface chemicals may be dispersed by vessel, plane or subsea. If there is a weather condition that prevents the application, this in itself, creates dispersion.<br><br>The OSTM output comparing dispersant and non-dispersant models indicated shoreline oil loading to be reduced by up to 40% when applied to oil thickness of 100 g/$m^2$, up to 56% for oil thicknesses of 50g/$m^2$ and up to 58% for thickness of 16g/$m^2$.<br><br>Chemical dispersants applied at sea surface can reduce the amount of floating oil but increase the oil concentrations in the water column, thus increasing the risk of exposure to organisms that live in the water column.<br><br>Diesel is not considered a persistent hydrocarbon and has high natural dispersion rates in the marine environment, hence, chemical dispersant application is not recommended.<br><br>Entrained oil risks are not constant; fluctuating with 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. Most potentially contacted shorelines are mangroves and tidal flats subjected to very high tidal influences, which make shoreline response infeasible or may cause more damage than not responding or unsafe. Therefore, Jadestone Energy consider that techniques that reduce potential shoreline loading could be more beneficial than the potential impact to organisms from entrained oil. As such, this strategy is considered a primary strategy. | Adopt |
| Physical dispersion | Physical dispersion is undertaken by running vessels through the spill. The propeller turbulence or hydro-blasting from vessel hydrants breaks up the slick. Once dispersed in the water column in smaller droplet sizes, biodegradation is enhanced. | This opportunistic strategy can be used on targeted, small, breakaway areas, e.g. patches close to shorelines. Given that oil may emulsify by the time it approaches shorelines, and chemical dispersant application is preferred to disperse bulk oil; this strategy has limited effectiveness and is not considered a strategy requiring further planning and associated control measures. | Reject |

| Strategy | Description | Environmental Benefits | Decision |
|---|---|---|---|
| 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.<br>This strategy is only effective in calm conditions. | For a spill of *Montara* or Skua oil, this is the preferred way to remove oil from the water surface before the risk of contacting shorelines/sensitive receptors.<br>Given the fast spreading nature of diesel, and active sea states in the area causing dispersion, this response is not considered effective in reducing the net environmental impacts; and the ability to contain and recover diesel is extremely limited.<br>Containment and recovery may be applicable once evaporation of highly volatile components has occurred and a solidified residual can be collected. Shoreline booming and shoreline clean-up will be difficult across some locations within the EMBA. This strategy remains a primary strategy in the overall response. | Adopt |
| Protection and deflection | Protection and deflection activities use booms to:<br>• Protect sensitive receptors;<br>• Deflect spills from sensitive receptors/shorelines;<br>• Deflect spills to an area that provides increased opportunity for recovery.<br>This strategy is typically not effective in areas with large tidal variations and associated currents. | Boom anchors may result in additional damage to subsurface environments surrounding most offshore islands e.g. moving around on the intertidal coral reefs during lower tides.<br>Due to the types of shorelines that may be impacted (i.e. remote, high tidal - high energy beaches/intertidal reef platforms), protect and deflect would mostly not be considered to result in a net environmental benefit. The use of vessels to deploy booms may be feasible to protect priority locations. If a positive outcome can be demonstrated a protect and deflect operation may be used.<br>Thus booming may not be applicable for all shorelines, and is considered a secondary strategy for targeted use. | 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. The selection of the most appropriate clean-up techniques requires a rapid evaluation of the degree and type of contamination, and the length, nature and accessibility of the coastline.<br>This response has the potential to cause secondary disturbance associated with the clean-up, so applicability of the strategy is based on aerial surveillance reconnaissance, shoreline assessments and NEBA in the shoreline clean-up assessment.<br>Diesel is relatively non-adhesive and will not form a thick adhesive barrier on a shoreline. The clean-up of diesel from a beach/shoreline is likely to be difficult generating high waste volumes relative to recovered oil, and therefore not recommended.<br>Consequently, this strategy may not be applicable across all shorelines identified as being oiled but is considered a secondary strategy for targeted use. | Adopt |
| 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 oiled animals. | Within the EMBA, areas with importance for wildlife have been identified that may be threatened by an 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 occur at sea, on shorelines and in specialised facilities inland. Options for wildlife | Adopt |

| Strategy | Description | Environmental Benefits | Decision |
|---|---|---|---|
| | | management are considered and a strategy determined guided by the WA Oiled Wildlife Response Plan (WAOWRP) and relevant regional plans. | |
| In-situ burning | In situ burning is a controlled burn technique sometimes used at the location of the spill to reduce the amount of oil on water. The oil must be amenable to lighting e.g. unweathered, high lighter oil fractions and not prone to emulsification. | Operational and oil constraints expected during a spill from the *Montara* Operations suggest in-situ burning is not feasible. For effective burning, oil must be thicker than 1-2 mm but diesel, *Montara* and SKUA oil have high evaporation rates and spread rapidly into thin films. Due to operational constraints and the expected hydrocarbon not being suitable for in-situ burning, this response is deemed inapplicable for *Montara* Operations. | Reject |
| Scientific Monitoring | This is the main tool for determining the extent, severity and persistence of environmental impacts from an oil spill. It allows operators to determine if environmental protection outcomes have been met. This strategy also evaluates recovery from the spill. | 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 |

### 4.9.2 Impacts

Some of these response hazards are unique to spill response (e.g. shoreline clean-up). Some hazards common to the operations have also been detailed and re-evaluated on the basis that the environment within which spill response activities take place may be of higher sensitivity than the environment within which the *Montara* Operations occurs.

Lighting may cause behavioural changes to fish, birds and marine turtles which can have a heightened consequence during key life-cycle activities (e.g. turtle nesting, hatching) and may include threatened and migratory fauna. Restrictions on night-time operations by spill response vessels require demobilisation to mooring areas offshore with safety lighting only. The positioning of temporary camps will be determined in consultation with DBaC with lighting restricted to minimum directional lighting.

Underwater noise from vessels may impact marine fauna and key life-cycle processes (e.g. breeding, calving). Underwater noise can also mask communication used by cetaceans and impact fauna in protected areas; this includes the whale migration pathways.

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 turtles e.g. near important nesting areas for turtles and/or roosting/feeding areas for shorebirds.

The humpback whale and Blue pygmy whale (distribution) BIAs overlaps the EMBA and species may be vulnerable during their peak migration season. Control measures, by means of compliance to Part 8 of EPBC Regulations, will reduce potential impacts from response activities.

Nesting, roosting or feeding aggregations of birds may be the most sensitive receptors to noise from onshore mobile equipment and vehicles. However, the equipment used is not considered to have excessive sound levels and DoT and DBCA will be consulted regarding the location of temporary camp.

Atmospheric emissions from spill response equipment such as the use of mobile equipment, vessels and vehicles may result in a temporary, localised reduction of air quality in the environment immediately surrounding emission points.

Operational discharges from response vessels may create a localised and temporary reduction in marine water quality**.** Vessel use may occur in shallower coastal waters during spill response activities, so a different set of receptors may be impacted than previously described. Washing of vessels and equipment will occur only in defined offshore hot zones preventing impacts to shallow coastal habitats.

Cleaning oil contaminated equipment, vehicles and vessels, has the potential to spread oil from contaminated areas to (potentially more sensitive) unimpacted areas. Decontamination units will be used during the spill response thus containing waste and preventing secondary contamination.

Flushing of oil from shoreline habitats can remove oil from the oiled receptor and remobilise it back to the marine environment for further dispersion. The process of flushing can physically damage shoreline receptors and increase erosion. As such, low pressure flushing only will be used, preventing further damage to habitats or erosion of sediments. For sensitive habitats, the deployment of booms will be considered to retain flushed hydrocarbons, if this presents a net benefit.

Sewage, putrescible and municipal waste will be generated from onshore activities at temporary camps. The storage and disposal of wastes have the potential to attract fauna, impact habitats, and reduce the

aesthetic value of the area, which may be within protected areas. Waste generated onshore will be stored and disposed of at approved locations with no discharges to the marine or coastal environment.

The use of vessels may disturb benthic habitats in coastal waters through damage from anchor/chain, nearshore booms and grounding. Vessel use in shallow coastal waters also increases the chance of contact or disturbance of marine megafauna. A review of shoreline and shallow water habitats, and bathymetry, will be used to establish demarcated areas for access and anchoring.

Vehicles, equipment and personnel during shoreline response activities have the potential to damage coastal habitats and habitats important to threatened and migratory fauna. Shoreline clean-up may involve the physical removal of substrates that could impact habitats and coastal hydrodynamics and alter erosion/accretion rates. An assessment of appropriate vehicles and equipment to reduce habitat damage, and the establishment of access routes/demarcation zones, and operational restrictions on equipment/vehicles use will limit sensitive habitat damage and damage to important fauna areas. The establishment of temporary camp areas will be done with consultation to DoT, DBCA and with a Heritage Advisor if access is sought to culturally significant areas.

Oiled wildlife response may include the hazing, capture, handling, transportation, cleaning and release of wildlife. Poor response can potentially create additional stress and exacerbate impacts from oiling, hampering recovery and in the worst instance increasing levels of mortality. The WA Oiled Wildlife Response Plan and the Kimberley Region Oiled Wildlife Response Plan will be adhered to.

Impacts from invasive marine species released from vessel biofouling include out-competition, predation and potentially impact socio-economic industries. Impacts from invasive terrestrial species are similar in that the invasive species can out-compete local species and interfere with ecosystem processes. Non-native species may be transported attached to equipment, vehicles and clothing.

### 4.9.3 Chemical dispersant application

The application of chemical dispersants aims to enhance oil dispersion and entrainment into the water column, thus avoiding or reducing the volume that could reach the shoreline. The use of dispersants has the potential to increase impacts to receptors under the sea surface by increasing entrained oil and dissolved aromatic hydrocarbon concentrations. Increased entrained and aromatic hydrocarbon concentration may also impact marine biota directly or through impacts to subsea habitats. Direct impacts are most likely to be encountered by filter feeding invertebrates, fish and sharks including threatened/migratory species. As a result of increased impacts to marine fauna and subtidal habitats, including those that represent values of protected areas, socio-economic impacts may be felt through industries such as tourism and fishing.

During a response, the area over which entrained oil will increase will be a function of the area treated with dispersants. The increase in entrained oil concentration will be short term (minutes to hours) as the floating oil moves into the water column and dispersion of the entrained oil decreases concentrations.

Modelling predicts a reduction in the predicted probabilities for shoreline oil contact by 40% total volume ashore, and greater predicted times to sensitive locations following application of chemical dispersant. These key findings support the use of chemical dispersants on *Montara* crude as they have potential to reduce hydrocarbon contact with sensitive locations and increase the time of the hydrocarbon contact to shorelines, thus giving time for other response strategies to take effect and further reduce impacts.

**Table 4-2 Summary evaluation of performance outcomes, controls and benefits**

| 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 NEBA (Jadestone Energy Incident Management Team Response | Ensures the selection of spill response activities has 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 impacts to ALARP | Adopt | Considered a standard spill response control |
| | Competency and Training Management System | Ensures response activities undertaken by competent personnel | Adopt | Considered a standard control |
| | DoT and DBC consulted with on shoreline operations location(s) in State waters | Prevents additional impacts to shoreline locations, fauna | Adopt | If a temporary camp is required, then locations 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. |
| | *Montara* Venture Waste Management Plan | Prevents secondary contamination and litter | Adopt | Considered a standard control |
| Light emissions | | | | |
| 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 |

| Performance Outcome | Control measure | Benefit | Outcome | Evaluation |
|---|---|---|---|---|
| | 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 Reg 8, *Montara* Marine Facility Manual, Aviation Operations Procedure | 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 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 | Regulatory requirement | Considered a standard control (regulatory requirement) – given low impact of atmospheric emissions, further controls not deemed necessary |
| **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 |

| Performance Outcome | Control measure | Benefit | Outcome | Evaluation |
|---|---|---|---|---|
| | Decant oily water from offshore containment and recovery behind boom | Prevents spreading of oily water | Adopt | Considered a standard control |
| | Pre-approval obtained from DoT/ AMSA prior to decanting oily water | Prevents spreading of oily water | Adopt | Considered a standard control (regulatory requirement) |
| | Offshore Equipment washdown confined to hot zones | 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 |
| | 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 | Use of shallow draft vessels for shoreline and nearshore operations | Reduce seabed and shoreline habitat disturbance | Adopt | Considered a standard control |

| Performance Outcome | Control measure | Benefit | Outcome | Evaluation |
|---|---|---|---|---|
| sensitive areas during spill response is reduced to ALARP | 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 |
| | 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 |
| | 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 |

| Performance Outcome | Control measure | Benefit | Outcome | Evaluation |
|---|---|---|---|---|
| | 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<br><br>Landing barges will be utilised where possible |
| | Vessel Check Biofouling Risk Assessment Tool (Vessel Check) completed for interstate and international vessels (only) | Reduce risk for introduction of invasive marine species as part of vessel biofouling | Adopt | Considered a standard control |
| | Vessel Check for all vessels | Small reduction in IMS risk given most vessels are local, already operating in the region<br><br>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<br><br>Reduce risk of introduced marine species | Adopt | Considered a standard control<br><br>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 Energy Chemical Selection, Evaluation and Approval Procedure | Reduce impacts on fauna / flora from toxicity of the dispersant | Adopt | A standard procedure Jadestone Energy Chemical Selection, Evaluation and Approval Procedure used for chemical selection |

| Performance Outcome | Control measure | Benefit | Outcome | Evaluation |
|---|---|---|---|---|
| | The evaluation must find the chemical acceptable for use prior to application. | | | |
| | Field trial undertaken of dispersant efficacy | Ensures dispersants are not added for no potential benefit | Reject | *Montara* crude has been evaluated in the laboratory and the field and dispersants are known to be effective |
| | Dispersant application location and volume assessment undertaken in IAP | Reduces impacts from dispersant and oil (entrained and dissolved) to sensitive shallow water habitats | Adopt | Considered a standard control |
| | 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 dispersants can reduce shoreline loading and spatial extent of oil in some scenarios. Therefore, it is better to have in the toolbox and decision for application subjected 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 | Early awareness of spill response activities which reduces potential disruption | Adopt | Considered a standard control |
| | Localised Risk Management Assessment conducted if the response is of significant size relative to size of coastal community | Reduces potential for higher utility demands to disrupt the local community | Adopt | Considered a standard control |

### 4.9.4 Summary of environmental performance

| Hazard | Oil Spill Response Activities |
|---|---|

| | |
|---|---|
| **Performance Outcome** | Spill response has an overall net environmental benefit |
| **Management Controls** | **Performance Standard** |
| **Overall spill response** | |
| OPEP provides for NEBA, notifications and consultation requirements to ensure net environmental benefit from response | NEBA undertaken every operational period and considered in development of following period Incident Action Plan. |
| | OPEP activated as per OPEP notification table |
| | DoT and DBCA consulted with on location of shoreline operations location(s). |
| Jadestone Energy Incident Management Team Response Plan procedure details IMT Core team members, resource pool and responsibilities | Jadestone Energy IMT comply with the Jadestone Energy Incident Management Team Response Plan |
| **Light emissions** | |
| OPEP provides for task description for response activities to manage lighting during spill response | Nearshore booming and skimming operations conducted during daylight hours only. |
| | Vessels to maintain minimal lighting required for safety and navigation requirements |
| **Noise** | |
| *Montara* Marine Facility Manual details vessel and helicopter operating requirements to reduce interactions with cetaceans | Spill response vessels and aircraft comply with EPBC Act Regulation 8 (cetacean interaction). |
| **Atmospheric emissions** | |
| International Air Pollution Prevention (IAPP) Certificate valid to certify measures are in place to reduce air emissions | If required under MARPOL, vessels have a current International Air Pollution Prevention (IAPP) Certificate. |
| **Operational discharges and waste** | |
| Vessels comply with MARPOL and protected area sewage disposal requirements | Vessel sewage disposal will meet MARPOL Annex IV requirements. If vessel activities occur within protected areas, discharges will meet marine park management plan requirements and the DoT sewage strategy |
| Vessels comply with MARPOL requirements for oily water (bilge) discharges | Vessel oily water disposal will meet MARPOL Annex I requirements. |

| | |
|---|---|
| OPEP details controls in place to manage oily water during shoreline flushing | Oily water collected during offshore containment and recovery to be decanted behind boom. |
| | DoT/ AMSA approval prior to decanting oily water back to marine environment. |
| | Offshore Equipment wash-down confined to hotzone. |
| | Onshore equipment wash-down occurs in a decontamination area |
| | Low pressure high volume is used for shoreline habitat flushing |
| | Seawater at ambient temperature is used for shoreline flushing. |
| | Booms are used for containment of shoreline flushing liquids if contaminated flushing has potential to cause secondary impacts in excess of oil dispersion into ocean. |
| Jadestone Energy's Waste Management Plan – Oil Spill Response Support details requirements and capability for waste treatment in the event of a spill | All waste associated with oil spill response activity transported and disposed of in accordance with Environmental Protection (Controlled Waste) Regs 2004, EP Act 1986 and associated regulations |
| | All waste associated with oiled wildlife facilities captured and disposed of in accordance with the NTOWRP, WAOWRP and KOWRP |
| | Compliance with Local government municipal waste requirements |
| | Onsite inductions include municipal waste requirements (how to manage domestic waste). |
| | Reduce/ Reuse/ Recycle assessment of collected waste conducted by waste contractor. |
| DoT OSCP 2015 Waste Management Sub-Plan Guidance informs waste management plans | DoT OSCP 2015 Waste Management Sub-Plan Guidance considered as part of Jadestone Energy's Waste Management Plan – Oil Spill Response Support |
| **Physical presence and disturbance** | |
| OPEP details appropriate equipment and sites for response selected during spill response activities to minimise potential impacts from vessel/equipment presence | Shallow draft vessels are used for shoreline and nearshore operations. |
| | A shoreline/ nearshore habitat/ bathymetry assessment is conducted prior to nearshore activities. |
| | Maintenance and inspection personnel are assigned to boom sets to ensure operational ability |
| | Vehicles are appropriate to shoreline conditions. |

| | |
|---|---|
| | Demarcation zones to be established for shoreline operations involving vehicle and personnel movement considering vegetation, bird nesting/roosting areas and turtle nesting timeframes |
| | Access plans for shoreline operations will prioritise use of existing roads and tracks. |
| | Terrestrial vehicle and equipment deployment via landing barges where there is no existing track access. |
| | A Specialist Advisor is consulted if shoreline operations overlap with areas of cultural or heritage significance. |
| | Vehicles and equipment are verified as clean and invasive species free prior to deployment to site. |
| Vessels comply with Montara Marine Facility Manual (MV-90-PR-H-00001) which provides IMS prevention requirements | Vessel Contractors required to conduct an IMS risk assessment for support vessel(s) sourced from outside WA using the WA Dept of Fisheries Vessel Check process, and for this assessment to indicate low / acceptable risk. |
| | Ballast water management plan review requirement for interstate and international vessels |
| **Oiled Wildlife Response** | |
| OPEP provides linkage to NTOWRP, WAOWRP and KOWRP | OWR undertaken in accordance with the NT and WA Oiled Wildlife Response Plans and the Regional Oiled Wildlife Response Plans |
| **Chemical dispersant application** | |
| Prioritise the use of dispersants that are listed as approved on the Register of Oil Spill Control Agents - National Plan for Maritime Environmental Emergencies | Dispersants listed as approved on the Register of Oil Spill Control Agents (OSCA) - National Plan for Maritime Environmental Emergencies shall be used prior to any other dispersant being considered for use |
| Chemical dispersant selected in accordance with Operations Chemical Selection Evaluation and Approval Procedure | Chemical dispersant is selected after having undergone a risk assessment by Jadestone Energy. The evaluation must find the chemical dispersant acceptable for use prior to application. |
| OPEP provides chemical dispersant application requirements | Operational monitoring of chemical dispersant efficacy undertaken throughout dispersant application |
| | Chemical dispersant application capability assessed by the NEBA during the IAP process prior to decision to apply |
| | Selection of correct equipment for chemical dispersant application prior to application |
| | Geographic location for chemical dispersant application assessed in the NEBA during the IAP process |
| | At no time, can chemical dispersant be applied:<br>• In waters shallower than 20 m (LAT); |

| | |
|---|---|
| | • Within 10 km of water shallower than 20 m;<br>• Within restricted zones for offshore facilities;<br>• Within an AMP boundary or its buffer;<br><br>Within State Waters unless approved by the HMA. |
| **Disruption to other users of marine and coastal area and townships** | |
| Consultation undertaken in accordance with Jadestone Energy Consultation of Relevant Persons Procedure prior to deployment in populated areas | Consultation is undertaken with relevant stakeholders prior to deployment of resources to townships and marine/coastal areas. |
| Localised Risk Management Assessment undertaken to minimise potential impacts on populated areas | A Risk Management Assessment is undertaken prior to large scale deployment to populated areas |
| **Spill response preparedness** | |
| Contracts valid and maintained in accordance with Jadestone Energy Contractor Management Framework to ensure access to competent personnel and appropriate equipment | Contracts for the supply of personnel and materials in place and current with competent service providers and suppliers |
| AMOSC MSC/ AMSA MOU/ OSRL MSC valid for life of the EP | AMOSC & OSRL memberships allowing access to mutual aid arrangements for spill response crew and equipment via a Master Services Contracts (MSC) for life of EP<br><br>AMSA MOU (access to NRT and resources) for life of EP |
| Response personnel competent and trained in accordance with Jadestone Energy Training and Competency Management System and OPEP for life of EP | Assessment of proposed/ rostered response personnel as being competent and trained according to the requirements of response roles defined in Jadestone Energy Incident Management Team Response Plan |
| Jadestone Energy Audit Manual includes emergency response and spill preparedness requirements to be audited for life of EP | Audit of Jadestone Energy's emergency response and spill preparedness requirements as scheduled and defined in the Audit Manual |
| Spill response exercise and training completed in accordance with Jadestone Energy Incident Management Team Response Plan to maintain spill preparedness readiness for life of EP | Training and exercising current and completed as required by the Incident Management Team Response Plan |
| OPEP risk register maintained to ensure spill response is appropriate to nature and scale of risk for life of EP | Spill response planning and preparedness aligned with nature and scale of risk of EP |

| | |
|---|---|
| *Montara Venture* 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, support vessels over 400 gross tonnage will have a current Shipboard Oil Pollution Emergency Plan/Shipboard Marine Pollution Emergency Plan and International Oil Pollution Prevention certificate |
| | FPSO spill exercises are conducted monthly |
| Jadestone Energy Incident Management Team Response Plan maintained to ensure ability to respond to spills | Provides current information for Jadestone Energy spill response resources and matches risk as defined in the EP |
| Personnel aware of roles and responsibilities in the event of a response in accordance with *Montara* Incident Response Plan | Instructs offshore response roles and responsibilities and training requirements. |
| *Montara* Drilling Source Control Plan in place one month prior to drilling commencing | *Montara* Drilling Source Control Plan in place that address loss of well containment actions as defined in the EP that minimise risk to personnel and reduce environmental impact |
| AMOSC Subsea First Response Toolkit membership is in place for the life of the EP, and appropriate insurance and an Operations, Training and Advice Agreement with Oceaneering | Maintain AMOSC Subsea First Response Toolkit membership, appropriate insurance and an OTA Agreement with Oceaneering which allows access to equipment, dispersant stocks and technical support for subsea dispersant application |
| ROV support in place for SFRT activity | Contract in place to provide ROV services for SFRT |
| Labour hire contract in place for life of EP to source labour for | Labour hire contract in place to provide access to personnel |
| Vessel availability for Subsea First Response Toolkit deployment is monitored monthly via Jadestone Energy's nominated vessel broker for life of EP | Monitor the availability of vessels that are suitable for deployment of the Subsea First Response Toolkit for life of EP |
| Maintain contract with Jadestone Energy's Waste Management Contractor for life of the EP | Waste management contract is maintained which enables access to waste storage facilities and waste transport |
| Monitor external drilling programs for MODU availability for life of EP | Jadestone Energy to have a process for monitoring external drilling programs for MODU availability<br><br>Monthly Monitoring reports |
| Monitor status of Registered Operators with Approved Safety cases for rigs for life of EP | Jadestone Energy have a process for monitoring the status of Registered Operators with Approved Safety cases for rigs<br><br>Monthly Monitoring reports |
| Contract and Equipment Access Agreement with Wild Well Control (WWC) for life of EP | Contract and Equipment Access Agreement with Wild Well Control are maintained providing technical support and equipment access for a LOWC incident |

| | |
|---|---|
| APPEA MOU for mutual assistance to facilitate and expedite the mobilisation of a relief well for life of EP | APPEA MoU for mutual assistance for relief well drilling |
| Vessel availability for containment and recovery activity is monitored monthly via nominated vessel broker | Monitor the availability of vessels that are suitable for deployment of the Containment and Recovery strategy as defined in the OPEP |

### 4.9.5 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 then the spill response is not ALARP. As such, a net environmental benefit analysis (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.

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 feasible for the scenario (Table **4-1**). For each of the environmental hazards associated with spill response strategies an ALARP evaluation was conducted as part of the hazard identification workshop. Several controls were identified as industry and/or Jadestone Energy standard controls while additional controls were evaluated and either accepted or rejected on the basis of the ALARP principal.

### 4.9.6 Acceptability assessment

| | |
|---|---|
| **Policy & management system compliance** | Jadestone Energy's HSE Policy objectives are met. Section 7 demonstrates that Jadestone Energy's HSE Management System is capable of meeting environmental management requirements for this activity. |
| **Stakeholders & reputation** | Stakeholder consultation has been undertaken (Section 6), and no stakeholder concerns have been raised with regards to spill response activities.<br><br>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. |
| **Environmental context & ESD** | The worst-case credible spill scenario for the operating activities is as a result of a collision between the FSO and another large vessel (e.g. third-party offtake tanker). The release of oil occurs over five hours 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.<br><br>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.<br><br>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.<br><br>The potential impact is considered acceptable after consideration of:<br>• Potential impact pathways;<br>• Preservation of critical habitats;<br>• Assessment of key threats described in species and Area Management /Recovery plans;<br>• Consideration of North-West Bioregional Plan; and<br>• Principles of ecologically sustainable development ESD. |
| **Conservation and management advice** | Jadestone Energy 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 objectives and values, of any AMPs, or state marine parks impacted by spill response activities to ensure that the objectives of the management plans are not contravened. |

| | |
|---|---|
| | Noting 'Emergency response' is permitted in all AMPs and State marine parks.<br><br>Actions required to respond to oil pollution incidents, including environmental monitoring and remediation, in connection with activities authorised under the OPGGS Act may be conducted in all zones. The Director will be notified in the event of an oil pollution incident that occurs within, or may impact upon, an Australian Marine Park and, so far as reasonably practicable, prior to a response action being taken within a marine park.<br><br>The Management Plans for EPBC protected species that identify light, noise and other risks apply here.<br><br>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. |

# 5 ASSESSMENT - ACCIDENTAL EVENTS

## 5.1 Unplanned flaring

### 5.1.1 Description of hazard

Where gas reinjection facilitates production, reinjection of produced gas occurs by a gas reinjection to the reservoir compressor on the FPSO. Sometimes reinjection of produced gas is unable to occur and produced gas that would otherwise be reinjected, is flared. The primary circumstance for this is if the reinjection system is unavailable or other gas-fuelled equipment on the FPSO does not require gas.

### 5.1.2 Impact and risks

Flaring can reduce air quality in the immediate vicinity of the Facility. While marine fauna individuals may be impacted by light emissions from unplanned flaring, the Operational Area does not contain any significant feeding, breeding or aggregation areas.

### 5.1.3 Summary of environmental performance

| | |
|---|---|
| **Hazard** | Unplanned flaring |
| **Performance Outcome** | Flaring from the *Montara Venture* does not exceed a set tonnage 299.674t of CO2 per annum |
| **Management Controls** | Performance standards |
| **Performance Standard Report) ensures integrity and maintenance requirements maintained** | Pipework and pressure vessels will be maintained to relevant Australian Standards |
| | Unplanned flaring does not exceed a continuous period of 1 month |
| **CMMS work instruction** | Gas reinjection compressor and turbine maintained and operated to manufacturers recommendations |
| **Spares of critical equipment for the gas reinjection system** | Critical spares for the gas reinjection system will be managed to reduce downtime of the system in the event of malfunction, damage or maintenance requirements |

### 5.1.4 ALARP assessment

| **Rejected control** | **Justification** |
|---|---|
| All emissions producing equipment is removed<br><br>Practicable – no<br><br>Cost effective – 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 equipment in the gas reinjection system is allocated a spare in inventory keeping<br><br>Practicable – no<br><br>Cost effective - no | Purchasing and maintaining equipment spares for the whole gas reinjection system is not practicable from a cost or maintenance perspective. As a compromise spares of critical equipment will be provided for where available and obtainable. Maintenance of critical spares is a consideration in achieving critical spares inventory. |
| Topside processing of production allows recycle of gas generated between production treatments stages 2 and 3 | While recycle of gas from production stages 2 & 3 will reduce flared emissions, at this stage cost effectiveness of this modification is not justifiable |

| | |
|---|---|
| to allow gas capture at these points and recycle of gas to the first production stage<br><br>Practicable – yes<br><br>Cost effective - no | |
| Administrative - Adopted<br><br>Practicable – n/a<br><br>Cost effective – n/a | Compliance with relevant and appropriate MARPOL requirements |
| Steam facilitating low opacity emissions. Current engineering design does not include this. A steam system would require steam 24 hours per day to be instantaneously operable which would place an operational load on the boiler. This may need to be redesigned (the cost for re-engineering the boiler has not been considered).<br><br>Practicable – yes<br><br>Cost effective - no | No parties (e.g. air force, navy, border force, local users) have complained or reported dark emissions at the *Montara* FPSO. The cost for the improvement versus the benefit that would be achieved is not ALARP. |
| High pressure water cleaning to create white smoke - as for the steam cleaning system, the flare system at *Montara* has not included this function within the original design of the facility.<br><br>Practicable – yes<br><br>Cost effective - no | The cost that would be incurred due to engineering design, construction and commissioning of a high-pressure water cleaning system at the flare tip outweighs the environmental benefit. No parties (e.g. air force, navy, border force, local users) have complained or reported dark emissions at *Montara*. The cost for the improvement versus the benefit that would be achieved is not ALARP. |
| Increased flaring: Increase flaring in the event of dark smoke emissions due to lack of oxygen at the flare tip. Increased flaring results in better combustion at the flare tip due to the sonic design of flare and thereby a reduction in the opacity of emissions.<br><br>Practicable – yes<br><br>Cost effective - yes | Not adopted – the increased flaring would be contrary to the intent of the environmental performance outcome of planned flaring operations |

### 5.1.5 Acceptability assessment

| | |
|---|---|
| **Policy & management system compliance** | Jadestone Energy's HSE Policy objectives are met. Section 7 demonstrates that Jadestone Energy's HSE Management System is capable of meeting environmental management requirements for the activities. |
| **Stakeholders & reputation** | Stakeholder consultation has been undertaken (see Section 6), and no stakeholder concerns have been raised with regards to impacts from unplanned flaring on sensitive receptors. |
| **Environmental context & ESD** | While there is light associated with unplanned flaring, the impact and risk assessment process indicate that light associated with unplanned flaring will not cause significant effects to marine fauna that may transit the Operational Area.<br><br>While there is an increase in atmospheric emissions to the airshed due to unplanned flaring, emissions occur immediately around the facility and vessels. The impact and risk assessment process indicate that emissions due to unplanned flaring will not result in significant effects to the environment or receptors. |

| | |
|---|---|
| | The potential impact is considered acceptable after consideration of:<br>• Potential impact pathways;<br>• Preservation of critical habitats;<br>• Assessment of key threats as described in species and Area Management / Recovery plans;<br>• Consideration of North-West Bioregional Plan; and<br>• Principles of ecologically sustainable development. |
| **Conservation and management advice** | 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 due to unplanned flaring and therefore the activity would not contravene the intent of the Recovery Plan.<br>No Management Plans identified air emissions such as those associated with unplanned flaring as being a threat to marine fauna or habitats.<br>Jadestone Energy considered the representative values of the protected areas within the EMBA, and the respective management plans and other published information. Impacts from light or air emissions from unplanned flaring will have a negligible impact on any of the social and ecological objectives and values, of any AMPs, or state marine parks. This is consistent with the objectives of the protected area management plans and considered acceptable. |

## 5.2 Marine pest introduction

### 5.2.1 Description of hazard

The *Montara* FPSO and the WHP were cleared as low risk installations when they first arrived in Australia, hence do not present a biosecurity risk. There is the potential for support vessels or vessels to transfer invasive marine pests (IMPs) from either international waters or Australian waters into the Operational Area and for them to establish in the local environment.

### 5.2.2 Impacts and risks

The introduction and establishment of marine pests can impact on native marine fauna and flora through competition, predation or displacement of native species, 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 marine pests include biofouling on vessels and other external niches and internal niches and wetted equipment and discharge of high risk ballast water taken up at international or domestic sources.

Under the National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (2009), a risk assessment approach is recommended to manage biofouling.

Any vessel or marine infrastructure destined for WA waters from interstate or overseas is required to meet the aquatic biosecurity standards set out under the *Fisheries Resources Management Act 1994*, including a Marine Biosecurity Inspection for the presence of known and potential IMS to ensure compliance with Regulation 176.

It is not likely that any IMS entering the Operational Area would establish on the natural soft sediments at the seabed. The depth of the Operational Area (80 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 IMPs.

Should IMPs 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.

### 5.2.3 Summary of environmental performance

| | |
|---|---|
| **Hazard** | Marine Pest Introduction |
| **Performance Outcome** | No introduction of marine species |
| **Management Controls** | Performance standards |
| **Vessels comply with the *Montara* Biosecurity Manual** | All vessels demonstrate compliance with the biosecurity manual requirements |

### 5.2.4 ALARP assessment

| **Rejected control** | **Justification** |
|---|---|
| Support vessels to be sourced from Australian waters<br><br>Practicable – no<br><br>Cost effective - no | The presence of the FPSO and associated support vessels is required to carry out operations. 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<br><br>Practicable – no<br><br>Cost effective - 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. If any invasive marine pests entered the Operational Area(s) the nearest habitat is the FPSO/ vessel hull or the benthic habitat (soft sediments at the seabed). The depth of the Operational Area (80 m), open ocean conditions and lack of available light at this depth provides a very hostile/ different environment to that within sheltered port and shallow coastal areas historically colonised by IMPs. |
| Substitute<br><br>Practicable – n/a<br><br>Cost effective – n/a | Wherever possible, domestic vessels will be sourced, but this may not always be feasible. Regardless, 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<br><br>Practicable – no<br><br>Cost effective - no | Substantial additional cost, potential delay to commencement of activity. 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 sea chests (marine growth prevention system) will occur. Anti-fouling coatings containing TBT are not an option as these anti-foulants are prohibited for use in Australia. |
| Administrative - Adopted<br><br>Practicable – n/a<br><br>Cost effective – n/a | The implementation of a Biofouling Management Plan and maintaining a Biofouling Record Book consistent with the DAWR (2015) *Anti-fouling and in-water cleaning guidelines*. No further administrative controls were considered. |

### 5.2.5 Acceptability assessment

| | |
|---|---|
| **Policy compliance** | Jadestone Energy's HSE Policy objectives are met. |

| | |
|---|---|
| **Policy & management system compliance** | Section 7 demonstrates that Jadestone Energy's HSE Management System is capable of continuously reviewing and updating activities and their practices to reflect the requirements of marine pest management in Australian waters. |
| **Stakeholder & reputation** | Stakeholder consultation has been undertaken (see Section 6), and no stakeholder concerns have been raised. Jadestone Energy will continue to liaise with Department of Primary Industries and Regional Development (Fisheries) on current requirements for the management of the risk of marine pest introduction in WA waters. |
| **Environmental context & ESD** | It is unlikely that any invasive marine pests entering the Operational Area(s) will establish on the natural benthic habitat (soft sediments at the seabed). The depth of the Operational Area (80 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 invasive marine pests.<br><br>The potential impact is considered acceptable after consideration of:<br>• Potential impact pathways;<br>• Preservation of critical habitats;<br>• Assessment of key threats as described in species and Area Management/ Recovery plans;<br>• Consideration of North-West Bioregional Plan; and<br>• Principles of ecologically sustainable development ESD. |
| **Conservation and management advice** | Application of guidelines detailed in the National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (2009), and in the IMO Guidelines for the Control and Management of Ships' Biofouling to Minimise the Transfer of Invasive Aquatic Species.<br><br>Jadestone Energy considered the representative values of the protected areas within the EMBA, and the respective management plans and other published information. Impacts from successful establishment of marine pests will not impact on any of the social and ecological objectives and values, of any AMPs, or state marine parks. This is consistent with the objectives of the protected area management plans and considered acceptable. |

## 5.3 Interaction with fauna

### 5.3.1 Description of hazard

The movement of support vessels, and helicopters in the Operational Area increases the potential for physical or disruptive interaction with marine fauna. Fauna most susceptible to vessel strike include cetaceans, whale sharks and turtles.

### 5.3.2 Impacts and risks

Collisions between vessels and cetaceans are most frequent on continental shelf areas where high vessel traffic and cetacean habitat occur simultaneously. Four listed threatened and migratory species of cetacean were identified as potentially occurring or having habitat in the Operational Area. The Conservation Management Plan for the Blue Whale identifies vessel strike as one of the threats to Blue Whale species However, there are no known key aggregation areas (resting, breeding or feeding) located within or immediately adjacent to the Operational Area. The Blue Pygmy whale BIA (distribution) overlaps the Operational Area, pygmy blue whales are typically solitary animals or occur in low numbers. Occasional individuals or groups of cetacean species may also be present from time to time.

Studies have indicated most lethal or severe injuries to cetaceans involved vessels 80 m or longer in length and have been associated with vessels travelling at 14 knots or faster (Vanderlaan and Taggart,

2007). The *Montara* support vessels typically travel at speeds under 14 knots as this represents the most economical speed. On rare occasions, higher speeds may be used where urgent delivery of supplies is needed. Supply vessel speeds within the Operational Area when approaching the FPSO are low and are required to be less than 5 knots within the 500 m PSZ.

Six species of listed threatened and migratory marine turtle were identified as potentially occurring in, or relating to, the Operational Area; Marine turtles are predominantly oceanic species except in the nesting season when they come ashore. There are no shorelines near the Operational Area. However, turtles may transit the offshore waters in proximity to the Operational Area and may forage on nearby shoals (noted as BIA foraging for some species).

The Operational Area does not intersect any Habitat Critical for the survival of marine turtles, with the closest nesting area being 84 km away (green turtle nesting area at Cartier Island boundary).

The most northern part of whale shark foraging biologically important areas (BIAs) overlaps the Operational Area and are susceptible to vessel strike. However, only occasional individuals could potentially occur as there are no whale shark aggregations (such as the Ningaloo Reef aggregation) in the region, hence a significant presence is not forecast.

Should individuals of listed or migratory bird species transit through the Operational Area, the worst-case consequence of a bird strike with a helicopter would be localised, with a potentially lethal effect on a single individual with no lasting effect to population or community baseline.

Considering the high visibility and noise levels associated with helicopter movements, birds are expected to avoid collisions. The number of helicopter flights required averages two inward/outward flights per week. Flights also occur in the daylight and not within major roosting areas, thereby reducing potential interactions.

### 5.3.3 Summary of environmental performance

| | |
|---|---|
| **Hazard** | Interaction with fauna |
| **Performance outcome** | No death or injury to EPBC Act listed marine fauna due to activities in the Operational Area |
| **Management Control** | Performance standards |
| **Potential for collision with marine fauna reduced by vessels operating at speeds in accordance with *Montara* Marine Facility Manual** | Vessels operating within the PSZ must not exceed a speed of five (5) knots. |
| **Competency and Training Management System provides personnel with awareness marine fauna interaction requirements** | Online induction includes information on speed limits in the PSZ and requirements on interacting with marine fauna |
| **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<br><br>Death or injury to EPBC Act listed marine fauna (including cetaceans or whale sharks) from vessel collision are recorded/reported to NOPSEMA and DoEE in line with regulations |

### 5.3.4 ALARP assessment

| **Rejected control** | **Justification** |
|---|---|
| Removal of vessels and helicopter use<br><br>Practicable – no<br><br>Cost effective - no | Vessel and helicopter presence is required during operations and there are no practicable alternatives. The potential for interaction between support vessels and fauna cannot be eliminated, however the risk is low given the location, low volume of vessel activity and speed limits. |
| Reduce frequency or size of support vessels Practicable – no<br><br>Cost effective - no | Reducing the frequency or size of support 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 of the necessities/ services to maintain effective operation of the FPSO. |
| Reduce or remove vessel and helicopter use during key sensitive periods Practicable – no<br><br>Cost effective - 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 FPSO all year round. |
| Use of marine fauna observers on all vessels to identify fauna close to vessels Practicable – n/a<br><br>Cost effective – n/a | 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. |

### 5.3.5 Acceptability assessment

| | |
|---|---|
| **Policy & management system compliance** | Jadestone Energy's HSE Policy objectives are met. Section 7 demonstrates that Jadestone Energy's HSE Management System is capable of meeting environmental management requirements for this activity. |
| **Stakeholder & reputation** | 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. |
| **Environmental context & ESD** | The Operational Area overlaps the whale shark BIA and the blue pygmy whale distribution BIA. However, risk to megafauna is considered low and acceptable as vessels will travel at low speeds within the Operational Area; minimal vessel activity in the area, and risk of mortality from a low-speed vessel strike is low. In this way, aspects of the EPBC Regulations 2000, Division 8.1 – Interacting with Cetaceans –are addressed.<br><br>The potential impact is considered acceptable after consideration of:<br>• Potential impact pathways;<br>• Preservation of critical habitats;<br>• Assessment of key threats as described in species and Area Management /Recovery plans;<br>• Consideration of North-West Bioregional Plan; and<br>• Principles of ecologically sustainable development |
| **Conservation and management advice** | Recovery Plan for Marine Turtles in Australia<br><br>The Recovery plan for marine turtles in Australia (DoEE, 2017a) identifies the following risk Vessel disturbance. It requires that risk of vessel strikes is evaluated and, if required, appropriate mitigation measures are implemented. This EP and the proposed controls is consistent with this advice.<br><br>Conservation Management Plan for the Blue Whale, 2015-2025 (DOF 2005)<br><br>The Management Plan identifies the following risk Vessel disturbance. It requires that risk of vessel strikes is evaluated and, if required, appropriate mitigation measures are implemented. This EP and the proposed controls are consistent with this advice.<br><br>Conservation Advice for Humpback Whales (*Megaptera novaeangliae*) DoE 2015.<br><br>The Conservation Advice identifies the following risk Vessel disturbance. It requires that risk of vessel strikes is evaluated and, if required, appropriate mitigation measures are implemented. This EP and the proposed controls is consistent with this advice.<br><br>Jadestone Energy has had regard to the representative values of the protected areas within the EMBA, and the respective management plans and other published information. Interactions with fauna may have a minor impact on any of the social and ecological objectives and values, of AMPs, or state marine parks. However, with controls in place to minimise the likelihood (to protect protected fauna) this is considered consistent with the objectives of the conservation advice or management plans and considered acceptable. |

## 5.4 Unplanned release of solid waste

### 5.4.1 Description of hazard

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 FPSO/WHP and support vessels

### 5.4.2 Impacts and risks

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. There are no known critical habitats within the Operational Area for EPBC listed species. The Area overlaps with the northern section of the whale shark foraging BIA; however, only low numbers are likely to be present. The accidental release of waste may result in injury or even death to individual marine fauna but is not expected to result in a threat to population viability.

Accidental spills of solid wastes could result in possible damage to or loss of soft sediment communities within the area affected with short term to long term impacts depending on the waste type, its degradation rate, and the amount lost to the marine environment. The extent of the seabed damage will be limited to the size of the dropped object and given the size of standard materials lifted overboard, any impact is expected to be very small.

Given there are no sensitive or unique marine habitats in the area and the diversity and coverage of epibenthos is low, benthic communities are expected to rapidly recolonise any damaged area. Given the relatively small footprint of any dropped object, the widespread distribution and abundance of benthic communities within the Operational Area, the consequence to benthic communities would be a highly localised, negligible, and reversible change to a very small proportion of the of the overall benthos.

### 5.4.3 Summary of environmental performance

| | |
|---|---|
| **Hazard** | Unplanned discharge of solid waste |
| **Performance outcome** | Zero unplanned discharge of solid wastes into the marine environment |
| **Management Control** | Performance standards |
| **Waste generated during operations will be managed in accordance with the *Montara* Waste Management Plan** | 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. Garbage Record Book shall be maintained on all facilities in accordance with MARPOL 73/78 Annex V |
| | Hazardous solid wastes will be managed in accordance with relevant legislation. A waste register will be maintained to show that hazardous wastes are being collected and returned onshore for disposal |
| **Competency and Training Management System** | FPSO crew and support vessel masters complete an induction containing basic information on environmental practices |
| ***Montara* Lifting Operations Procedure) implemented for lifts undertaken in the Operational Area** | All personnel involved with lifting equipment operations and maintenance receive adequate training and are competent appropriate to their level of responsibility |
| | JSA is completed for all lifts and approved under the PTW |
| | A Lift Plan completed for Complex and/or Engineered Lifts |

### 5.4.4 ALARP assessment.

| **Rejected control** | **Justification** |
|---|---|
| Removal of solid waste generation during activity and eliminate transfers (lifts)<br><br>Practicable - no<br><br>Cost effective - no | Solid wastes produced onboard are disposed of onshore and are not discharged to the marine environment. FPSO and vessels will not have enough deck space to store all required equipment, materials, supply needed for activities. |

| | |
|---|---|
| Reduce or remove solid waste generation and transfers during key sensitive periods<br><br>Practicable - no<br><br>Cost effective - no | Reducing or removing waste generating 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 FPSO all year round. The activity is located at distance from sensitive receptors and the coastline. |

### 5.4.5 Acceptability assessment

| | |
|---|---|
| **8olicy & management system compliance** | Jadestone Energy's HSE Policy objectives are met. Section 7 demonstrates that Jadestone Energy's HSE Management System is capable of meeting environmental management requirements for this activity. |
| **Stakeholder & reputation** | Stakeholder consultation has been undertaken (Section 6), and no stakeholder concerns have been raised with regards to impacts from solid waste generation or unplanned discharges on sensitive receptors. |
| **Environmental context & ESD** | Benthic habitats have the potential to be impacted with solid wastes resulting in potential loss of soft sediment communities and harm to marine fauna. If impacted, benthic habitats and associated biota are well represented in the region and there are no known areas of sensitive habitat within the area that may be affected by accidental release of solid waste. Marine fauna can become entangled in waste plastics, which can also be ingested when mistaken as prey potentially leading to injury or death. Generally, no toxic effects are expected from non-hazardous solids<br><br>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 Marine region and North Marine Region and the transient nature of marine fauna that may be present in the Operational Area. The potential impact is considered acceptable after consideration of:<br><br>• Potential impact pathways;<br>• Preservation of critical habitats;<br>• Assessment of key threats as described in species and Area Management /Recovery plans;<br>• Consideration of North-West Bioregional Plan; and<br>• Principles of ecologically sustainable development. |
| **Conservation and management advice** | Marine debris is identified as a potential threat to a number of marine fauna species in relevant Recovery Plans and Conservation Advice:<br><br>• Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale);<br>• Conservation management plan for the blue whale: A recovery plan under the EPBC Act 1999 2015-2025;<br>• Conservation advice *Balaenoptera borealis* (sei whale);<br>• Conservation advice *Balaenoptera physalus* (fin whale);<br>• Recovery Plan for Marine Turtles in Australia; and<br>• Recovery plan for the white shark (*Carcharodon carcharias*).<br><br>The controls implemented demonstrate that the activity will be conducted in a manner that reduces marine debris and therefore the activity will be conducted in a manner that is acceptable under the relevant Recovery Plans and Approved Conservation Advice to prevent accidental release of non-hydrocarbon solids (marine debris).<br><br>The limited quantities associated with this event indicate that even in a worst-case release of solid waste, fatalities would be limited to individuals and is not expected to result in a decrease of the local population size for any of the species identified. |

## 5.5 Unplanned release of (non-hydrocarbon) liquids

### 5.5.1 Description of hazard

Both non-hazardous and hazardous chemicals are routinely transported to and from, stored and used aboard the *Montara Venture* FPSO. There is potential for these chemicals to be accidentally spilled from both the *Montara* facilities and support vessels, the maximum volume likely to be small and realistically limited to the volume of individual containers stored on-deck.

Accidental chemical releases may occur during any season/time. Based upon existing maximum inventories, the volume of spill is conservatively estimated to be limited to a single discharge of $5m^3$ with lesser volumes for other chemicals. An unplanned discharge would be an instantaneous release within the Operational Area with some chemicals possibly persisting in the marine environment.

### 5.5.2 Impact and risk

The potential impact pathways to marine fauna and benthic communities include ingestion or physical contact with chemical compounds within the water column or sediment; and accumulation and biomagnification of chemicals within the food chain.

The potential impacts would most likely be highly localised and restricted to the immediate area, with rapid dispersal to concentrations below impact thresholds likely in the open area of ocean.

Spikes of degraded water quality may occur for very short durations and as such any affects to benthic habitats are expected to be temporary as the most common benthic habitat is soft sediments, which would recover quickly if impacted. Given the water depth and the high dispersion of any potential marine pollutant in an open-ocean environment, it is considered unlikely that there be an adverse impact on benthic communities.

There is no emergent or inter-tidal habitat that could be impacted by a surface spill. Any spilled material is unlikely to reach any of the demersal species or benthic habitats at the seabed. Sub-lethal or lethal effects from unplanned discharges at the seabed on marine fauna, is considered unlikely given the expected low concentrations and short exposure times.

Short-term water quality perturbations could result in short-term alterations to marine fauna behaviour. with chronic impacts not expected owing to the short exposure times likely. The susceptibility of marine receptors to non-hydrocarbon releases will be dependent on the nature of the liquid released, toxicity and other chemical properties such as biodegradation and bioaccumulation potential.

Contaminated fish stocks and filter feeders such as oysters and mussels can pass on harmful chemicals to humans, if contaminated organisms are consumed.

### 5.5.3 Summary of environmental performance

| | |
|---|---|
| **Hazard** | Unplanned discharge of solid waste |
| **Performance Outcome** | Zero unplanned discharge of solid wastes into the marine environment. |
| **Management Control** | Performance standards |
| **Hazardous Substances & Dangerous Goods** | Any hazardous liquid storage on deck must be designed and maintained to have at least one barrier to contain and prevent deck spills entering the ocean |

| | |
|---|---|
| **Hazard** | Unplanned discharge of solid waste |
| **Performance Outcome** | Zero unplanned discharge of solid wastes into the marine environment. |
| **Management Control** | Performance standards |
| **Standards is complied with and meets requirements of Marine Order 94** | Safety data sheet (SDS) available for all chemicals to aid in the process of hazard identification and chemical management |
| | Chemicals managed in accordance with SDS in relation to safe handling and storage, spill-response and emergency procedures, and disposal considerations |
| **Chemical Selection, Evaluation and Approval Procedure** | For hazardous chemicals, the following standards apply to reduce the risk of an accidental release to sea:<br>• Selected chemical substances comply with relevant regulatory requirements and approved activity environment plans;<br>• Selected chemical substances are subject to mandatory risk review and formal approval before procurement;<br>• Transport, storage and handling of chemicals is in accordance with relevant regulations and manufacturer requirements;<br>• Least hazardous chemicals are preferentially selected for use thereby minimising and/or eliminating potential safety and environmental impacts;<br>• Control measures for safe transport, storage and handling for chemicals classified hazardous and/or dangerous goods are deemed adequate;<br>• Selected chemical substances meet technical specifications and are fit for purpose. |
| **Vessels are compliant with Marine Order 93 to prevent any contaminating liquids and chemicals from entering the marine environment** | Vessels compliant with Marine Order 93, including:<br>• Vessels have a valid International Pollution Prevention Certificate;<br>• The owner and Master of a vessel must report marine incidents to AMSA;<br>• Incidents reported to AMSA via Form 196 within 24 hours;<br>• Vessels have a Shipboard Marine Pollution Emergency Plan and Cargo Record Book;<br>• Vessel tanks must be washed in accordance with the Pollution Prevention Act. |
| **Spill kits are present in high spill risk areas** | Spill kits are Located near high risk spill areas, intact, clearly labelled and contain adequate quantities of absorbent materials. |

### 5.5.4 ALARP assessment

| Rejected control | Justification |
|---|---|
| No waste produced or use of hazardous materials<br><br>Practicable - no<br><br>Cost effective - 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<br><br>Practicable - no<br><br>Cost effective – n/a | 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. |

### 5.5.5 Acceptability assessment

| | |
|---|---|
| **Policy & management system compliance** | Jadestone Energy's HSE Policy objectives are met. Section 7 demonstrates that Jadestone Energy's HSE Management System is capable of meeting environmental management requirements for this activity. |
| **Stakeholder & reputation** | Stakeholder consultation has been undertaken (Section 6), and no stakeholder concerns have been raised with regards to impacts from unplanned discharges of non-hydrocarbon liquids on sensitive receptors. |
| **Environmental context & ESD** | While the risk of unplanned liquid waste discharges could occur from the activity and have an impact on the waters immediately nearby, the impact and risk assessment process indicates that unplanned discharges will have a temporary and localised impact on marine waters and will not result in significant impact to marine fauna. The potential impact is considered acceptable after considering:<br>• Potential impact pathways;<br>• Preservation of critical habitats;<br>• Assessment of key threats as described in species and Area Management /Recovery plans;<br>• Consideration of North-West Bioregional Plan; and<br>• Principles of ecologically sustainable development. |
| **Conservation and management advice** | Minimising chemical discharge is an action identified by the Recovery Plan for Marine Turtles in Australia 2017-2027. This requires that best practice industrial management is implemented to minimise impacts to marine turtle health and habitats. A marine chemical spill is unlikely due to the controls in place for secure storage and on-board clean-up of spills, transient nature of marine fauna and the remote open ocean environment, there are no relevant management requirements in the recovery plan to implement for this hazard. |

## 5.6 Unplanned release of hydrocarbons

## 5.7 Credible spill scenarios

Table **5-1** summarises the scenarios in which hydrocarbon could be released to the marine environment.

**Table 5-1 Credible worst-case hydrocarbon spill scenarios**

| Hydrocarbon | Release point | Maximum release scenario |
|---|---|---|
| Diesel | At surface | 906 $m^3$ released over 5 hours |
| Crude oil | Loss of well control – subsea and surface | 164,718 $m^3$ |

To determine the maximum worst-case credible spill volumes for each identified spill scenario, Jadestone Energy has adopted the AMSA (2015) guideline - *Technical guideline for preparing contingency plans for marine and coastal facilities*. 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; thus, total volumes evaluated are much greater than what would be released in the event of a spill.

## 5.8 Worst case crude oil spill

### 5.8.1 Description of the hazard

A loss of well control (LOWC) may occur at surface or subsurface resulting from:

- Catastrophic damage to platform and associated wells;
- Loss of function downhole of safety critical equipment (loss of barriers); and
- Damage to subsea well infrastructure (well valves, wellhead).

Hydrocarbons may be released to the marine environment with the most likely release points at either the WHP floor (sea surface) or subsea wellheads. In a loss of well control scenario, large quantities of hydrocarbon (worst-case oil release 164,096 $m^3$) will be released to the marine environment until well control can be re-established.

Six credible LOWC scenarios resulting in a *Montara* or Skua crude oil spill to the marine environment were identified. Four were subsea releases (the maximum being 161,762 $m^3$) and two were surface releases (the maximum being 164,096 $m^3$), all over a duration of 77 days.

Other loss of containment scenarios considered a rupture of a subsea cable, leaks of flowlines, ruptured cargo tanks and breakages of offtake hoses. As the largest volume, the well - H6 LOWC scenario represents the worst case credible crude oil release scenario for the *Montara* Operations activity.

### 5.8.2 Modelling results of the LOWC scenarios

Stochastic spill modelling was conducted for the three scenarios for each of three seasons- summer (November to February), winter (April to August) and combined transition (March, September and October), totalling 300 runs. 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. With several different release scenarios resulting in different floating oil, entrained oil and dissolved aromatic hydrocarbon affected areas, the results for each hydrocarbon component and scenario were combined to create a total EMBA.

The worst-case scenario was determined to be Scenario 9 - a long-term (77-day) uncontrolled surface release of 164,096 $m^3$ of *Montara* Crude from the H6 well, representing loss of hydrocarbon containment after a loss of well control. No mitigation measures were applied in this modelled scenario. The boundaries of the total EMBA have been plotted in **Figure *5-1***.

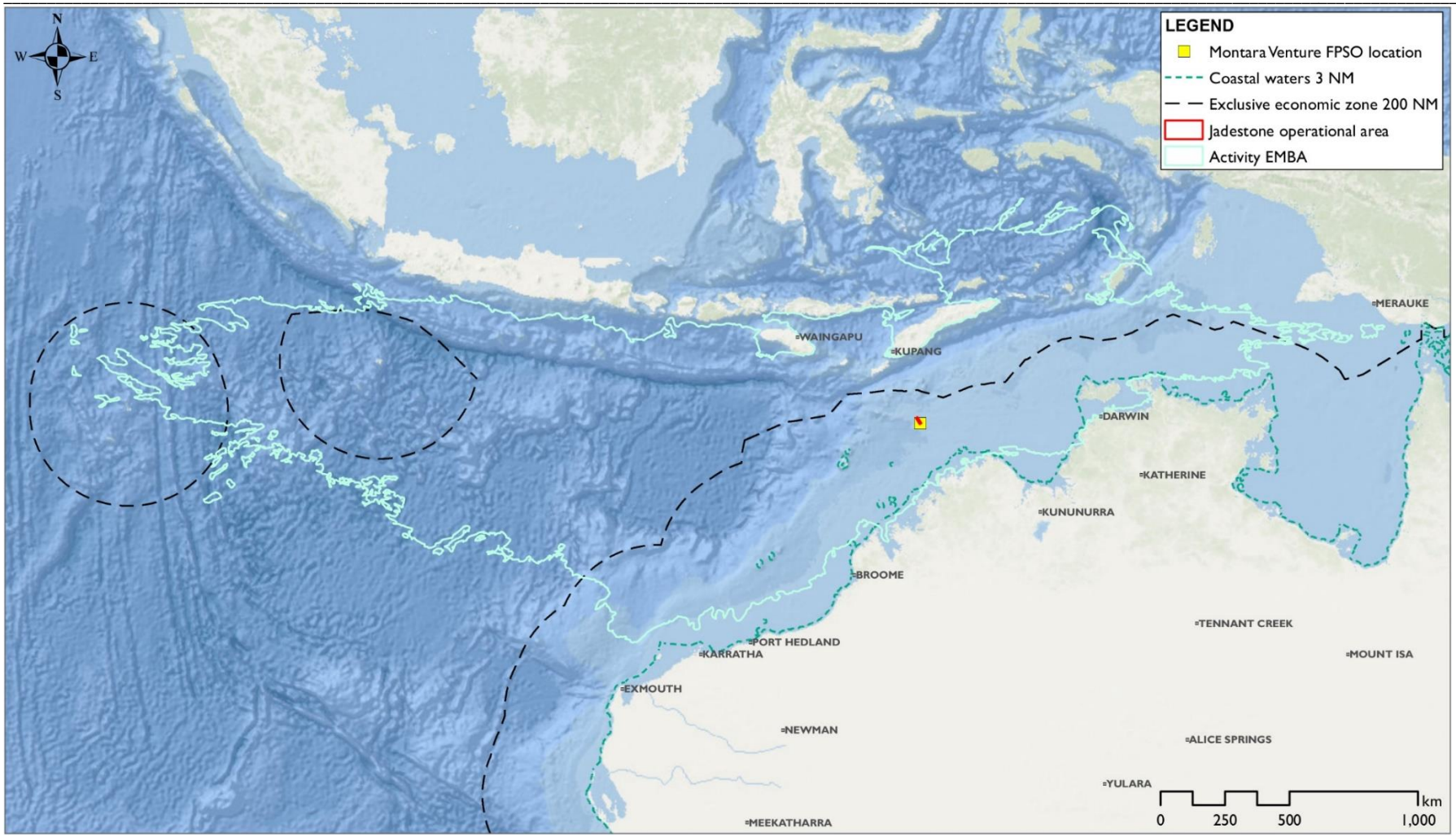



**Figure 5-1** ***Montara*** **Operations Activity EMBA**

### 5.8.3 Worst Case Scenario summary results

#### 5.8.3.1 Floating oil results

Results of the worst-case modelling indicate that surface sheens of floating oil (<1 g/m$^2$) may pass over the following sensitive receptors, with a probability of <1% of reaching these locations:

- Oceanic Shoals AMP after 3 days;
- Ashmore Reef, Cartier Island and surrounding Commonwealth waters KEF after 8 days;
- Seringapatam Reef and Commonwealth waters in the Scott Reef Complex KEF after 29 days; and
- Rowley Shoals after 57 days.

Floating oil at concentrations of 10 g/m$^2$ were predicted to reach Ashmore Reef, Cartier Island and surrounding Commonwealth waters KEF after 8 days of commencement of release (at a probability of <1%).

#### 5.8.3.2 Entrained Oil results

Results of the stochastic modelling indicated that entrained oil concentrations greater than 100 ppb were predicted to reach the following locations to receive the highest volumes (with the highest concentrations):

- Sahul Bank (1459 ppb);
- Karmt Shoal (1374 ppb);
- Barton Shoal (1067 ppb); and
- Margaret Harries Bank (843 ppb).

The AMPs and State Marine Parks predicted to be impacted by entrained oil >100 ppb include Oceanic Shoals AMP, Argo-Rowley Shoals AMP, Kimberley AMP, Ashmore Reef AMP, Cartier Island AMP and North Kimberley Marine Park.

The KEFs predicted to be impacted by entrained oil >100 ppb include Continental Slope Demersal Fish Communities, Ashmore Reef and Cartier Island and surrounding Commonwealth waters, Seringapatam Reef and Commonwealth waters in the Scott Reef Complex, Pinnacles of the Bonaparte Basin KEF, Carbonate Bank and Terrace system of the Sahul Shelf KE, and the Ancient Coastline at 125 m depth contour.

#### 5.8.3.3 Dissolved aromatic hydrocarbons results

Contact by dissolved aromatic hydrocarbons at concentrations ≥70 ppb is predicted to be high in summer at the Carbonate Bank and Terrace System of the Sahul Shelf KEF (58%) and the Oceanic Shoals AMP (49%). Probabilities in winter are predicted to be high at the Continental Slope Demersal Fish Communities KEF (76%) and The Ashmore Reef, Cartier Island and surrounding Commonwealth waters KEF (58%). Transitional months were generally predicted to have lower probabilities than summer and winter.

The maximum dissolved aromatic hydrocarbon concentration forecast for any receptor is predicted as 4,274 ppb at the Oceanic Shoals AMP.

### 5.8.4 Impacts and risks

#### 5.8.4.1 Surface oil

Coating of marine flora, fauna and habitats or ingestion of oil by marine fauna. 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.

Shoreline habitats have the potential to be coated by stranded oil and shoreline fauna can be exposed to toxic effects from ingestion. There are no thresholds identified at which coating 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.

Surface oil occurring in coastal waters (of 1 g/$m^2$) and accumulating on shorelines may also reduce the visual amenity of an area diminishing the natural, historic and indigenous heritage values of a place.

#### 5.8.4.2 Entrained oil exposure

Entrained oil has the potential to impact benthic and shoreline habitats and organisms.

According to a review by IRC (2011) of Group II (MGO) hydrocarbons toxicity to the marine environment, a contact threshold of 500 ppb was found to be highly conservative for a range of species including crustaceans, molluscs, echinoderms and fish (NERA, accessed 2019). Therefore, the threshold selected for this activity of 100 ppb is considered very conservative.

Potential impacts to marine fauna (including invertebrates such as corals and sponges) due to exposure to >100 ppb entrained oil include acute and chronic toxicological effects with sub lethal and lethal results if ingested, damage/irritation to eyes and skin and damage to feathers of marine birds.

Potential impacts to sensitive receptors are summarised in **Table 5-2** below.

**Table 5-2 Key potential impacts to sensitive receptors present in the EMBA**

| **Shoreline habitats (excluding Mangroves)** |
|---|
| Sensitivity<br><br>The type of shoreline will influence the volume of hydrocarbon that could be stranded ashore and its thickness before the shoreline saturation point occurs. Shoreline data for the northern and western Australian coasts and islands was obtained from the OzCoasts Smartline data set sourced via Geoscience Australia.<br><br>*Floating*<br><br>Shoreline habitats which have the potential to be smothered 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, reduced mobility and inability to thermoregulate, irritation to eyes, noses and breathing apparatus and/or inability to breathe or see.<br><br>A proportion of the stranded oil may contaminate sand deeper in the beach profile. This may occur through re-suspension of sediments in the surf zone, the oil moving down through the beach sediments or soluble fractions of the stranded oil percolating through to deeper beach sediments.<br><br>Oiling of tidal zones and rocky shores may cause coating of organisms present possibly leading to suffocation or loss of purchase on the substrate. While oil may stick to platform surfaces, in high energy areas high water movement and energy will remove oil over time; however, in lower energy areas stranded oil may persist and |

oil may also be 'hidden' under rubble, ledges and in pockets/crevices. Once oil has been removed from platform surfaces, re-colonisation of the hard substrate surfaces by organisms is often rapid (weeks to months)

*Entrained and dissolved*

Intertidal and subtidal zones may be exposed to entrained and dissolved 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 crude, the accessibility of PAHs to aquatic organisms is decreased.

***Potential impact from modelled event***

Locations of shoreline habitats that could be impacted by surface or entrained and dissolved oil throughout the EMBA and the shoreline loading of oil at these locations have been determined from the modelling.

| | |
|---|---|
| *Timeframe to recovery* | 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. |
| *Consequence* | The consequence of a loss of well control event on shoreline habitats was assessed as *Major* given recovery may take years. |

**Mangroves and saltmarsh**

*Floating*

Mangrove root systems are sensitive to physical coating by crude oil which may persist for prolonged periods given the persistent components of crude oil and the tendency for mangrove root habitat to trap oil. Surface slicks that make their way into a mangrove will make contact with pneumatophores used by mangroves for gas exchange. Oil coating may result in yellowed leaves, defoliation and tree death depending on the extent and degree of oiling. Exposure of mangroves to floating oil may also damage cellular membranes leading to impairment of salt exchange, disruption of ion transport mechanisms, and growth of branched pneumatophores. More chronic toxicity impacts including genetic damage, have population-scale effects. A high sensitivity of seedlings to oiled sediments would also impact longer term recruitment of the affected population.

This could have prolonged negative effects on the faunal communities within mangroves. Mangroves are amongst the most susceptible and slowest recovering emergent habitat types with recovery potentially on a decadal scale if death of trees was to occur.

Salt marshes would likely trap floating crude oil to a certain degree and therefore persistent oil may remain 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, 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.

*Entrained and dissolved*

Mangrove communities may be impacted through the sediment/mangrove root interface. Where entrained hydrocarbons include contaminants that may become persistent in the sediments, 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).

| | |
|---|---|
| Impacts to mangroves include yellowing of leaves, defoliation, reduced reproductive success, mutation and increased sensitivity to other stresses (Duke 2016) as well as impacts to the resident marine biota (invertebrates, fish, birds). | |
| **Potential impact from modelled event** | |
| Mangroves could be impacted at the North Kimberley Marine Park, Port Hedland, Darwin Coast, Tiwi islands and other shorelines along the Australian mainland. These mangroves are identified as KPI values within many of the respective management plans. Floating crude oil could reach salt marsh areas (North Kimberley marine park), which are often landward of mangrove communities, on high spring tides. | |
| *Timeframe to recovery* | Depending upon the level of impact, recovery to affected mangrove areas can be on the scale of years to decades (Duke 2016). |
| *Consequence* | The consequence of a loss of well control event on mangroves and saltmarshes was assessed as *Critical* given recovery may take years. |
| **Plankton** | |
| Sensitivity<br><br>*Floating*<br><br>Surface oil can affect light qualities and the ability of plankton to photosynthesise, thus reducing primary productivity<br><br>*Entrained and dissolved*<br><br>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 source where oil concentrations are likely to be highest.<br><br>Planktonic communities comprise sensitive receptors to hydrocarbon exposure including single-celled organisms (e.g. phytoplankton) and larval stages of vertebrates and invertebrates. Smaller organisms are more likely to become entrained in a parcel of water; if contaminated with dissolved aromatic hydrocarbons, and organisms are entrained in a parcel of water for 96 hours or more acute/lethal effects may result. Where plankton are exposed to entrained hydrocarbons for a period less than 96 hours and at concentrations that may cause effect, chronic/non-lethal impacts may occur including impaired movement, predatory/avoidance response and degraded respiration.<br><br>Numerous studies on the influence of oil on plankton communities have been carried out, including a study conducted by Varela *et al.* (2006), which also compared their results with other published studies. Despite limitations (oil type, environmental conditions and planktonic communities) it was not possible to demonstrate any effects on plankton communities and that any changes are within the range of natural ecosystem variability. Variations in the temporal scale of oceanographic processes typical of the ecosystem have a greater influence on plankton communities than the direct effect of spilt oil. | |
| **Potential impact from modelled event** | |
| *All areas and species* | 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 and offshore islands within the EMBA. The EMBA has the potential to overlap with spawning of some fish species given the year round spawning of some species and the ongoing operations activity. 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 and closest to the source. |

| | |
|---|---|
| *Timeframe to recovery* | Reproduction by survivors or recruitment from unaffected areas (via sea surface currents) would be likely to rapidly replenish any losses from permanent zooplankton (Abbriano *et al.* 2011). Plankton have life cycles based on rapid reproduction with levels of high productivity and dispersive. Field observations from oil spills have shown minimal or transient effects on marine plankton (Abbriano *et al*. 2011).<br><br>Once background water quality conditions have re-established, the plankton community will take weeks to months to recover (ITOPF 2011), allowing for seasonal influences. |
| *Consequence* | The consequence of a loss of well control event on plankton was assessed as *Minor* given recovery may take weeks to months. |

**Benthic habitat and communities (including deep water habitats and shallow shoals, corals, intertidal zones)**

Sensitivity

*Floating*

Contact of floating 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 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. Impacts to hard corals could be intensified if during the peak spawning, oil smothered intertidal corals or contacted floating coral eggs and larvae. Dependent on the level of contact, this could diminish coral recruitment, and impact longer term recovery.

Other benthic habitats are unlikely to be impacted by surface oil given their water depths.

*Entrained and dissolved*

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.

The smothering of submerged benthic habitats and those within tidal zones from water column oil has only been reported where very large 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 to reefs may occur. Yender and Michael (2014) indicates 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 includes impaired feeding, fertilisation, larval settlement and metamorphosis, larval/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, thus reducing primary productivity.

Waters that contain extensive fringing coral reef may experience impacts from entrained hydrocarbons as described for benthic habitats. Reefs are often characterised by increased levels of biological productivity, which attracts commercially valuable fish species. Epifauna associated with hard substrates (e.g. ascidians and sponges) may experience direct toxicity through ingestion.

**Potential impact from modelled event**

| | |
|---|---|
| *All areas and species* | Benthic habitats in the EMBA that may be impacted by entrained oil include soft sediments and benthic fauna, coral reef, sponges, macroalgae and seagrasses. |
| *Timeframe to recovery* | 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., 2001). |
| *Consequence* | The consequence of a loss of well control event on benthic habitats was assessed as *Moderate* given recovery may take months to a year depending on the habitat type. |

**Marine Reptiles**

Sensitivity

Marine reptiles (including turtles) are potentially directly affected by the toxicity of in-water and surface hydrocarbons through ingestion, volatile organic compounds through inhalation, and effects of contact with surface hydrocarbons.

*Floating*

Marine turtles and sea snakes when surfacing to breathe may be affected from surface slick hydrocarbons through damage to their airways and eyes, tainted food source or by absorption through the skin. Highest risk of contact would likely be along intertidal sections of nesting beaches or within shallow waters adjacent to nesting beaches. Contact might also occur within foraging areas.

Depending on species, adult females will lay eggs on the beach above the high tide mark followed by emergence of hatchlings that will make their way to the water. Adult females will often wait in nearshore water before coming up onto the beach and may revisit the beach several times before exiting onto the beach and laying her eggs. Coating (particularly of hatchlings) can lead to reduced mobility and buoyancy, mortality, drowning, starvation, dehydration, increased predation and behavioural disruption.

Other potential impacts include inhalation of volatile compounds, ingestion and internal adsorption, adsorption across exposed skin and membranes, ingestion of oiled food, cell damage, lesions, reduced metabolic capacity, reduced immune response, reduced reproductive output, growth abnormalities, behavioural disruption and mortality.

*Entrained*

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. 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.

*Dissolved*

Most 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 (Shigenaka et al. 2010). 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

Whilst turtle nesting beaches may be contacted by weathered oil, turtles will always nest above the high tide mark and any oil moving through the beach profile should not contact the 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.

**Potential impact from modelled event**

Threatened and migratory marine reptile species may occur within the spill area EMBA as turtles are widely dispersed at low densities across the NWMR and NMR and in the unlikely event of a spill occurring, individuals traversing open water may come into contact with water column or surface oil. The 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. The adult nesting females are at risk from surface slicks as they come into nearshore waters and emerge from the beach through the surf zone and would also come into contact with any stranded oil on the beach. Once emerged from the nests, hatchlings will move down the beach and into the water migrating away from the beach at surface. Hatchlings also would be exposed to stranded oil on the beach and surface slicks in nearshore and offshore waters.

| | |
|---|---|
| *Timeframe to recovery* | Recovery of marine reptiles will depend on the degree of oiling and potential impacts at critical life stages but could result in impacts at a population level resulting in recovery within years e.g. if a spill occurred in turtle hatchling season and significant numbers affected when leaving nesting beaches. |
| *Consequence* | The consequence of a loss of well control event on marine reptiles was assessed as *Major* given impacts may occur at population level with recovery in 1-2 years. |

**Fish and Sharks**

Sensitivity

*Floating*

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). 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 body surfaces resulting in irritation and infection. Ingestion of hydrocarbon droplets or contaminated food can lead to reduced growth.

*Entrained*

Reef fish with high site fidelity can experience degraded water quality with entrained hydrocarbon concentrations >500 ppb within the EMBA. Hydrocarbon droplets can affect fish exposed for an extended duration (weeks to months) by coating of gills, leading to lethal and sub-lethal effects from reduced oxygen exchange and coating of body surfaces resulting in increased 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.

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 when they (and their prey) were present in the region.

*Dissolved*

Tainting by DAHs of commercially targeted pelagic fish species can have a range of effects from affecting edible quality of the fish (with economic consequences), to exceeding recommended human consumption toxicity guidelines.

**Potential impact from modelled event**

Whale sharks could potentially transit through the spill EMBA and the foraging activity occurring in July-November each year. Whale sharks may be vulnerable to surface oil due to their surface feeding nature and may result in coating of gills and ingestion of oil. Entrained and dissolved oil affecting whale sharks, and their food source plankton, can result in impacts as described above. The NWMR and NMR 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 and be exposed to entrained and dissolved oil. Some fish assemblages within the EMBA are also part of protected areas such as AMPs or KEFs and may also be targeted in the commercial fishing industry.

| | |
|---|---|
| *Timeframe to recovery* | Recovery of fish and sharks will depend on the degree of oiling and potential impacts at critical life stages but could result in impacts at a population level resulting in recovery within months given relatively regular spawning activity that occurs in most fish species. 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. |
| *Consequence* | The consequence of a loss of well control event on fish and sharks was assessed as *Moderate* given impacts may occur to localised populations with recovery in months to a year. |

**Marine Mammals**

Sensitivity

*Floating*

Physical and chemical effects of hydrocarbons with some mammals have been demonstrated through direct contact e.g. 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 can result. Whales, dolphins and dugongs are smooth skinned, hairless mammals so oils tend not to stick to their skin therefore physical impacts from surface oil coating is unlikely.

Physical impacts due to ingestion are applicable to surface slicks; however, the susceptibility of cetacean species varies with feeding habits. Baleen whales are more likely to ingest surface slick hydrocarbon than "gulp feeders" such as toothed whales. 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/m2) of oil might contact humpback whales as they migrate. Similarly, blue whales may encounter a sea surface plume (>10 g/m2) as they pass through the area during their northern migration in May–August.

Marine mammals are at risk of inhaling volatile compounds evaporating from a spill if they surface to breathe in an oil slick (Geraci 2012). Oil may foul sensory hairs around the mouth and/or contact eyes while surfacing to

breathe which may cause inflammation and infections. 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.

*Entrained*

Impacts from ingested hydrocarbon can be lethal or sub-lethal. However, the susceptibility of marine mammal species varies with feeding habits. Entrained oil attached to seagrass can also be ingested by dugongs.

*Dissolved*

Marine mammals that may occur within the EMBA for DAHs include whales and dolphins in offshore waters. 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.

**Potential impact from modelled event**

Marine mammals present within the EMBA include threatened and migratory whales and dolphins, and potentially dugongs. The activity is being undertaken all year round and may overlap with blue whale migration and humpback whale migration and calving as well as dugong calving and breeding, therefore crude oil may contact whales and dugongs during these life stages when the fauna are less likely to move away from the area if undertaking critical breeding activity.

| | |
|---|---|
| *Timeframe to recovery* | Recovery of marine mammals will depend on the degree of potential impacts at critical life stages but could result in impacts at a population level resulting in recovery within years e.g. if a spill occurred in migration or calving season and significant numbers were affected by preventing normal migration and calving activity from occurring. Recovery of individuals may be more rapid once moved away from the area of potential impact due to their smooth hairless skin. |
| *Consequence* | The consequence of a loss of well control event on marine mammals was assessed as *Major* given impacts may occur at population level with recovery in 1-2 years. |

**Avifauna**

Sensitivity

*Floating*

Seabirds are highly susceptible to surface oils and may experience hypothermia due to matted feathers, an inability to fly, decreased foraging success, decline in prey populations (Andres 1997, NRC 2003) or increased time preening to remove oil from their feathers (Burger and Gochfield 2002). 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) such as at Ramsar sites. Reduced abundance of a preferred food may cause shorebirds to move and forage in other alternative habitats to 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. 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).

*Entrained and dissolved*

Seabirds may contact entrained oil while searching for food (diving) below the sea surface, but exposure times would be very short 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 hemolytic anemia, reduced reproduction, and immunosuppression.

As most fish survive beneath floating slicks, they will continue to attract foraging seabirds, which typically do not exhibit avoidance behaviour.

**Potential impact from modelled event**

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 oil while foraging (dive and skim feeding). Higher numbers would be expected during breeding periods.

**Risk**

| | |
|---|---|
| *Timeframe to recovery* | Recovery of avifauna will depend on the degree of oiling and potential impacts at critical life stages but could result in impacts at a population level resulting in recovery within years e.g. if a spill occurred in bird nesting season and significant numbers were affected when foraging in the region resulting in impacts carrying over into the breeding season and other breeding habitats. |
| *Consequence* | The consequence of a loss of well control event on avifauna was assessed as *Major* given impacts may occur at population level with recovery in 1-2 years. |

**Socio economic**

Sensitivity

*Floating*

Surface oil may impact upon socio-economic receptors including the oil and gas industry, commercial shipping, fisheries/aquaculture, recreation and tourism, resulting in economic and social impacts. 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.

Many of the protected areas have 'wilderness' and 'seascapes' identified as a value, and these would be compromised by the presence of any oil.

*Entrained*

Impacts to fish may result in tainted flesh and fishery closure resulting in an economic impact on commercial, recreational 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.

*Dissolved*

Socio-economic receptors will be affected by hydrocarbon exposure in three 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.

| | |
|---|---|
| **Potential impact from modelled event** | |
| Impacts to fisheries could occur due to fish death and tainting of flesh resulting in potential fishery closures and loss of income. The potential area of impact may also be closed to fishers during cleanup for health and safety reason, reducing the area and timeframe for fishing to occur and potentially affecting income. Perceived and actual impacts to areas popular for tourism can result in a loss of income to the local region through reduced numbers of visitors. | |
| *Timeframe to recovery* | Recovery will depend on the degree of oiling along shorelines and that which is perceived by the public. Recovery of fish is likely to occur within months to years of water quality returning to normal given the regular spawning events that occur. Timeframes for fish tainting to disappear may be similar. |
| *Consequence* | The consequence of a loss of well control event on socio-economic receptors was assessed as *Major* given impacts on the values of tourism may take 1-2 years to recover and have a national reputational impact. |
| **Protected Areas** | |
| Sensitivity<br><br>*Floating*<br><br>Surface oil and/or shoreline loading may be expected at some AMPs affecting shoreline habitats and intertidal zones.<br><br>*Entrained and dissolved*<br><br>Entrained 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 (see assessments above) | |
| **Potential impact from modelled event** | |
| AMPs | There are 14 AMPs present within the EMBA. Surface oil could be expected to accumulate at some locations including Eighty Mile Beach and Roebuck Bay (amongst others), however entrained hydrocarbons are predicted to contact all of these AMPs. The highest entrained oil concentrations are expected at Oceanic Shoals and Cartier Island, with lesser concentrations at other AMPs. Entrained hydrocarbons could therefore impact on the potential values outlined for these parks and includes all marine fauna as, marine habitats and socio-economic receptors described within this table.<br><br>With the deeper AMP features, the geomorphological features are unlikely to be affected by entrained hydrocarbons, but the receptors may be affected by changes in water quality and impacts to the food chain. However, shallower features within AMPs such as coral reefs would potentially have long term impacts to the habitats supporting receptors as described within this table for coral reefs and other habitats.<br><br>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. 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. Tourism may be impacted by real or perceived reduction in health or mortality of habitats that support tourism activities. |

| | |
|---|---|
| State and Territory Marine Parks | There are five marine parks within the EMBA.Values associated with these marine parks include marine fauna and coral reefs, mangroves, saltmarshes and sandy beaches. These values may be contacted by entrained and dissolved oil which would potentially impact the receptors as described in this table. |
| World, National and Commonwealth Heritage Places | The Kakadu National Park is the only world heritage place within the EMBA. Receptors within this park include mangroves and wetlands which in turn support migratory birds. Impacts to these receptor types are described in this table from surface, entrained and dissolved oil. |
| Threatened Ecological Communities (TEC) | The Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula is the only TEC within the EMBA. Receptors within this TEC include coastal sand dunes and beaches which may result in impacts to fauna utilising the beaches. Impacts to shoreline habitats are described in this table from both entrained and dissolved oil. |
| Wetlands of International Importance | Wetlands identified within the EMBA include Ashmore Reef National Nature Reserve, Cobourg Peninsula, The Dales, Roebuck Bay, Kakadu National Park and Eighty Mile Beach. Some of these wetlands represent wetland types near natural condition within the region and may be contacted by surface or entrained oil. Impacts to wetlands, tidal marshes and associated receptors are described within this table. |
| KEFs | 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.<br><br>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; or benthic habitats at Ashmore Reef and Cartier Island and surrounding Commonwealth waters. Impacts to marine fauna are discussed above.<br><br>There are a number of KEFs that are overlapped by the EMBA: including Continental Slope Demersal Fish Communities, Ashmore Reef and Cartier Island and Surrounding Commonwealth Waters, Seringapatam Reef and Commonwealth Waters in the Scott Reef Complex, Canyons Linking the Argo Abyssal Plain with the Scott Plateau, Mermaid Reef and Commonwealth Waters Surrounding Rowley Shoals, Pinnacles of the Bonaparte Basin, Ancient Coastline at 125 m Depth Contour Carbonate Bank and Terrace System of the Sahul Shelf, Shelf Break and Slope of the Arafura Shelf, Carbonate Bank and Terrace System of the Van Diemen Rise, Exmouth Plateau, Tributary Canyons of the Arafura Depression, Glomar Shoals, Gulf of Carpenteria Basin.<br><br>Potential impacts from entrained and dissolved oil may occur at these KEFs. Impacts to features (such as canyons or pinnacles) in deep waters are not expected to be affected by entrained or dissolved oil due to the nature of these features. However, values associated with shallower KEFs such as reefs and islands and the surrounding waters will be affected by changes in water quality and impacts to receptors within the water as described in this table. |
| *Timeframe to recovery* | 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). The timeframe for recovery of receptors within these areas are described within this table. |
| Consequence | The consequence of a loss of well control event on protected areas was assessed as *Critical* given recovery to some habitats within these protected areas may take decades to recover. |

| Critical worst case of all above receptors | Likelihood | Ranking |
|---|---|---|
| | Unlikely | Medium |

### 5.8.5 Priority Receptors

For spill response planning purposes, priority receptors were identified from the sensitive receptors. 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.

Seven priority receptors for spill response have been determined from the worst-case modelling results - Ashmore Reef / Cartier Island, International Waters, Darwin Coast, Bonaparte Gulf NT, Western NT, Tiwi Islands and Kimberley Coast.

### 5.8.6 NEBA

Net environmental benefit assessment (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 environmental impacts of an oil spill.

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.

The NEBA for the Priority receptors and the potential impact that response strategy has on the environmental values of the area has been undertaken whilst noting that response strategies are not used in isolation. This information is to be considered 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, real time monitoring of the effectiveness and potential impacts of a response and will also consider accessibility, feasibility and safety of responders.

### 5.8.7 Summary of environmental performance

| | |
|---|---|
| **Environmental Risk** | Unplanned release of crude oil |
| **Performance Outcome** | No spill of hydrocarbon to the marine environment. |
| **Management controls** | Performance Standards |
| ***Unplanned release during offtake*** | |

| | |
|---|---|
| *Montara* Marine Facility Manual | All hoses are fitted with dry-break couplings and are buoyant or fitted with floats |
| | Visual inspection of dry break couplings / hoses prior to crude transfer |
| | Permit-to-work documentation is complete and signed off |
| | Static tow in place |
| | Monitoring of hawser |
| Competency and Training Management System | Vessel crew qualified in accordance with competency system |
| ***Unplanned release due to equipment failure*** | |
| Tests and maintenance completed in accordance with Performance Standards Report (MV-70-REP-F-00002) to ensure emergency shutdown can occur | The SIS are tested according to the assurance plan which is planned and managed using CMMS |
| | Emergency Shutdown push buttons located in the central control room and throughout the FPSO/WHP tested and fit for purpose |
| | ESDVs are regularly tested and fit for purpose |
| | Hydrocarbon containing equipment is inspected and maintained |
| | PSVs undergo external inspection annually and internally inspected |
| Permit to Work Procedure implemented | A Permit to Work system is implemented to assure competent personnel and implementation of relevant maintenance procedures |
| Wellhead valves maintained and tested as per Jadestone Energy's Performance Standards Report | Wellhead Valves are maintained/ tested and found fit for purpose |
| Subsea equipment inspected in accordance with Subsea Inspection Procedure | Subsea equipment shall be inspected in accordance with the schedule, applicable standards, regulatory requirements and procedures described referenced in Performance Standards Reports |
| *Montara* Marine Facility Manual details designated anchoring locations | AMSA designated anchoring locations is listed as a 3nM radius around facility and marked on Aus Charts 741, 415, 327 |
| *Montara* Lifting Operations Procedure prevents dropped loads | Lifting with associated risk to topside and subsea infrastructure undertaken as per *Montara* Lifting Operations Procedure |
| *Catastrophic failure* | |
| Wells maintained as per *Montara* Well Operations Management Plan | Well integrity and maintenance undertaken according to in force Well Operations Management Plan |
| Asset integrity maintenance and inspections undertaken as per Performance Standards Report | Asset integrity and maintenance inspections of facilities and critical equipment undertaken as planned |
| ***Oil spill response*** | |
| Implement *Montara* Oil Pollution Emergency Plan | In the event of a tier 2 or tier 3 oil spill implement the *Montara* OPEP to reduce environmental impacts due to spill |
| Incident Management Team Response Plan | Implement the Incident Management Team Response Plan in the event of a spill of hydrocarbons to the marine environment |

### 5.8.8 ALARP assessment

The table below lists those resources and options that were considered (over and above those listed in the OPEP) and have been rejected as the cost (in terms of safety, social or economic) was grossly disproportionate to the benefit gained and the option was not considered to reduce the risk or impact to ALARP.

| Strategy tasks and resources arrangement improvements rejected | Environmental/Social/Economic consequences of additional resources from those described in the OPEP | Practicality of additional resources | ALARP assessment |
|---|---|---|---|
| Source Control – increase oil spill response capability of FPSO and support vessel beyond a Level 1 response | Reduce volume or speed of spill entering marine environment | Significant cost to alter the contractual arrangements with the *Montara Venture* and support vessel to increase capability (equipment, storage, maintenance, crew training and safety). | The National Plan considers the FPSO and vessels to have a level 1 capability. For Jadestone Energy to increase the FPSO or vessel response capability beyond Level 1 would be a disproportionate cost for the cost.<br><br>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.<br><br>Therefore, there is no value in supplementing the vessel SOPEP capability. Arrangements described in the OPEP are considered ALARP. |
| Source control - standby MODU available in-field during drilling operations instead of having to source and deploy at the time of loss of containment | Potentially reducing the time to drill the relief well, resulting in less hydrocarbon to the environment. | The total cost is about $700,000 per day (approx. $63 million during the EPs life over five years). If adopted this cost is paid regardless if there is a loss of containment event or not. | A MODU on standby close to the well location for the duration of the EP in readiness to drill a relief well may remove 10 days from the base case required to source and mobilise the MODU. However, *Montara* is an operating facility and the MODU would be required to be on standby 24/7 over the five-year life of the EP – this is not feasible for an operating facility.<br><br>The costs, safety concerns and complexity of having a MODU and maintaining this arrangement for the duration of the EP is grossly disproportionate to the environmental benefit gained. |
| Source control - Position Subsea First Response Toolkit (SFRT) to Darwin, closer to the potential spill location | Potentially reducing the time to start the application of subsea dispersants, resulting in a reduction of floating oil and shoreline loading | AMOSC does not agree to the relocation of the SFRT due to the risk to other SFRT members | Relocating the SFRT is not a reasonably practicable strategy as the SFRT is a shared resource. Mobilisation of the SFRT will occur at the same time as mobilisation of a suitable construction class vessel to Darwin. The SFRT cannot be transported to the well location until the vessel is available in Darwin, which is expected to take 7 days.<br><br>This option has not been adopted as it is not reasonably practicable and the costs and risks to other SFRT members are considered grossly disproportionate to the environmental benefit that might be gained. |

| | | | |
|---|---|---|---|
| Aerial surveillance – additional dedicated aircraft and observers | No environmental benefit for additional dedicated resources paid for upfront | Additional charter costs would be incurred by Jadestone Energy to increase aerial surveillance.<br><br>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, chemical dispersant applications and C&R. Increasing aerial surveillance would increase the safety risk.<br><br>The two-dedicated aerial surveillance is sufficient to validate and inform the IAP process to ensure overall response is commensurate with nature and scale of incident.<br><br>Therefore, there is no value in increasing dedicated overpasses and therefore the arrangements described in the OPEP are considered ALARP. |
| Vessel surveillance – additional dedicated vessels and observers | No environmental benefit for additional dedicated resources | 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. Increasing vessel surveillance would increase the safety risk.<br><br>Aerial surveillance, tracker buoys and UAVs are more efficient and effective at determining extent of oil movement, vessel surveillance is a secondary tactic.<br><br>Therefore, there is no value in increasing dedicated vessel numbers and arrangements described in the OPEP are considered ALARP. |
| Tracking buoys – additional tracking buoys | No environmental benefit for additional dedicated resources | Additional buoys are available through AMSA and AMOSC within days with no additional upfront cost | The number of tracking buoys immediately available is sufficient to cover tracking of oil given the other response activities that will be undertaken.<br><br>Therefore, there is no value in increasing tracker buoy numbers and therefore the arrangements in the OPEP are considered ALARP. |
| Ongoing real time collection of data prior to any spill event. | Greater awareness of the environment | An ongoing surveillance program would be at considerable cost depending on the scope (order of hundreds of thousands each year). | Ongoing collection of real time environmental data would provide immediate inputs into decision making however this would require the use of aerial resources, satellite resources, ground surveys and marine surveys.<br><br>The existing contracts in place for aerial surveillance, satellite imagery, trajectory modelling, and shoreline surveys can be activated in a timeframe that provides short, medium, and long-term access to data. |

| | | | |
|---|---|---|---|
| SCAT – additional resources to increase number of SCAT | SCAT continues during the response to verify shoreline oiling, clean-up effectiveness, and eventually, to conduct final evaluations of shorelines to ensure they meet clean-up 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 above numbers described in the OPEP could cause unnecessary environmental impacts. If required, additional equipment will be sourced, and the additional cost borne by Jadestone Energy. | Jadestone Energy undertook an evaluation to determine the most effective resource capability to reduce the environmental risk from a worst-case spill event (refer OPEP).<br><br>Not all the shoreline in the EMBA will be contacted. The potentially oiled shoreline is remote and most comprises mangroves, tidal wetlands and no access via land. Aerial and marine deployment of teams and surveys can be done efficiently for accessible areas. The limiting factor is being able to access those areas.<br><br>The existing arrangements are considered sufficient to meet SCAT purposes. Additional personnel can be sourced and deployed should the need arise; this is not considered time critical and the additional benefit is considered low.<br><br>Therefore, there is no value in increasing SCAT numbers and therefore the arrangements described in the OPEP are considered ALARP. |
| Chemical dispersant application – additional resources to that in the OPEP | 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.<br><br>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. This could have negative flow-on social and economic consequences e.g. recreational and commercial fishing, diving. | Additional resources include the cost of dispersant, FWADC aircraft, vessels plus fuel costs and additional expert personnel per day.<br><br>Chemical dispersant operations are to be conducted in daylight hours only.<br><br>Indicative costs include the cost of suitable aircraft, standby specialists, purchasing dispersant and maintenance in Darwin and purchasing dispersant vessel and application equipment. | Jadestone Energy 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 weathering of oil, 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. If there is a weather condition that prevents the application of dispersant (which is unusual for the environment around the *Montara* facility), this in itself, creates dispersion.<br><br>The results of the best-case capability evaluation for dispersant application as described in the Chemical Dispersant Plan shows that Jadestone Energy has access to more than enough dispersant through national and international stockpiles to exceed the required need. The modelling undertaken indicates negligible environmental benefit in terms of reduction of floating oil between Day 1 and Day 5 if chemical dispersant was applied up to 3 days earlier. Therefore, Jadestone Energy consider that the Chemical Dispersant Strategy described in the OPEP is ALARP.<br><br>.<br><br>**Application of Chemical Dispersant from the FPSO**. In the event of the worst-case spill, the priority is to ensure safety of people, manage the integrity of the vessels and enact source control. Once these aspects are managed, then spill response at site can be implemented. A |

| | | | |
|---|---|---|---|
| | | | collision capable of causing a spill to the marine environment would result in the FPSO being evacuated except for personnel essential to undertake damage repairs and tasks described in the SOPEP which, from a safety and operational perspective, would be significantly hindered if dispersant spraying was being undertaken from the FPSO.<br><br>The FPSO does not have the capacity to appropriately store/maintain sufficient dispersant stocks and application equipment, the skilled personnel to undertake spraying, nor resources to solely allocate to dispersant spraying in the event of a collision.<br><br>**Dedicated dispersant vessels stationed in the field**. In the event of the worst-case spill, the priority is to ensure safety of people, manage the integrity of the vessels and enact source control. Once these aspects are managed, then spill response at site can be implemented. To have vessels spraying dispersant near the incident within 12 hours would hinder the emergency actions and present a safety risk for personnel. The FPSO and WHP have a 500m exclusion zone within which vessels are not allowed to egress without approval and cannot be permanently moored within for legal and safety reasons. To have a vessel dedicated to dispersant application moored permanently near the *Montara* Operations 24/7/365 creates an unnecessary safety risk to vessel crew and is grossly disproportionate to the environmental risk.<br><br>**Aircraft or vessels on 24/7 standby.** Aircraft and vessels used for spill response and dispersant application are normally employed in activities such as crop dusting, firefighting and marine services, and adapted for dispersant application when required. It is not practicable to have dedicated crews, aircraft or vessels in 24/7 state of readiness in Darwin because the frequency of use would result in cost being grossly disproportionate to the environmental risk. In essence, Jadestone Energy would be replicating the FWADC which has been established for industry as a cost effective and fit for purpose preparedness measure.<br><br>**Ownership / Storage of Dispersant by Jadestone Energy in Darwin,** waiting for use by FWADC or vessels. The limiting factor for dispersant application is the availability of aircraft and associated resources for application, not the availability of dispersant. There is no added environmental benefit to this option and is not commensurate with the environmental risk. Therefore, Jadestone Energy consider that the Chemical Dispersant Strategy described in the OPEP is ALARP.<br><br>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), a party to an MOU with AMSA and OSRL for oil spill |

| | | | |
|---|---|---|---|
| | | | response, Jadestone Energy has access to sufficient response capability to reduce the environmental risk associated with the worst credible spill to ALARP.<br><br>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 (C&R) - additional resources to that in the 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. | Costs assessed per day included vessels plus fuel, boom hire for 6 teams, 6 skimmers and additional personnel. | Containment and recovery operations will be focussed at source outside the dispersant operations, and near shorelines on the trajectory of the spill. If this is tracking towards Ashmore/Cartier, big volumes (or contact at all) is not predicted for mainland Australia.<br><br>Operations will focus on the priority receptors (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.<br><br>Jadestone Energy undertook an evaluation to determine the most effective resource capability to reduce the environmental risk from a worst-case spill event.<br><br>In addition, C&R activities will be undertaken in areas outside those that have allowed for natural evaporation of the oil and been subject to chemical dispersant operations. C&R is targeted to discrete patches of oil.<br><br>For Jadestone Energy to purchase and maintain suitable vessels and equipment to be on standby 24/7/365 is cost prohibitive and disproportionate to the risk. Access to supplies via AMOSC, DoT, AMSA, OSRL, contracted marine providers and marine brokers will address half the volume in Week 1, meet the need in Week 2 and exceed the need from Week 3. Jadestone Energy monitors the availability of larger vessels through existing marine brokers to meet specifications for containment and recovery operations.<br><br>It is not feasible to pre-deploy containment and recovery equipment as modelling identifies many potential shoreline contact locations, largely remote, subjected to very high tides, mangroves and uninhabited. For example, only 33% of the shoreline between Darwin and Broome is beach (OPEP Section 13). Even when the priority receptors are focussed on, the intrusion caused by equipment deployment and maintenance (considering the continuing operational aspect of *Montara* (24/7/365)) would result in unnecessary additional impact to |

| | | | |
|---|---|---|---|
| | | | these locations and potential safety risks for personnel. In addition, the cost of doing this is disproportionate to the benefit.<br><br>The current level of resources meets for the need as it allows for flexibility in response operations as not all locations will be contacted in a single spill event, exceeds the need from Week 3 onwards and is therefore above to recover excess oil from Weeks 1 and 2, and, is the maximum realistic resource deployment.<br><br>Containment and recovery arrangements described in the OPEP are considered ALARP. |
| Protection and Deflection - additional resources to that in the OPEP | Additional Protection and Deflection resources reduces shoreline contact and accumulation of oil, and subsequent impacts to shorelines.<br><br>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.<br><br>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 Energy. | Protection and deflection have limited application for most locations due to very high tidal influences, nature of shorelines, remoteness and lack of anchoring points for booms. Oil doesn't contact all shorelines instantaneously but reaches various locations over a period, dependant on oceanic currents and wind directions. As such, implementing a greater initial response is not appropriate, however resources are ramped up as required.<br><br>Jadestone Energy undertook an evaluation to determine the most effective resource capability to reduce the environmental risk from a worst-case spill event. Jadestone Energy determined the resources required based upon the priority receptors estimated worst-case shoreline volumes and timeframes to contact. Jadestone Energy has access to resources via AMOSC, AMSA, OSRL and DoT, and has the ability to move across locations if this strategy is determined to be feasible and safe to implement in consultation with DoT.<br><br>Mobilising additional resources too early, may result in excess resources being on-location that are not required. Consequently, this has the potential to cause additional environmental impacts if larger than required storage areas and increased personnel presence result in further sensitising coastal habitats without providing significant benefit.<br><br>For Jadestone Energy to purchase equipment, store and maintain is cost prohibitive when access via existing stockpiles will meet the need, and the limiting factor is people.<br><br>Vessels and people will be used as determined through the IAP and NEBA.<br><br>Development of tactical response plans was considered, and Jadestone Energy has access to the INPEX Browse Island Oil Spill Incident Management Guide, which guides response for remote shorelines and islands.Jadestone Energy has enough time to develop required plans without having a pre-prepared one. |

| | | | |
|---|---|---|---|
| | | | Given the remoteness of the locations with shoreline contact modelled and continuing operational aspect of *Montara* (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. The cost of doing this is disproportionate to the benefit.<br><br>The current level of resources meets the need as it allows flexibility in response operations; as not all locations will be contacted in a single event.<br><br>Therefore, the arrangements described in the OPEP are considered ALARP. |
| Shoreline Clean-up - additional resources to that in 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.<br><br>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.<br><br>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. | 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.<br><br>If required, additional personnel and machinery will be sourced and the additional cost borne by Jadestone Energy. | Jadestone Energy undertook an evaluation to determine the most effective resource capability to reduce the environmental risk from a worst-case spill event. Section 13 of the OPEP describes how the Jadestone Energy's plan is to focus resources on the priority receptors based upon the worst-case maximum average daily oil ashore, the nature of the shoreline and the recoverable ability of the clean-up teams.<br><br>The remoteness and character of potentially affected shorelines raises significant logistical challenges associated with mounting a shoreline response and the potential health and safety risks to personnel.<br><br>It is the opportunity for use rather than the availability of machinery and personnel which is considered the limiting factor.<br><br>For Jadestone Energy to purchase equipment, store and maintain it is cost prohibitive when access via AMOSC Mutual Aid/DoT/OSRL and mainstream suppliers will meet the need, and the limiting factor is people (who have to be accessed from outside Darwin), health and safety issues for shoreline work and suitable vessels.<br><br>Given the remoteness of the locations with shoreline contact modelled and continuing operational aspect of *Montara* (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. Allocating shoreline clean-up resources relies on understanding the trajectory of the oil and timeframe for expected contact. The cost of doing this is grossly disproportionate to the benefit.<br><br>Jadestone Energy considered increasing the number of resources to support shoreline response, however, the stated number is based upon the nature of the shorelines and the |

| | | | |
|---|---|---|---|
| | 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. | | option of natural attenuation if conducting operations would be too environmentally damaging. Real time modelling and assessment will determine if extra resources are required. If this is the case, then the resources required can be obtained within the shortest time to contact shorelines.<br><br>The current level of resources meets for the need as it allows flexibility in response operations and surge capacity; as not all locations will be contacted in a single spill event.<br><br>The arrangements described in the OPEP are considered ALARP. |
| OWR – additional resources to that described in the OPEP | The OWR level is a Level 5 (refer WAOWRP and NTOWRP) as dugongs may be oiled.<br><br>OWR aims to prevent/reduce the impact to marine fauna (in particular birds and turtles) and any long-term effects. | Significant additional cost would be incurred if Jadestone Energy were to purchase or hire a facility to base at a staging site or have OWR expert personnel on standby.<br><br>Significant additional cost would be incurred if Jadestone Energy provided its own oiled wildlife response (personnel, experts, facilities, plans etc). | Jadestone Energy undertook an evaluation to determine the most effective resource capability to reduce the environmental risk from a worst-case spill event (refer OPEP).<br><br>Additional strategies that have been considered include:<br><br>• 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);<br>• Jadestone Energy to have OWR expert personnel on standby to improve response;<br>• Jadestone Energy to commission additional training of Australian based OWR personnel to increase numbers of competent OWR personnel; and<br>• OWR resources purchased and based at Darwin and Broome to increase OWR facilities and process timeframes.<br><br>Given the local (AMOSC and DBAC) 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 WA and NT.<br><br>The NTOWRP, WAOWRP and the Kimberley regional plan were developed by the Territory and State environmental agency in conjunction with industry, AMSA, AMOSC, Perth Zoo and academia. Therefore, they represent the best-oiled wildlife response plans that NT, WA and Jadestone Energy can utilise. The cost for Jadestone Energy to:<br><br>• purchase/hire OWR equipment and pre-set up facilities at Darwin and/or Broome;<br>• have OWR expert personnel on standby 24/7/365;<br>• commission additional OWR training in WA. |

| | | | |
|---|---|---|---|
| | | | The *Montara* Operations are 24/7/365 and significant costs would be incurred to undertake these options. The equipment can easily be purchased/hired.<br><br>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.<br><br>The arrangements described in the OPEP are considered ALARP. |
| Waste Management - additional resources to that described in the OPEP | While oil is arriving on shorelines, there is limited benefit from additional resources that might remove waste quicker as the waste is still being collected.<br><br>After the oil has finished arriving, there may be an additional benefit in having increased resources at particular locations of higher sensitivity (e.g. a turtle nesting beach during the nesting/hatching season may benefit in having additional resources deployed to clean the beach before nesting/hatching events). | The cost of additional resources is not considered the limiting factor; the limiting factor is considered to be the ability to utilise resources at the physical location.<br><br>If required, additional resources will be sourced, and the additional cost borne by Jadestone Energy. | Jadestone Energy undertook an evaluation to determine the most effective resource capability to reduce the environmental risk from a worst-case spill event (refer OPEP).<br><br>The limiting factor for waste collection (which is a support service for Jadestone Energy) is the collection of oily waste. As the arrangements in the OPEP are ALARP, the waste contractor is able to resource a plan that meets the nature and scale of the event within realistic timeframes.<br><br>The arrangements described in the OPEP are considered ALARP. |

### 5.8.9 Acceptability assessment

| | |
|---|---|
| **Policy & management system compliance** | Jadestone Energy's HSE Policy objectives are met. Section 7 demonstrates that Jadestone Energy's HSE Management System is capable of continuously reviewing and updating activities and practices during the operation, including spill response arrangements. |
| **Stakeholder & reputation** | Stakeholder consultation has been undertaken (see Section 6), including engagement with the Director of Parks, State and National response agencies of DoT and AMSA, Northern Territory government, commercial and recreational fishing industry bodies and fishers. No concerns have been raised with regards to impacts of a crude 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 persons during response operations. |
| **Environmental context & ESD** | The worst-case credible crude spill scenario for the *Montara* Operations (scenario 9) is a result of a loss of well control with up to 164,718 $m^3$ released from within the Operational Area.<br><br>The potential impact is considered acceptable after consideration of:<br><br>• Potential impact pathways;<br>• Preservation of critical habitats;<br>• Assessment of key threats as described in species and Area Management /Recovery plans;<br>• Consideration of North-West Bioregional Plan; and<br>• Principles of ecologically sustainable development. |
| **Conservation and management advice** | Jadestone Energy will have regard to the representative values of the reserves and other conservation advice published and endeavour to ensure that priority is given to the social and ecological objectives and values, of any AMPs, or state marine parks impacted by unplanned crude release to ensure that the objectives of the management plans are not contravened.<br><br>Noting 'Emergency response' is permitted in all AMPs and state marine parks.<br><br>Actions required to respond to oil pollution incidents, including environmental monitoring and remediation, in connection with activities authorised under the OPGGS Act may be conducted in all zones. The Director will be notified in the event of an oil pollution incident that occurs within, or may impact upon, an Australian Marine Park and, so far as reasonably practicable, prior to a response action being taken within a marine park.<br><br>Protected areas within the EMBA predicted to potentially be impacted by crude above threshold levels have been identified as Priority receptors.<br><br>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. |
| **Recovery Plan for Marine Turtles in Australia, 2017-2027** | The Recovery plan for marine turtles in Australia (DoEE 2017) identifies Marine pollution as a risk. The Plan requires that the risk of oil spill impact to marine turtles is evaluated and, if required, appropriate mitigation measures are implemented. This section and the proposed controls are consistent with this advice. |
| **Approved Conservation Advice** | The Conservation advice for the *Calidris ferruginea* (Curlew Sandpiper), *Calidris canutus* (Red Knot), *Limosa lapponica bauera* (Bar-tailed Godwit, *Limosa lapponica menzbieri* (Northern Siberian Bar-tailed Godwit)and *Numenius madagascariensis* (Eastern Curlew) identifies Marine pollution as a risk: The advice requires the risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented. Cartier Island has been identified as important bird nesting location. This section and the proposed controls are consistent with this advice. |
| **Approved conservation advice for green sawfish (Threatened Species** | The Conservation advice for Green sawfish identifies Marine pollution as a risk: The advice requires measures to reduce adverse impacts due to pollution to be considered; and to reduce likely impact on green sawfish. |

| | |
|---|---|
| **Scientific Committee 2008b)** | |
| **Approved Conservation Advice for *Pristis pristis* (largetooth sawfish)** | The Conservation advice for largetooth sawfish identifies Habitat degradation and Marine debris as risks: The advice requires measures to reduce adverse impacts of habitat degradation and/or modification to be considered; and to reduce marine debris likely to impact on largetooth sawfish. |
| **Approved Conservation Advice for *Glyphis garricki* (northern river shark)** | In a LOWC scenario, habitat important for the large tooth sawfish would be identified and given high priority for protection. Any spill response activities that generate marine debris are also managed to reduce further potential environmental impacts. This is consistent with the conservation advice. |
| **Wildlife conservation plan for migratory shorebirds (Commonwealth of Australia 2015c)** | In a LOWC scenario, habitat important for the migratory birds would be identified and given high priority for protection. Any spill response activities are also managed to reduce further potential environmental impacts to migratory habitats. This is consistent with the conservation advice for Common Sandpiper *(Actitis hypoleucos) and* Sharp-tailed Sandpiper *(Calidris acuminata).* |
| **Australian Marine Parks** | Australian Marine Parks are established by proclamation under the *EPBC Act* for the purpose of protecting and maintaining biological diversity in the parks.<br><br>Environment plan (EP) must be consistent with the Australian Marine Park Management plans.<br><br>In all cases where an activity has potential to impact or present risk to AMPs, regardless of whether the activity is inside or outside a park, the EP should evaluate how these impacts and risks will be of an acceptable level and reduced to as low as reasonably practicable (ALARP).<br><br>There are fourteen AMPs within the EMBA, including:<br><br>• Cartier Island AMP<br>• Kimberley AMP<br>• Ashmore Reef AMP<br>• Oceanic Shoals AMP<br>• Joseph Bonaparte Gulf AMP<br>• Argo-Rowley Terrace AMP<br>• Roebuck AMP<br>• Mermaid Reef AMP<br>• Eighty Mile Beach AMP<br>• Arafura AMP<br>• Arnhem AMP<br>• Dampier AMP<br>• Montebello AMP<br>• Wessel AMP<br><br>Actions required to respond to oil pollution incidents, including environmental monitoring and remediation, in connection with mining operations authorised under the OPGGS Act may be conducted in all zones. The requirement is that The Director should be notified in the event of an oil pollution incident that occurs within, or may impact upon, an Australian Marine Park and, so far as reasonably practicable, prior to a response action being taken within a marine park.<br><br>Consultation to notify the Director of the proposed Activity was completed as part of the Consultation process (Section 6).<br><br>The Director notification in the event of a spill that would impact one of the AMPs is included in the OPEP and Implementation section of this EP (Section 7).<br><br>As such this EP is consistent with the Australian Marine Park Management plans. |

## 5.9 Worst case diesel spill

Release of diesel may occur from a support vessel due to vessel collision within the Operational Area or from a dropped object event. Two scenarios were considered – rupture of refuelling hose during bunkering (5 $m^3$) and a collision with the FPSO resulting in damage to a fuel oil tank resulting in release to sea. The maximum worst-case credible spill volume of diesel has been calculated as 906 $m^3$ based on the largest fuel oil tank on the FPSO.

Diesel characteristics were assessed, modelling undertaken to cover all likely environmental conditions, and based on maps for surface, entrained and dissolved hydrocarbons, impacts assessed to sensitive receptors.

### 5.9.1 Impact and risk

There is potential for localised mortality of plankton due to reduced water quality and toxicity with effects greatest in the upper 10 m of the water column and areas close to the spill source. 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.

There are several shoals within the worst-case diesel spill EMBA with diverse benthic habitats and associated fish and invertebrate assemblages which could be affected by entrained or dissolved oil. Sea grasses and macroalgae may experience a phytotoxic effect caused by absorption of DAHs from the water column. Direct contact to shallow hard corals by entrained diesel could lead to short or long-term sub-lethal effects, in the worst-case instance irreversible tissue necrosis and death.

Marine mammals potentially present include threatened and migratory whales and dolphins, and potentially dugongs. 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.

Whale sharks potentially transit the EMBA, but given the small area affected by the diesel spill and its distance from known aggregation areas, the rapid evaporation and dispersion expected, impacts to the whale shark would be expected to be minimal. Impacts to other shark and pelagic fish species would be anticipated to be negligible as most species will be well below the affected area of the water column.

The EMBA intercepts with breeding BIAs for several migratory seabird species and therefore foraging and breeding habitat in the area may be impacted by surface oils 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.

Three AMPS are present within the diesel EMBA: Oceanic Shoals AMP, Ashmore Reef AMP and Cartier Island AMP but no state marine parks, world, national or Commonwealth heritage places, threatened ecological communities, wetlands of international importance. Three KEFS overlap the EMBA which have fish and habitats that may be impacted by dissolved and entrained oils as described above.

### 5.9.2 Summary of environmental performance

| **Environmental Risk** | **Unplanned release of diesel** |
|---|---|
| **Performance Outcome** | No spill of hydrocarbon to the marine environment. |
| **Management Controls** | Performance Standards |
| | All hoses are fitted with dry-break couplings and are buoyant or fitted with floats |

| | |
|---|---|
| ***Montara* Marine Facility Manual** | Visual inspection of dry break couplings and hoses prior to diesel transfer |
| | Permit-to-work documentation is complete and signed off |
| | Bunding, sumps, drip trays and drains are inspected prior to bunkering or transfer |
| | Testing of emergency shutdown mechanism (transfer pumps) before bunkering/transfer |
| | No night-time bunkering or transfer, unless a risk assessment is undertaken, and additional mitigation measures are implemented |
| | Maintain radio contact with vessel during bunkering or transfer operations |
| **Shipboard Oil Pollution Emergency Plan (SOPEP)** | Compliance with MARPOL 73/78 Annex I (Prevention of pollution by oil) and Marine Order 91 (Marine pollution prevention – oil), including valid SOPEP for managing spills |
| | Vessels to have stocks of spill response kits/bins available and accessible onboard |
| | Drills undertaken as per SOPEP |
| **Implement *Montara* Oil Pollution Emergency Plan** | In the event of a tier 2 or tier 3 oil spill implement the *Montara* OPEP to reduce environmental impacts due to spill |
| **Competency and Training Management System** | Personnel trained and assessed competent in accordance with their role requirements |

### 5.9.3 ALARP assessment

| Rejected control | Justification |
|---|---|
| Eliminate diesel<br><br>Practicable – N/A<br><br>Cost effective - 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<br><br>Practicable – N/A<br><br>Cost effective - 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. |

### 5.9.4 Acceptability assessment

| | |
|---|---|
| **Policy & management system compliance** | Jadestone Energy's HSE Policy objectives are met. Section 7 demonstrates that Jadestone Energy's HSE Management System is capable of continuously reviewing and updating activities and practices during the operation, including spill response arrangements. |
| **Stakeholder & reputation** | 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.<br><br>During any spill response, a close working relationship with key regulatory bodies (e.g. DoT, DBaC, AMSA, DER) will occur and thus there will be ongoing consultation with relevant persons during response operations. |
| **Environmental context & ESD** | The worst-case credible diesel spill scenario for the *Montara* Operations is a result of a vessel collision within the Operational Area. The release of oil occurs over five hours and floating oil may contact Browse Island. Entrained oil is predicted to contact the KEF Carbonate Bank and Terrace System of the Sahul Shelf and a number of shoals. |

| | |
|---|---|
| | Sensitive receptors at risk include seabirds, shorebirds, marine fauna, intertidal and shoreline habitats.<br><br>The potential impact is considered acceptable after consideration of:<br><br>• Potential impact pathways;<br>• Preservation of critical habitats;<br>• Assessment of key threats described in species and Area Management /Recovery plans;<br>• Consideration of North-West Bioregional Plan; and<br>• Principles of ecologically sustainable development. |
| **Conservation and management advice** | Jadestone Energy will have regard to the representative values of protected areas and other published information or conservation advice and endeavour to ensure that priority is given to the social and ecological values, of any AMPs, or State Marine Parks impacted by diesel.<br><br>Noting 'Emergency response' is permitted in all AMPs and state marine parks.<br><br>Actions required to respond to oil pollution incidents, including environmental monitoring and remediation, in connection with activities authorised under the OPGGS Act may be conducted in all zones. The Director will be notified in the event of an oil pollution incident that occurs within, or may impact upon, an Australian Marine Park and, so far as reasonably practicable, prior to a response action being taken within a marine park.<br><br>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. |

# 6 CONSULTATION WITH RELEVANT PERSONS

## 6.1 Stakeholder engagement process

Jadestone Energy has developed a Stakeholder Engagement Process to assist in addressing this requirement across its approvals (**Figure 7-1).**

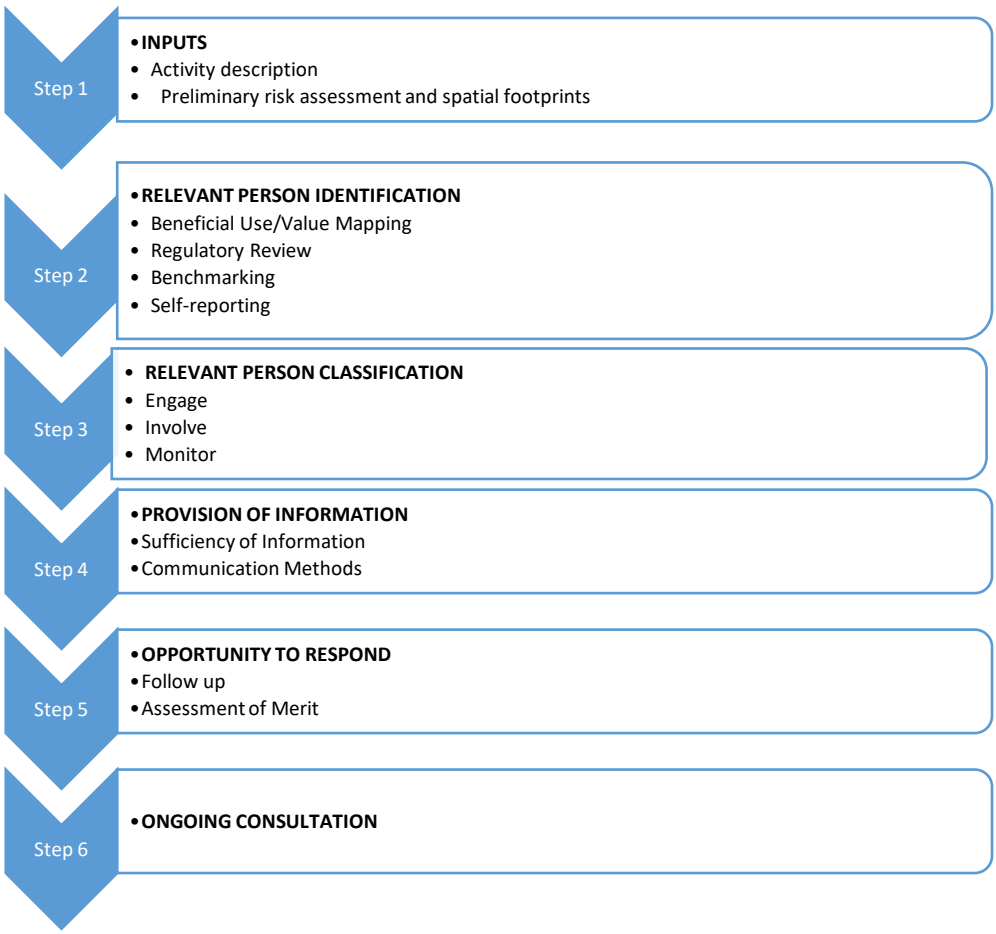



**Figure 6-1 JSE Stakeholder Engagement Process**

For each consultation process, Jadestone Energy utilises standardised identification methods (in accordance with the JSE Stakeholder Engagement Process) to compile a list of relevant persons across these categories. The results of applying this process to determine the relevant persons is summarised in **Table 6-1**. Relevant persons were then classified according to criteria outlined in the Stakeholder Engagement Process to assist with determining sufficiency of information and level of engagement.

**Table 6-1 Relevant persons**

| Beneficial use/Interest | Relevant activities | Group 1 & 2<br>Department or Agency (State and Commonwealth) | Group 3 & 4<br>People or Organisations whose Functions, Activities or Interests affected | Group 5<br>Any other relevant person JSE consider relevant |
|---|---|---|---|---|
| Shipping | Physical presence | Australian Hydrographic Service, AMSA<br><br>Department of Transport | Shipping operators (through AMSA) | |
| | Release of hydrocarbons | As above | Darwin Port Authority, Kimberley Port Authority (Port of Broome), Pilbara Port Authority | |
| Commercial Fishing: Commonwealth (including biosecurity) | Physical presence<br><br>Introduction of Marine Pests<br><br>Produced water discharge | AFMA<br><br>Department of Agriculture and Water Resources | Commonwealth Fisheries Association (CFA)<br><br>Fishing licence holders in Operations Area -<br><br>Western Tuna and Billfish Fishery | IMS consultant |
| | Release of hydrocarbons | As above | As above<br><br>Australian Southern Bluefin Tuna Industry Association<br><br>Northern Prawn Fishery Industry P/L<br><br>Australian Council of Prawn Fisheries<br><br>Fishing licence holders in EMBA<br><br>Southern Bluefin (due to migration) | |
| Commercial Fishing: State (including biosecurity) | Physical presence<br><br>Introduction of Marine Pests<br><br>Produced water discharge | Department of Primary Industries and Regional Development (WA)<br><br>DPIF (NT) | NT Seafood Council<br><br>WAFIC<br><br>Western Tuna and Billfish Fisheries<br><br>Australian Fisheries Trade Association | |

| Beneficial use/Interest | Relevant activities | Group 1 & 2<br>Department or Agency (State and Commonwealth) | Group 3 & 4<br>People or Organisations whose Functions, Activities or Interests affected | Group 5<br>Any other relevant person JSE consider relevant |
|---|---|---|---|---|
| | | | Fishing licence holders in operations area<br>• Joint Authority Northern Shark Fishery (WA)<br>• Mackerel Managed Fishery (Area 1) (WA)<br>Northern Demersal Scalefish Managed Fishery (Area 2) (WA) | |
| | Release of hydrocarbons | As above | As above<br>Pearl Producers Association<br>Fishing licence holders in EMBA | |
| Recreational Fishing | Release of hydrocarbons | Department of Primary Industries and Regional Development (WA)<br>DPIF (NT) | Amateur Fisherman's Association of the NT<br>Recfish West<br>NT Guided Fishing Association<br>Individual recreational fishers | |
| Subsistence fishing/ Indigenous Fishing | Physical presence | Department of Foreign Affairs and Trade | | |
| | Release of hydrocarbons | As above | Individual Indonesian/Timor/PNG traditional fishers, Individual Australian Indigenous fishers | |
| Defence | Release of hydrocarbons | Department of Defence<br>Australian Border Force (formerly Australian Customs and Border Protection Service) | N/A | |
| Oil and Gas | Release of hydrocarbons | NOPSEMA<br>Department of Industry, Innovation and Science | Australian Petroleum Production and Exploration Association (APPEA) | Hon Josh Frydenberg - Minister for Environment & Energy |

| Beneficial use/Interest | Relevant activities | Group 1 & 2<br>Department or Agency (State and Commonwealth) | Group 3 & 4<br>People or Organisations whose Functions, Activities or Interests affected | Group 5<br>Any other relevant person JSE consider relevant |
|---|---|---|---|---|
| | | Department of Mines, Industry Regulation and Safety (WA)<br><br>Department of Primary Industry and Resources – Mines, Energy and Fisheries (NT) | PTTEP, Finder Pty LTd, Melbana Energy Ltd (Vulcan Exploration), Eni Australia Limited, Total E&P Australia Production Pty Ltd, Murphy Australia Oil Pty Ltd, Sinopec O&G Australia (Puffin) Pty Ltd, Bounty Oil and Gas NL | Senator the Hon Matt Canavan - Minister for Resources and Northern Australia<br><br>Hon Greg Hunt - Minister for Industry, Innovation & Science |
| Tourism | Release of hydrocarbons | Department of Jobs, Tourism, Science and Innovation<br><br>Department of Jobs, Tourism, Science and Innovation (WA)<br><br>Department of Tourism and Culture (Parks and Wildlife Commission of the NT) | Tourism NT<br><br>Tourism Top End<br><br>Australian Northwest Tourism<br><br>Tourism Western Australia<br><br>Kimberley Birdwatching, Kimberley Expeditions | Shire of Wyndham East Kimberley<br><br>Shire of West Derby/West Kimberley |
| Cultural/ Indigenous Heritage | Release of hydrocarbons | National Native Title Tribunal | Tiwi Land Council<br><br>Northern Land Council (NT)<br><br>North Australian Indigenous Land and Sea Management Alliance<br><br>Kimberley Land Council<br><br>Individuals in coastal communities | |
| Environment/ Environmental Management | Release of hydrocarbons | Director of Parks<br>Parks Australia - Australia Marine Parks<br><br>Department of Environment and Energy<br><br>Department of Biodiversity, Conservation and Attractions (WA) | WA Conservation Council<br><br>World Wildlife Fund<br><br>The Wilderness Society<br><br>Environs Kimberley<br><br>International Fund for Animal Welfare | |

| **Beneficial use/Interest** | **Relevant activities** | **Group 1 & 2**<br>**Department or Agency (State and Commonwealth)** | **Group 3 & 4**<br>**People or Organisations whose Functions, Activities or Interests affected** | **Group 5**<br>**Any other relevant person JSE consider relevant** |
|---|---|---|---|---|
| | | Department of Water and Environmental Regulation (WA)<br><br>Department of Environment and Natural Resources (NT)<br><br>Department of the Chief Minister (NT)<br><br>Northern Territory EPA | Save the Kimberley<br><br>Australian Marine Conservation Society<br><br>World Dolphin Conservation Society<br><br>Australian Conservation Foundation<br><br>Greenpeace<br><br>General Public | |
| Research | Release of hydrocarbons | CSIRO<br><br>Western Australian Museum<br><br>Geoscience Australia | Australian Institute of Marine Science | |
| Emergency Response | Release of hydrocarbons | Department of Foreign Affairs and Trade<br><br>Department of Transport (WA)<br><br>Department of Infrastructure, Planning and Logistics (NT) | | Jacobs<br><br>Aerotech<br><br>OSRL |

## 6.2 Jadestone Energy consultation to date

Jadestone Energy has recently purchased the existing *Montara* Operations Activity from PTTEP AA. PTTEP AA had already been in contact with many stakeholders regarding their intended review of the Operations Environment Plan. This included engaging WAFIC to consult with the relevant Western Australian managed commercial fisheries and fishing associations. PTTEP AA passed on issues and information gathered from this consultation. Jadestone Energy has considered any referred information about the intended operation of the *Montara* facilities, and where appropriate addressed it in this EP (**Table 6-2**). Noting any comments in relation to PTTEP AA's response to the previous spill at the site or compensation from this spill were not considered relevant and have not been included. This summary of response was provided back to stakeholders who had previously commented through the PTEPP consultation to show how Jadestone Energy were addressing these issues.

**Table 6-2 Jadestone Energy's consideration of PTTEP consultation issues**

| Issue raised with PTTEP | PTTEP Response | How Jadestone Energy has considered the issue |
|---|---|---|
| (No) recreational fishing from support/commercial vessels. | PTTEP AA employees and contractors are required to complete an 'Environmental Awareness' induction prepared by PTTEP AA prior to mobilisation. The induction provides and EP overview including stakeholder concerns. Contractors and sub-contractors will be made aware of commercial fishing sensitivities regarding fishing from support/commercial vessels. | Sensitivities regarding recreational fishing from support vessels will be included in compulsory inductions for Jadestone Energy employees and contractors. |
| Potential conflict with PTTEP AA staff, contractors and sub-contractors regarding the difference between exclusion zones and cautionary zones. | There are no cautionary zones in the 5-year Operations EP scope. A Notice to Mariners will be issued and the safety exclusion zones will be noted on the Admiralty Chart covering the region. | Fishing license holders have been provided a Jadestone Energy information pack that includes clarification on the PSZ that precludes entry by other users unless OIM approves, and a cautionary area (2.5 NM around FPSO) that allows other users in this area. The function of the cautionary area is simply to notify other users of a risk to use, in this instance FPSO, WHP and possible presence of a tanker. |
| Concern regarding communication between PTTEP AA, their staff, contractors and sub-contractors regarding interacting and protecting the rights of active commercial fishers on the water (concern that support vessels may not divert around active fishing activity). | The 'Environmental Awareness' induction will be used to communicate the rights of commercial fishers to access ocean resources to all employees and contractors. If a vessel is engaged in fishing (with nets, lines, trawls or other fishing apparatus which restrict manoeuvrability), the fishing vessel is restricted in its ability to manoeuvre. Therefore, it is the responsibility of other vessels (not restricted in their ability to manoeuvre) to ensure they take the appropriate actions to avoid a vessel collision. | Safe operation of support vessels in the vicinity of commercial fishing operations be included in compulsory inductions for Jadestone Energy employees and contractors. |

| Issue raised with PTTEP | PTTEP Response | How Jadestone Energy has considered the issue |
|---|---|---|
| Legal protection should there be another spill event | PTTEP AA is required by the regulator (NOPSEMA) to hold sufficient financial resources to ensure it can meet any likely clean-up costs. | Under the same legislative requirement, Jadestone Energy is required by the regulator (NOPSEMA) to hold sufficient financial resources to ensure it can meet any likely clean-up costs. |
| Capabilities to respond in the event of a hydrocarbon release, especially given isolated location | As part of PTTEP AA's commitment to continuous improvement, PTTEP AA's management culture, operational capabilities, safety processes, and environmental systems are routinely evaluated and strengthened to align with industry good practice.<br><br>PTTEP AA is committed to operate safely, responsibly and sustainably to deliver maximum benefit while minimising impact on the environment. PTTEP AA has recently increased its commitment to refresher training of the PTTEP AA emergency response team. PTTEP AA has also increased the level of external resources to support PTTEP AA's response (including environmental specialists) in the event that an unplanned release of hydrocarbons occurs. In addition, PTTEP has increased the response team to allow 24-hour coverage for an extended time frame.<br><br>PTTEP AA has developed an Oil Pollution Emergency Plans (OPEP) for *Montara* Operations. The purpose of the OPEP is to detail the procedures and resources through which PTTEP AA will minimise the effect of a marine oil spill. The OPEP provides background on the appropriate response strategies and available oil spill response resources.<br><br>The Department of Transport (DoT), Australian Marine Safety Authority (AMSA) and Australian Marine Oil Spill Centre (AMOSC) will have an opportunity to review and provide feedback on the OPEP. | As part of the development of this EP Jadestone Energy has developed an Oil Pollution Emergency Plan (OPEP) for *Montara* Operations. The OPEP ensures rapid resourcing and response to any unplanned event. The Department of Transport (DoT), Australian Marine Safety Authority (AMSA) and Australian Marine Oil Spill Centre (AMOSC) will have an opportunity to review and provide feedback on the OPEP and it must meet regulators requirements. |

## 6.3 Assessment of Merit

For all responses received, the merit of each of these responses was assessed. The assessment of merit for all other responses is provided in Table **6-3**.

**Table 6-3 Responding to merits of objections and claims**

| Stakeholder | Stakeholder Concern, Objection or Claim | JSE Assessment of merit | JSE Response |
|---|---|---|---|
| Department of Transport | What will be the timing of EP submission to DoT?<br><br>Ongoing communications with DoT<br><br>JSE requested clarification of the DoT focus of OPEP review | *No objection, concern or claim.*<br><br>*Request only:*<br><br>DoT is the key regulatory agency for the management of WA Oil Spill Response and provides significant input for EP consideration. | • Jadestone Energy will submit the OPEP and supporting documents to DoT as per the IGN upon submission of the *Montara* EP to NOPSEMA<br>• Jadestone Energy will set up regular meetings with DoT to provide an update on the transitional process<br>• DoT review focus for the OPEP is to ensure that Jadestone Energy has the response arrangements in place to allow DoT to use and is aligned with the IGN |
| | Submission of '*Montara* Ops EP Specific Information for DoT' with relevant EP and OPEP sections highlighted, in addition to an initial meeting, enabled a smooth review process.<br><br>Documents refer to DoT Industry Guidance Note December 2017. Please refer to most recent version - September 2018. This version refers to the new 'State Hazard Plan - Maritime Environmental Emergency', WestPlan-MOP has been superseded.<br><br>OSR Arrangements Table 8.1 information on Control Agency is incorrect. | Information noted and where appropriate OPEP updated | • DoT satisfaction with engagement and format noted<br>• OPEP updated based on 'State Hazard Plan - Maritime Environmental Emergency' Sept 2018<br>• OSR arrangement in EP Table 8.1 has been updated |
| | Known or indicative oil type/properties - OPEP Appendices A3, A4 and A5 not provided. | JSE considers these comments have merit and have incorporated these into the OPEP. | • Oil assay information provided in Jadestone Energy IMT Response Plan (EP Appendix C) |
| | Potential Incident Control Centre arrangements – inadequate detail. OSR Arrangements does not give details of ICC location or facilities. Section 11 states that IMT will be established in Perth, however no information given on:<br><br>• what facilities are required for the ICC,<br>• will ICC will be established at Jadestone Energy offices, or<br>• if alternate ICC locations have been identified. | JSE considers these comments have merit and have incorporated these into the OPEP. | • Jadestone Energy ICC arrangements (Primary and alternative) detailed within IMT Response Plan sections 5.6 and 6.6 – 6.7 |
| | Potential staging areas/ Forward Operating Base - OSR Arrangements focusses on North West Shelf activities: Section 11 refers to Dampier, Stag, Exmouth and North West Shelf. Lack of detail around *Montara* requirements in Kimberley region. | JSE considers these comments have merit and have incorporated these into the OPEP. | • Jadestone Energy FOB arrangements detailed within IMT Response Plan sections 5.7 – 5.8 |
| | Details on proposed IMT structure – OSR Arrangements Figure 5.1 shows Jadestone Energy IMT Structure. In the event of a cross jurisdictional response as per the *Montara* scenario please show how the DoT IMT would interact with the Jadestone Energy IMT. Include detail on IMT structures relevant to this specific scenario. For example, how<br><br>Version: 1 Approved Date: N Owner: OSRC Objective ID: A2492301 Page 2 of 2 would Northern Territory oil spill response arrangements interact with these structures? | | • Jadestone Energy IMT Structure detailed within IMT Response Plan sections 5.5 and Appendix A (OSRA) section 3.2 (WA) and 3.3 (NT) |
| | Details of exercise and testing arrangements of OPEP/OSCP – OSR Arrangements Section 12.2 focuses on Stag. No detail given around *Montara*. As stated in the Industry Guidance Note, DoT has capacity for involvement in Petroleum Titleholder exercises, subject to availability of DoT resources. | JSE considers these comments have merit and have incorporated these into the OPEP. | • Jadestone Energy Test/Exercising arrangements detailed within IMT Response Plan section 10 (Administration) |
| | Confirmation that the Petroleum Titleholder has access to staff for the Initial Personnel Requirements as outlined in Annex 2 of the IGN – OSR Arrangements Section 4.2 confirms the initial personnel requirement. Please also note that as per the IGN, the Deputy Planning Officer and the Deputy Logistics Officer must have intimate knowledge of Jadestone Energy processes. | JSE considers these comments have merit and have incorporated these into the OPEP. | • Jadestone Energy arrangements detailed within IMT Response Plan Appendix A (OSRA) section 3.2 (WA) |
| Australian Maritime Safety Authority | Shipping traffic plot shows area clear of major international shipping routes but noting that some heavy vessels following the charted Osborn Passage will pass through both permits to the north of the *Montara* Venture FPSO. The AIS also shows support vessels in the area of activity. | Information noted and risk assessment updated | • Considered during ENVID. Refer to Interference with other users |
| | To notify AMSA's JRCC (rccaus@amsa.gov.au, Ph 1800 641 792) 24-48 hrs prior to operations commencing | JSE considers these comments have merit and have incorporated these into the EP. | • Item included in implementation section of EP to ensure notification 48 hrs prior to operations commencing. |

| Stakeholder | Stakeholder Concern, Objection or Claim | JSE Assessment of merit | JSE Response |
|---|---|---|---|
| | Australian Hydrographic Office (datacentre@hydro.gov.au) to be contacted no less than 4 weeks prior to operations commencing for the promulgation of related notices to mariners. | Action to be taken | • Item included in implementation section of EP to ensure notification 4 weeks prior to commencement. |
| DPIRD (Fisheries) | Key items raised by DPIRD (Fisheries) regarding *Montara* Operations are listed below. | DPRID (Fisheries) is the key regulatory agency for the management of State fisheries and provides significant input for EP consideration. | • See below |
| | Consultation<br><br>Request for JSE to consult with:<br><br>• WAFIC, PPA and Recfishwest<br>• Commercial fishers | JSE agrees with DoF comments and has undertaken consultation with the representative bodies requested. | • Consultation undertaken with WAFIC, PPA, Recfishwest and Commercial fishers using current datasets which fulfils Fisheries request. |
| | Timeframes<br><br>• Advice provided valid for duration of activity commencing within six months of the date this letter is signed.<br>• Request to be advised of actual commencement date and any changes to this proposal as soon as practicable prior to the commencement of any activity.<br><br>Response to any updated advice provided at this time required. | JSE considers these comments have merit and have incorporated these into the EP. | • Timeline for validity of advice noted.<br>• Item included in implementation section of EP to ensure notification 4 weeks prior to commencement. |
| | Pollution Emergency Plans<br><br>• Request that when developing OPEP JSE collects baseline marine data to compare against post spill monitoring. Baseline data should be made available to the Department.<br>• Consideration of spawning grounds and nursery areas should be included in OPEP. | JSE considers these comments have merit and have incorporated these into the EP. | • Baseline sampling was undertaken by PTEPP (*Montara* Environmental monitoring: Produced Formation Water Chemical Characterisation and Potential effects on the receiving Environment, 2018). These reports can be made available to the DPIRD.<br>• Fish spawning is addressed in Section 5.5.3 including Table 5-2 of the full EP. |
| | Biosecurity<br><br>• JSE must take reasonable measures to minimise the biosecurity risk. Recommend using the Departments Vessel Check tool<br>• Request that any suspected marine pest or disease be reported within 24 hours. | JSE considers these comments have merit and have incorporated these into the EP. | • ALARP assessment of biosecurity risk included in Section 8.2, including management of residual risks. This includes a performance standard (Section 8.2.3) that all vessels sourced from outside WA must use the 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.<br>• Item included in implementation section of EP to ensure notification within 24 hrs of biosecurity incident. |
| | Implementation<br><br>Ensure all vessel and asset operators associated with the project are aware of IMS risk and management methods. | JSE considers these comments have merit and have incorporated these into the EP. | • A JSE IMS management plan has been developed to ensure implementation of appropriate standards across the company, including contractors. |
| WAFIC | Response requesting consideration of more detailed response to previous queries raised with PTEPP. | JSE considers these comments have merit and actioned them during consultation process. | • JSE responded 14.11.18. Response to PTEPP issues included in package sent to previous fisheries responders. |
| | Response in relation to PTEPP news article seeking clarification of safety, maintenance and risk reduction and existing issues leading to another oil spill. | JSE considers merit in providing further information to address their concerns. | • 20.11.18- response to WAFIC outlining JSE position and commitments. This was forwarded by WAFIC to fishers on 20.11.18. Refer to Appendix G of EP for full text of response. No further issues raised following response. |

## 6.4 Ongoing Consultation

Ongoing consultation activities build upon Jadestone Energy's consultation for the EP. The Stakeholder Engagement Process outlines 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 Energy will undertake activities as shown in **Table 6-4**. In addition, Jadestone Energy will undertake additional triggered consultation as outlined in

**Table 6-5**.

**Table 6-4 Ongoing consultation requirements**

| Activity | Frequency and method |
|---|---|
| Provisions of updates on activity progress | Annual updates placed on Jadestone Energy's website and email notification to relevant persons, including Commonwealth and WA State government agencies identified as relevant persons. |
| Notification of Australian Hydrographic Office | No less than four weeks prior to operations commencing email AHO for the promulgation of related notices to mariners. |
| Notification of AMSA Joint Rescue Coordination Centre | To notify AMSA's JRCC 24-48 hrs prior to operations commencing |
| Notification of DPIRD (Fisheries) | No less than 4 weeks prior to operations commencing notify DPIRD (Fisheries) of actual commencement date and any change to proposal. |
| Notification of Director National Parks | No less than 4 weeks prior to operations commencing notify DNP of actual commencement date and any change to proposal. |
| Update to website | Place copy of Jadestone Energy information sheet on Jadestone Energy website |
| Review of relevant persons list | Annually unless triggered earlier |
| Provision of broader information relating to the Jadestone Energy environmental policy | Website updates as required |

**Table 6-5 Triggered consultation**

| Trigger | Action |
|---|---|
| Feedback received from relevant person | Follow standard process outlined the Jadestone Energy Stakeholder Engagement Strategy |
| Suspected IMS or disease | Report to DPIRD (Fisheries) within 24 hours |
| Change to risk profile operations area | Website update<br>Notification to relevant persons<br>Re-engage for consultation if quantum of risk change significant |

| Trigger | Action |
|---|---|
| Change to risk profile in EMBA | Notification to government agencies via email to key contact |
| Loss of Well Control event | Trigger separate Loss of Well control consultation process.<br><br>Notification to response agencies and government agencies as per OPEP<br><br>Attempt to electronically notify all relevant persons within 72 hours of spill<br><br>Notify AMP Director General of spill response activities within AMP (prior to response activities within a MP) on 0419 293 465. To include titleholder details, time and location of the incident, proposed response arrangements and locations as per the OPEP and contact details for the response coordinator. |
| AMP access | Notify AMP Director General of SMP (or other response activities) within AMP 10 days prior to entering (where possible) and at the cessation of activities in AMPs. |
| Change to Offshore Petroleum Greenhouse Gas Storage (Environment) Regulations 2009 consultative requirements | Review of Stakeholder Engagement Process |
| Change to *Montara's* operating jurisdiction | Review of Stakeholder Engagement Process |
| An element of Jadestone Energy's continuous improvement process identifies the procedure needs to be amended | Review of Stakeholder Engagement Process |
| Change to infrastructure that affects exclusion zone | Notify the Australian Hydrographic Service of activities and infrastructure for inclusion in Marine Notices |
| SMP activation and termination | Notify relevant persons of SMP commencement 10 days prior to and at the cessation of activities. |

# 7 IMPLEMENTATION STRATEGY

## 7.1 Systems, practices and procedures

Jadestone Energy applies an integrated Business Management System that is aligned with ISO 55000: Asset Management. This covers all activities and includes provision for the systematic management of environment and safety and all other business functions. 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.

### 7.1.1 Stakeholder management

Ongoing consultation activities build upon Jadestone Energy's consultation for the activity. **Section 6** 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 Energy will undertake the following activities (**Table 7-1**).

**Table 7-1 Standard consultation actions**

| Activity | Frequency and method |
|---|---|
| Provision of updates on activity progress | Annual updates placed on Jadestone Energy's website |
| Close out of communication commitments made during pre-start consultation including:<br>• Provide response organisations with a copy of the OPEP;<br>• Summary Notification to DMIRS of NOPSEMA EP acceptance<br>• Consultation with DNP regarding SMP design | Copy of EP Summary on Jadestone Energy's website<br>Email DMIRS stakeholder contact within 3 months |
| Email DPIRD and AHO stakeholder contact | Within 4 weeks of commencement date |
| Review of relevant persons list | Annually unless triggered earlier |
| Provision of broader information relating to Jadestone Energy environmental policy | Website updates as required |
| Notification of AMSA Joint Rescue Coordination Centre (JRCC) | 48-24 hours from commencement of operations |

In addition, Jadestone Energy will undertake additional triggered consultation as outlined below, should an unplanned event occur (**Table 7-2**).

**Table 7-2 Triggered consultation actions**

| Trigger | Action |
|---|---|
| Feedback received from relevant person | Follow consultative process outlined in the Consultation for Environmental Approvals procedure |
| Deviation to *Montara* Operations from those originally provided in consultation | Notification to relevant persons via email<br>Website update<br>Email DPIRD stakeholder contact a minimum of 4 weeks prior to commencement of any varied activity<br>Notify AMP Director General any change to risk within AMPs |
| Change to risk profile in Operational Area | Notification to government agencies via email to key contact |
| Change to risk profile in EMBA | Notification to government agencies via email to key contact<br>Notify AMP Director General any change to risk within AMPs |
| Oil spill event | Notification to response agencies and government agencies<br>Attempt to electronically notify all relevant persons listed in *Montara* EP Consultation Plan within 72 hours of spill<br>Ongoing updates and communication in accordance with requirements and response procedures<br>Notification of DPIRD within 24 hours of incident report<br>Notify AMP Director General within 24 hours of incident report and prior to spill response activities within AMP |
| AMP access | Notify AMP Director General of SMP (or other response activities) within AMP 10 days prior to entering (where possible) and at the cessation of activities in AMPs |
| Biosecurity incident: suspected marine pest or disease | Notification of DPIRD within 24 hours |
| Change to Offshore Petroleum Greenhouse Gas Storage (Environment) Regulations 2009 consultative requirements | Review of Consultation Plan |
| Change to *Montara* operating jurisdiction such that other legislative instruments stipulate new or additional consultative requirements | Review of Consultation Plan |
| An element of Jadestone Energy's continuous improvement process identifies the consultation procedure needs to be amended | Review of Consultation Plan |

| Trigger | Action |
|---|---|
| Change to infrastructure that affects PSZ | Notify the Australian Hydrographic Service of activities and infrastructure for inclusion in Marine Notices |

## 7.2 Monitoring, auditing, management of non-conformance and review

### 7.2.1 Routine Monitoring

The purpose of assurance and audits is to record performance data and routinely check conformance with environmental performance standards and achievement of environmental performance outcomes defined by the EP. Routine assurance and audit activities are scheduled, and records kept in the CMMS.

Emissions and discharges to the environment are monitored to assess the environmental performance of the operation on an ongoing basis. **Table 7-3** details the quantitative records that are maintained for all emissions and discharges during routine operations or emergencies within the Operational Area at frequencies described in the EP.

**Table 7-3 Quantitative records to be maintained for monitoring of discharges and emissions**

| Measurement | Monitoring Strategy |
|---|---|
| Oily sludge is disposed of at shore | Oily sludge is monitored as per MARPOL |
| Dosing of production chemicals, including biocide in cooling water system, are recorded | Biocide levels in cooling water system, and chemicals in production system, are maintained as per the operations plan |
| Volume of chemicals used | Volumes used determined from change in inventory |
| Food waste from the FPSO will be recorded | Putrescible waste as monitored per MARPOL |
| Produced water OIW concentration, discharge volume, and oil loads are recorded | Monitoring designed to accommodate batch discharge operations |
| Produced water turbidity | Turbidity monitoring tracks acceptable limit of discharge stream |
| Characterisation of PW finds contaminant concentrations meet 99% species protection concentration after applying a pre-set dilution | NATA accredited lab analyses PW samples a range of parameters. |
| Whole effluent toxicity testing confirms area of impact not exceeded | WET testing results less than 2017 results used to determine mixing zone |
| Weekly OIW inline spec service | OIW inline spec serviced weekly by Production Technician |
| OIW inline spec calibration | Calibration of inline spec according to manufacturer's recommendations |
| Quantity ($kms^3$)<br><br>Gas emissions | Metering on the FPSO |

| Measurement | Monitoring Strategy |
|---|---|
| Volumes of the waste types are recorded | Logged on facility when transferred via vessel to shore then to licensed waste facility. Invoicing process checks vessel manifest against waste disposal records of service provider, and evidence of disposal |
| All waste associated with oil spill response tracked to disposal | Disposal monitored as per Controlled Waste Regulations |

### 7.2.2 Audits

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 Energy Audit Manual describes the planning and conduct of audit activities. Jadestone Energy's Annual Plan and audit program, including frequency and scope of audits, are developed to reflect the risk profile of Jadestone Energy'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, unplanned audits may also be added to the audit program. An outline of Jadestone Energy's auditing schedule is provided in **Table 7-4**.

**Table 7-4 Annual audit schedule**

| Type | Scope |
|---|---|
| Planned | Compliance with EPOs and EPSs |
| | Drill down on close-out of corrective actions and/or areas of compliance focus (e.g. produced water, oil spill response) |
| | Contractor management |
| | Independent audit by third-party (Independent Competent Person, ICP) |
| Reactive | As determined by performance / non-compliances identified during internal/ external inspections, reviews, audits and incident investigations |

### 7.2.3 Non-compliances and Corrective Actions

Non-conformances from audits, inspections, incidents, regular monitoring or response testing are communicated immediately to the OIM and tracked and monitored by the HSE Manager until closed.

Opportunities for improvement and corrective actions from daily operations, reviews, audits, inspections, monitoring and testing activities are documented and tracked to closure by Jadestone Energy's action tracking system.

### 7.2.4 Reporting

## 7.3 Routine Reporting

Table **7-5** details the approach to routine environmental performance reporting to the regulator. Reports will be of sufficient detail to demonstrate whether specific environmental performance outcomes and standards have been met.

## 7.4 Incident Reporting

Table **7-5** 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 FPSO Incident Reporting Procedure incorporates reporting timeframes for incidents depending on their environmental impacts and is reviewed on an annual basis.

**Table 7-5 Routine and incident reporting requirements**

| ***Requirements*** |
|---|
| **Routine Reporting to NOPSEMA** |
| The Annual Performance Report for *Montara* Facility Operations will assess compliance with the EP performance objectives, standards and procedures and performance criteria.<br><br>Start and end of activities |
| Annual Review of Environment Plan. |
| **Recordable Environmental Incident Monthly Report**<br><br>A written report will be provided to NOPSEMA of any breaches of a performance outcome or performance standard identified in the EP, and is not classed as a reportable incident |
| **Reportable Incidents: Notifications** |
| **NOPSEMA**<br><br>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. |
| **AMSA**<br><br>Oil pollution incidents in Commonwealth waters must be reported to AMSA. |
| **Department of the Environment and Energy (DoEE)**<br><br>DoEE will be notified of the following incidents:<br>• Harm or mortality to Commonwealth EPBC Act Listed Marine Fauna (attributable to the operations activity).<br>• Spills of hydrocarbons or environmentally hazardous chemicals more than 80 litres to the marine environment.<br><br>Any unplanned event identified as having caused or having the potential to cause moderate to significant impact to a matter of NES. |
| **Reportable Incidents: Written Reports** |

| *Requirements* |
| --- |
| **NOPSEMA**<br>A written report of a reportable environmental incident will be provided to NOPSEMA |

## 7.5 Continuous Improvement

### 7.5.1 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. 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.

Outcomes of the Annual Performance Review are recorded and contribute to the EP Annual Performance Report.

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 considers:

- 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 or management) and relevant IUCN principles.

The results of the review and any identified improvements or recommendations will be incorporated into processes and procedures used for the operation, or the EP, to facilitate continuous improvement in environmental performance.

### 7.5.2 Management of Change and Revisions of the Environment Plan

Jadestone Energy's Management of Change (MoC) process will determine whether a proposed change to activities trigger the requirements of Regulation 17 *Offshore Petroleum Greenhouse Gas Storage (Environment) Regulations 2009*, which may result in a revision and resubmission of an EP to NOPSEMA

as described in the Jadestone Energy's Change Management Procedure. 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.

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;
- Changes are assessed to determine if it introduces a new risk/impact or increases an existing impact/risk,
- The MoC is prepared internally by Jadestone Energy 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 Energy requires confirmation that impacts and risks have been assessed and appropriate reduction measures implemented to manage risks and impacts to ALARP and acceptable levels;
- All approved changes that affect the EP 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 drawings are updated accordingly.

The MOC must be designed to meet the particular requirements for the type of change 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
- All alterations and updates to controlled documents must be in accordance with Document Control requirements. If the change meets any of the criteria detailed by Regulation 17, a revision/resubmission of the EP to NOPSEMA will occur.

## 7.6 Emergency Preparedness and Response

Under the Environment Regulations 14(8) the Oil Pollution Emergency Plan (OPEP, MV-70-PLN-G-00001 Rev1) (OPEP) contains arrangements for responding to and monitoring oil pollution.

Emergency response procedures and manuals are in place to describe how controls and consequences are mitigated. These documents are available on the *Montara Venture* FPSO and are made accessible to all personnel. The relevant incident response procedures and manuals are detailed in the OPEP. Jadestone Energy has prepared an Operational and Scientific Monitoring Program for its activities in the Timor Sea for use in the event of a large spill. Together the OPEP, scientific monitoring plans and the EP provide a clear, robust approach to efficiently and effectively manage a potential hydrocarbon spill while achieving Jadestone Energy's environmental performance criteria. Specifically, the SMP provides guidance on how and when monitoring data will be collected in the event of a Level 2 or Level 3 hydrocarbon spill.

### 7.6.1 Operational monitoring strategy

To coordinate the operational monitoring requirements, an overarching operational monitoring plan will be developed and implemented by the IMT. The OPEP details how the following tactics supply the required information to achieve situational awareness and inform response decisions to reduce impacts resulting from the worst-case potential spill, from the *Montara* Operations, to ALARP:

- Tracking buoys;
- Vessel surveillance;
- Aerial surveillance;
- OSTM;
- Fluorometry; and
- Shoreline and coastal habitat assessment using Shoreline Clean-up Assessment Technique (SCAT) surveys.

Each tactic has predetermined initiation and termination criteria, resource rationale, monitoring and reporting requirements detailed in the OPEP.

Similarly, predetermined initiation and termination criteria, resource rationale, monitoring and reporting requirements are detailed in the OPEP for each strategy listed below.

#### 7.6.1.1 Chemical dispersion strategy

For the Worst-Case Scenario surface release, Jadestone Energy will apply surface chemical dispersants as soon as practically possible to maximise the application of dispersant to the freshest oil (<24 hours old). Modelling indicates that the volume of oil ashore worst case is reduced by 40% with dispersant application.

For dispersant planning purposes, Jadestone Energy has targeted visible oil closest to the source. The dispersant budget has accounted for this option which shows that Jadestone Energy are able to exceed and deliver the maximum volume of dispersant required from Day 5 onwards.

Jadestone Energy will monitor the effectiveness of dispersant application to assess whether to continue planned volumes through the NEBA process. For a subsea release, Jadestone Energy will initially mobilise the surface dispersant capability as required until the AMOSC SFRT is operational.

#### 7.6.1.2 Containment and recovery strategy

Jadestone Energy consider containment and recovery planning as a primary response around the source (with dispersant application) and a secondary response targeting priority receptors. Containment involves using booms (inflatable or solid) to corral oil usually in the offshore environment near the

hydrocarbon source. Once contained, an attempt to recover the hydrocarbons from the surface waters can be undertaken. The response has limitations such as:

- specific weather and sea states
- where the concentration threshold of surface hydrocarbons is a minimum of 50g/$m^2$; and
- containment of fresh volatile hydrocarbons should not be attempted due to safety concerns.

#### 7.6.1.3 Protection and deflection strategy

This strategy involves a combination of nearshore booming using vessel-based operations ('nearshore operations') while the spill remains on a predicted shoreline impact trajectory, and the placement of shoreline boom to:

- Protect sensitive shorelines;
- Deflect the oil back to ocean or to easier locations for shoreline clean-up;
- Reduce the volume of oil impacting sensitive shoreline habitats to ALARP; and
- Align the response strategy with NEBA.

Jadestone Energy has time for pre-assessment of shoreline areas for which oil may contact, noting sensitive receptor locations, fauna presence (e.g. nesting turtles and birds) and morphology of shorelines/creek systems. These aspects change seasonally, and a pre-assessment window provides the ability for up to date information to be considered when formulating a specific plan for shoreline protection

#### 7.6.1.4 Shoreline clean up strategy

Jadestone Energy will undertake a NEBA of shoreline response strategies utilising findings from SCAT surveys and implement shoreline clean-up and waste management.

Intrusive shoreline clean-up techniques have the potential to damage sensitive shorelines. Given that the majority of the mainland shoreline contacted consists of tidal mangroves and saltmarshes, the appropriateness of clean-up will be determined as opposed to natural attenuation. Selection of the shoreline clean-up methods and controls to prevent further damage from the clean-up activities are to be undertaken in consultation with the HMA and selected based on the results of the NEBA.

#### 7.6.1.5 Oiled wildlife response

The Oiled Wildlife Response Plan describes how, in the event of a spill that will or could potentially oil wildlife, the Planning Team Lead will activate Government and Industry (AMOSC) Oiled Wildlife Advisors (OWAs) as stipulated in Jadestone Energy's IMT Response Plan. These roles ensure minimum standards for Oiled Wildlife Response (OWR), as outlined within the WA/NT OWRP, are met and ensure timely mobilisation of appropriate resources (equipment and personnel) through communication with the wildlife logistics team.

Timely provision of equipment and personnel will be provided by AMOSC through a combination of owned and operated equipment, call-off contracts with suppliers, and the management of industry OWR response personnel (refer IMTRP). Under the WA/NT OWRP arrangement, the AMOSC OWA may

request further assistance from State/Territory in the form of trained personnel, and vice versa, if their own expertise has been exhausted.

#### 7.6.1.6 Scientific monitoring

The Scientific Monitoring Plan (GF-70-PR-I-00035) is activated within 24 hours of IMT activation. An environmental service provider is in place. An audit of capability and readiness as described in the Implementation Plan and SMP Framework is conducted by Jadestone Energy annually, with 12 monthly reviews of the individual SMPs.

# 8 REFERENCES

ANZECC & ARMCANZ. (2000). Australian guidelines for water quality monitoring and reporting. Volume 1, Chapter 1-7. October 2000. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

Australian Petroleum Production and Exploration Association (APPEA) (2008). Code of Environmental Practice. Australian Petroleum Production and Exploration Association. Canberra, Australia

Baldwin, R., Hughes, G., & Prince, R., (2003). Loggerhead Turtles in the Indian Ocean. In: Bolten, A. & B. Witherington, eds. Loggerhead sea turtles. Washington: Smithsonian Books.

Bamford, M., Watkins, D., Bancroft, W., Tischler, G., & Wahl, J. (2008). Migratory Shorebirds of the East Asian - Australasian Flyway: Population estimates and internationally important sites. Canberra, ACT: Department of the Environment, Water, Heritage and the Arts, Wetlands International-Oceania. Available at: http://www.environment.gov.au/resource/migratory-shorebirds-east-asian-australasian-flyway-population-estimates-and. Accessed: 17 April 2018.

Bannister, J.L., Kemper, C.M., & Warneke, R.M. (1996). The Action Plan for Australian Cetaceans. [Online]. Canberra: Australian Nature Conservation Agency. Available from: http://www.environment.gov.au/coasts/publications/cetaceans-action-plan/pubs/whaleplan.pdf

Black, K.P., Brand, G.W., Grynberg, H., Gwythe, D., Hammond, L.S., Mourtikas, S., Richardson, B.J., & Wardrop, J.A. (1994). Production Activities. Pages 209-407 In: J.M. Swan, J.M. Neff, and P.C. Young, eds., Environmental Implications of Offshore Oil and Gas Development. In Australia Findings of an Independent Scientific Review. Australian Petroleum Production and Exploration Association, Canberra, Australia.

Bowlay, A., & Whiting, A. (2007). Uncovering Turtle Antics. Landscope. 23 (2). Western Australia Department of Environment and Conservation, Perth, Western Australia.

Chatto, R., and B. Baker (2008). The Distribution and Status of Marine Turtle Nesting in the Northern Territory-Technical Report 77/2008. [Online]. Parks and Wildlife Service, Department of Natural Resources, Environment, The Arts and Sport. Northern Territory Government. Available from: http://www.nt.gov.au/nreta/publications/wildlife/science/pdf/marine_turtle_nesting.pdf

Clark, J.R., Bragin, G.E., Febbo, R.J., and Letinski, D.J. (2001). Toxicity of physically and chemically dispersed oils under continuous and environmentally realistic exposure conditions:Applicability to dispersant use decisions in spill response planning. Proceedings of the 2001 International Oil Spill Conference. Pp. 1249-1255, Tampa, Florida. American Petroleum Institute, Washington, D.C.

Clarke, R.H. (2010). The Status of Seabirds and Shorebirds at Ashmore Reef and Cartier and Browse Islands: Monitoring Program for the Montara Well Release – Pre-Impact Assessment and First Post-Impact Field Survey. Prepared on behalf of PTTEP Australasia and the Department of the Environment, Water, Heritage and the Arts, Australia.

Cobourg Peninsula Sanctuary and Marine Park Board and Parks and Wildlife Service of the Northern Territory, Department of Natural Resources, Environment, The Arts and Sport (2011). Cobourg

Marine Park Plan of Management. https://dtc.nt.gov.au/__data/assets/pdf_file/0006/249045/Cobourg-Marine-Park.pdf (accessed 07/04/2017)

Connell DW and Miller GJ. (1981). Petroleum hydrocarbons in aquatic ecosystems – behaviour and effects of sublethal concentrations. CRC Report: Critical Reviews in Environmental Controls.

Department of Agriculture and Water Resources (DAWR). (2017). Australian Ballast Water Management Requirements, Version 7.

Department of Environment (DoE) (2014a) Conservation Advice – Glyphis garricki - Northern River Shark. http://www.environment.gov.au/biodiversity/threatened/species/pubs/82454-conservation-advice.pdf

Department of Environment (DoE) (2014b) Conservation Advice – Pristis pristis – Largetooth Sawfish. http://www.environment.gov.au/biodiversity/threatened/species/pubs/60756-conservation-advice.pdf

Department of the Environment (DoE) (2014c). Threat abatement plan for disease in natural ecosystems caused by Phytophthora cinnamomi. Canberra, ACT: Commonwealth of Australia. Available from: http://www.environment.gov.au/resource/threat-abatement-plan-disease-natural-ecosystems-caused-phytophthora-cinnamomi

Department of the Environment and Energy (DoEE) (2014d). Recovery Plan for the Grey Nurse Shark. Available at https://www.environment.gov.au/system/files/resources/91e141d0-47aa-48c5-8a0f-992b9df960fe/files/recovery-plan-grey-nurse-shark-carcharias-taurus.pdf.

Department of the Environment and Energy (DoEE) (2017a). Recovery Plan for Marine Turtles in Australia. Australian Government, Canberra. Available at: http://www.environment.gov.au/marine/publications/recovery-plan-marine-turtles-australia-2017.

Department of the Environment and Energy (DoEE) (2017b). Species Profile and Threats (SPRAT) Database. Department of the Environment and Energy, Australian Government. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl . Accessed 17 April 2018.

Department of the Environment and Energy (DoEE) (2017c), Australia's National Heritage List. Available from: http://www.environment.gov.au/heritage/places/national-heritage-list

Department of the Environment and Energy (DoEE) (2018) Threat Abatement Plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans. Available at: http://www.environment.gov.au/biodiversity/threatened/publications/tap/marine-debris-2018

Department of the Environment and Energy (DoEE) (2018a). Australian Ramsar management principles. Available from: https://www.environment.gov.au/water/wetlands/managing/australian-ramsar-management-principles.

Department of the Environment and Energy (DoEE) (2018b). Oceanic Shoals Commonwealth Marine Reserve. Commonwealth of Australia, Canberra. Available at: http://www.environment.gov.au/topics/marine/marine-reserves/north/oceanic-shoals. Accessed 17 April 2018

Department of the Environment and Heritage (DEH) (2006). Australian National Guidelines for Whale and Dolphin Watching 2005. Australian Government, Canberra.

Department of the Environment, Water, Heritage and the Arts (DEWHA) (2007a). A Characterisation of the Marine Environment of the North-west Marine Region. A summary of an expert workshop convened in Perth, Western Australia, 5-6 September 2007. Prepared by the North-west Marine Bioregional Planning Section, Marine and Biodiversity Division. Available from: https://www.environment.gov.au/system/files/resources/b1760d66-98f5-414f-9abf-3a9b05edc5ed/files/nw-characterisation.pdf

Department of Heritage (DOH) (2005). The Conservation Management Plan (Recovery Plan) for the Blue Whale (B. musculus). Australian Government, Canberra.

Department of State Development (DSD) (2010). Draft Strategic Assessment Report for Browse Liquefied Natural Gas Precinct, Part 3 Environmental Assessment – Marine Impacts. Department of State Development, Perth, Western Australia.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2013). Approved Conservation Advice for the Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula. Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/communities/pubs/105-conservation-advice.pdf.

Director of National Parks (DoNP) (2015). Pulu Keeling National Park Management Plan 2015 – 2025. Available at: environment.gov.au/topics/national-parks/parks-australia/publications.

Environment Australia. (2002). Australian IUCN Reserve Management Principles for Commonwealth Marine Protected Areas.

Garnet, S.T., Szabo, J.K., Dutson, G. (2011) The Action Plan for Australian Birds 2010. CSIRO Publishing, Melbourne.

Guinea, M. (2007). Marine Snakes: Species Profile for the North-west Planning Area. Report for the National Oceans Office, Hobart.

Guinea, M.L., Whiting, S.D., 2005. Insights into the distribution and abundance of sea snakes at Ashmore Reef. The Beagle. Supplement 1, 199–205.

Hale, J., & Butcher, R. (2013). Ashmore Reef Commonwealth Marine Reserve Ramsar Site Ecological Character Description. A report to the Department of the Environment, Canberra.

Heyward, A., Pinceratto, E. and Smith, L.(eds.) (1997). Big Bank Shoals of the Timor Sea: An Environmental Resource Atlas. Prepared by Australian Institute of Marine Science and BHP Billiton Pty Ltd., Perth, Western Australia

Heyward, A., Moore, C., Radford, B., & Colquhoun, J. (2010). Monitoring program for the Montara well release Timor Sea: final report on the nature of Barracouta and Vulcan Shoals. Report prepared by the Australian Institute of Marine Science for PTTEP AA, Perth, Western Australia.

Heyward, A. Peed, C. Meekan, M. Cappo, M. Case, M. Colquhoun, J. Fisher, R. Meeuwig, J. and Radford B. (2013) Montara: Barracouta East, Goeree and Vulcan Shoals Survey 2013. Prepared by the Australian Institute of Marine Science for PTTEP Australasia (Ashmore Cartier) Pty Ltd

Heyward, A., Jones, R., Meeuwig, J., Burns, K., Radford, B., Colquhoun, J., Cappo, M., Case, M., O'Leary, R., Fisher, R., Meekan, M. and Stowar, M. (2011a) Monitoring Study S5 Banks and Shoals, Montara 2011 Offshore Banks Assessment Survey. Report for PTTEP Australasia (Ashmore Cartier) Pty. Ltd. Australian Institute of Marine Science, Townsville. 253pp.

Heyward, A., Moore, C., Cappo, M., & Radford, B. (2017). Submerged oceanic shoals of north Western Australia are a major reservoir of marine biodiversity.

Hutomo M and Moosa M K. (2005). Indonesian marine and Coastal biodiversity: Present Status. Indian Journal of Marine Sciences 34:1 88-97.

International Tanker Owners Pollution Federation Limited (ITOPF) (2011). Clean-up of oil from shorelines. Technical Paper 7. The International Tanker Owners Pollution Federation Limited, London, United Kingdom

IPIECA. (2015). A guide to oiled shoreline clean-up techniques. Good practice guidelines for incident management and emergency response personnel. International Association of Oil & Gas Producers (IOGP) Report 521.

Jacobs Group Australia Pty Ltd (2017) Montara Environmental Monitoring - Produced Formation Water Toxicity and Potential Effects on the Receiving Environment Rev 2. Reported prepared for PTTEP AA. December 2017

JASCO. 2012. Ambient Noise Monitoring in the Timor Sea: December 2010 – December 2011. JASCO Document 00329, Version 1.1. Technical report by JASCO Applied Sciences for Environmental Resources Management.

Jenner, K.C.S., M.N. Jenner and K.A. McCabe (2001). Geographical and Temporal Movements of Humpback Whales in Western Australian Waters. APPEA journal, pps. 749-765.

Johnstone, R.E. and Storr, G.M. (1998). Handbook of Western Australian Birds. Vol. 1: Non-passerines (Emu to Dollarbird). Perth, Western Australia: West Australian Museum.

Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S. and Podesta, M. (2001). Collisions between Ships and Whales. Marine Mammal Science, 17(1):35-75.

Last PR, Stevens JD (2009) Sharks and Rays of Australia, ed 2. Collingwood, CSIRO Australia.

Limpus, C. J., Parmenter, C. J., Baker, V., & Fleay, A. (1983). The flatback turtle, Chelonia depressa, in Queensland: post-nesting migration and feeling ground distribution. Wildlife Research, 10(3), 557-561.

Lewis, M., Pryor, R., & Wilking, L. (2011). Fate and effects of anthropogenic chemicals in mangrove ecosystems: a review. Environmental pollution, 159(10), 2328-2346.

Limpus, C.J. and MacLachlin, N. (1994). The Conservation Status of the Leatherback Turtle, Dermochelys coriacea, in Australia. In: James, R, ed. Proceedings of the Australian Marine Turtle Conservation Workshop, Gold Coast 14-17 November 1990. Page(s) 63-67. Queensland Department of Environment and Heritage. Canberra: ANCA.

Marchant, S & Higgins, PJ (eds) (1990). Handbook of Australian, New Zealand and Antarctic birds, volume 1: ratites to ducks, part A: ratites to petrels, Oxford University Press, Melbourne.

Marquez, R. (1990). FAO Species Catalogue; Sea Turtles of the World. An Annotated and Illustrated Catalogue of the Sea Turtle Species Known to Date. FAO Fisheries Synopsis. 125 (11): pp 81. Rome: Food and Agriculture Organisation of United Nations.

Marshall, A., Bennett, M.B., Kodja, G., Hinojosa-Alvarez, S., Galvan-Magana, F., Harding, M., Stevens, G. & Kashiwagi, T. (2011a). *Manta birostris*. The IUCN Red List of Threatened Species 2011: e.T198921A9108067. http://dx.doi.org/10.2305/IUCN.UK.2011-2.RLTS.T198921A9108067.en. Downloaded on 02 April 2017.

McCauley, R.D. and Jenner, C. 2010. Migratory Patterns and Estimated Population Size of Pygmy Blue Whales (*Balaenoptera musculus brevicauda*) Traversing the Western Australian Coast based on Passive Acoustics. Report for the International Whaling Commission, SC/62/SH26. 9pp.

National Energy Resources Australia, 2017. Environment Plan Reference Case: Planned discharge of sewage, putrescible waste and grey water, https://referencecases.nopsema.gov.au/assets/reference-case-project/2017-1001-Sewage-grey-water-and-putrescible-waste-discharges.pdf

National Energy Resources Australia, accessed 2019. Environment Plan Reference Case: Consequence analysis of an accidental release of diesel, https://referencecases.nera.org.au/Attachment?Action=Download&Attachment_id=225

National Environmental Research Program Marine Biodiversity Hub (NERP MBH) (2014). Exploring the Oceanic Shoals Commonwealth Marine Reserve., NERP MBH, Hobart.

Nichol, SL, Howard, FJF, Kool, J, Stowar, M, Bouchet, P, Radke, L, Siwabessy, J, Przeslawski, R, Picard, K, Alvarez de Glasby, B, Colquhoun, J, Letessier, T and Heyward, A, (2013). Oceanic Shoals Commonwealth Marine Reserve (Timor Sea) Biodiversity Survey: GA0339/SOL5650 - Post Survey Report., Record 2013/38, Geoscience Australia, Canberra.

Ochi, D., Oka, N. & Watanuki, Y. (2010) Foraging trip decisions by the Streaked Shearwater Calonectris leucomelas depend on both parental and chick state. J. Ethol. 28: 313–321.

Storr, G.M., R.E. Johnstone & P. Griffin (1986). Birds of the Houtman Abrolhos, Western Australia. Records of the Western Australian Museum Supplement

Threatened Species Scientific Committee (TSSC) (2008a). Approved Conservation Advice for *Pristis zijsron* (Green Sawfish). Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/68442-conservation-advice.pdf

Threatened Species Scientific Committee (TSSC) (2008b). Commonwealth Conservation Advice on *Dermochelys coriacea.* Department of the Environment, Water, Heritage and the Arts. Available: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1768-conservation-advice.pdf

Threatened Species Scientific Committee (TSSC) (2011). Commonwealth Conservation Advice on *Aipysurus apraefrontalis* (Short-nosed Seasnake). Department of Sustainability, Environment, Water, Population and Communities. Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1115-conservation-advice.pdf.

Threatened Species Scientific Committee (TSSC) (2014a). Approved Conservation Advice for *Glyphis garricki* (northern river shark). Canberra: Department of the Environment. Available: http://www.environment.gov.au/biodiversity/threatened/species/pubs/82454-conservation-advice.pdf.

Threatened Species Scientific Committee (TSSC) (2014b). Approved Conservation Advice for Pristis pristis (largetooth sawfish). Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/60756-conservation-advice.pdf.

Threatened Species Scientific Committee (TSSC) (2015a). Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale). Canberra: Department of the Environment. Available: http://www.environment.gov.au/biodiversity/threatened/species/pubs/38-conservation-advice-10102015.pdf.

Threatened Species Scientific Committee (TSSC) (2015b). Approved Conservation Advice for *Balaenoptera borealis* (sei whale). Canberra: Department of the Environment. Available: http://www.environment.gov.au/biodiversity/threatened/species/pubs/34-conservation-advice-01102015.pdf

Threatened Species Scientific Committee (TSSC) (2015c). Approved Conservation Advice for *Balaenoptera physalus* (fin whale). Canberra: Department of the Environment. Available: http://www.environment.gov.au/biodiversity/threatened/species/pubs/37-conservation-advice-01102015.pdf.

Threatened Species Scientific Committee (TSSC) (2015d). Approved Conservation Advice for *Rhincodon typus* (whale shark). Canberra: Department of the Environment. Available: http://www.environment.gov.au/biodiversity/threatened/species/pubs/66680-conservation-advice-01102015.pdf.

Threatened Species Scientific Committee (TSSC) (2015e). Approved Conservation Advice for *Anous tenuirostris melanops* (Australian lesser noddy). Canberra: Department of the Environment. Available: http://www.environment.gov.au/biodiversity/threatened/species/pubs/26000-conservation-advice-01102015.pdf.

Threatened Species Scientific Committee (TSSC) (2015f). Approved Conservation Advice for *Calidris ferruginea* (Curlew Sandpiper). Canberra: Department of the Environment. Available: http://www.environment.gov.au/biodiversity/threatened/species/pubs/856-conservation-advice.pdf

Threatened Species Scientific Committee (TSSC) (2015g). Conservation Advice *Numenius madagascariensis* eastern curlew. Commonwealth of Australia. Canberra. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/847-conservation-advice.pdf

Threatened Species Scientific Committee (TSSC) (2015h). Approved Conservation Advice for *Papasula abbotti* Abbott's booby. Canberra: Department of the Environment. Available: http://www.environment.gov.au/biodiversity/threatened/species/pubs/59297-conservation-advice-01102015.pdf

Threatened Species Scientific Committee (TSSC) (2016a). Approved Conservation Advice for *Calidris canutus* (Red knot). Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/855-conservation-advice-05052016.pdf

Tomascik, T., Mah, A.J., Nontji, A. and Moosa, M.K., The ecology of Indonesia series, volume VII: the ecology of the Indonesian Seas, part one, Periplus Editions: Hong Kong, (1997). Cited in: Hutomo M and Moosa M K. (2005). Indonesian marine and Coastal biodiversity: Present Status. Indian Journal of Marine Sciences 34:1 88-97.

Yamamoto T, Takahashi A, Katsumata N, Sato K and Trathan PN. (2010). At-Sea Distribution and Behavior of Streaked Shearwaters (*Calonectris leucomelas*) During the Nonbreeding Period. The Auk: October 2010, Vol. 127, No. 4, pp. 871-881.

# APPENDIX 1 EXISTING ENVIRONMENT

## 8.1 Marine regional setting

Australia's offshore waters have been divided into six marine regions to facilitate their management by the Australian Government under the EPBC Act. The *Montara* Operations activity (Operational Area) lies within the North West Marine Region (NWMR), while the EMBA are located within the NWMR and the North Marine Region. The objectives of the North and North-west Marine Parks Management Plan 2018 are to provide for:

A. the protection and conservation of biodiversity and other natural, cultural and heritage values of marine parks in the North-west Network; and

B. ecologically sustainable use and enjoyment of the natural resources within marine parks in the North-west Network, where this is consistent with objective (A).

A summary of the two Regions is provided below.

### 8.1.1 North West Marine Region (NWMR)

Several regionally important marine communities and habitats as identified in the NWMR bioregional plan and WA State planning processes include Ashmore Reef, Cartier Island, Seringapatam Reef and Scott Reef, which have been identified as regionally important areas supporting a high biodiversity of marine life and several foraging and breeding aggregations. Ashmore Reef and Cartier Island are located approximately 160 km and 100 km north-west, respectively, from the Operational Area. A number of key ecological features (KEFs) in the NWMR include The Continental Slope Demersal Fish Community which is important due to its high species diversity and endemism, and The Carbonate Bank and Terrace System of the Sahul Shelf which is regionally important as its unique sea floor contributes to the biodiversity and productivity of the area.

### 8.1.2 North Marine Region (NMR)

The NMR is highly influenced by tidal flows and less by ocean currents. The marine environment of the NMR is known for its high diversity of tropical species but relatively low endemism, in contrast to other bioregions. Several regionally important marine communities and habitats have been identified as part of the NMR bioregional plan, including the Gulf of Carpentaria coastal zone, plateaux and saddle north-west of the Wellesley Islands, and the submerged coral reefs. Additional to these, KEFs in the region within the EMBA include the Pinnacles of the Bonaparte Basin, the Carbonate Bank and Terrace System of the Van Diemen Rise, the Shelf Break of the Arafura Shelf, the tributary canyons of the Arafura Depression and the Gulf of Carpentaria Basin.

#### 8.1.2.1 Provinces of the NWMR and NMR

These marine regions are divided into provincial bioregions with those overlapping the EMBA listed in Table 1.

Table 1 Description of the IMCRA Provincial Bioregions within the EMBA

| Provincial Bioregion | Description |
|---|---|
| Timor Province | The oceanographic environment is mainly influenced by tides, with some influence from the Indonesian Throughflow current. These open waters support pelagic species, including whale sharks, an unusual array of threadfin fish species and distinct genetic stocks of red snapper. |
| Northwest Shelf Transition | The Northwest Shelf Transition has a diverse seafloor topography including submerged terraces, carbonate banks, pinnacles, reefs and sand banks. |
| Northwest Shelf Province | Around half of the bioregion has water depths of only 50 – 100 m. It is characterised by a dynamic oceanographic environment, influenced by strong tides, cyclonic storms, long-period swells and internal tides. |
| Northwest Transition | The Northwest Transition includes the shelf break, continental slope and the majority of the Argo Abyssal Plain of the NMWR. Mermaid Reef is a key topographical feature of the bioregion; a biodiversity hotspot where the steep change in slope around the reef attracts a range of pelagic migratory species including billfish, sharks, tuna and cetaceans. |
| Northwest Province | Includes units defined by the distribution and abundance of pinnacles, banks, and sand banks, containing the 2nd largest area of Class 1 units of all the IMCRA shelf bioregions. |
| Northern Shelf Province | This bioregion contains the largest area of Class 1 units for all of the IMCRA shelf bioregions. This bioregion contains the largest area of Class 7 units of all IMCRA shelf bioregions. |
| Christmas Island Province | The Christmas Island bioregion surrounds Christmas Island, specifically capturing the endemic fish species and other fauna associated with Christmas Island. |

## 8.2 Physical environment

The Operational Area has two predominant seasons - a hot, wet summer (October to March) and a cool dry winter (April to September). Cyclonic activity occurs between November to April bringing on average three cyclones a year (one per annum within 180 km of the site). Mean annual rainfall in the region is 1,770 mm. Mean air temperature ranges from 24.9°C in July to 29.6°C in December.

Major surface currents influencing the Region, include the Indonesian Throughflow, the Leeuwin Current, the South Equatorial Current and the Eastern Gyral Current. The oceanographic regime of the north west Australian offshore area is strongly influenced by the Indonesian Through Flow which transports warm, low salinity, oligotrophic waters through a complex system of currents (Department of State Development (DSD) 2010).

The currents in the Operational Area and wider EMBA are influenced by the semi-diurnal tides that have four direction reversals per day, with some of the largest tides along a coastline in the world. The strength and direction of tidal current flow is also strongly influenced by local bathymetry.

The Operational Area lies on the continental shelf with the *Montara* field sloping from the east (76 m) to west (86.5 m) and is characterised by a north-south trending gentle scarp. A thin, discontinuous layer of unconsolidated surficial sediment overlies a variably consolidated calcarenite sequence. The thickness of unconsolidated sediment varies from very thin/absent to a local maximum of 3.7 m.

Concentrations of metals, metalloids, hydrocarbons and phenolics in sediment samples from the Operational Area were either below the laboratory limit of reporting and/or the ANZECC/ARMCANZ Sediment Quality Guidelines and particle sizes were dominated by fine and coarse sands, with very little clay (Jacobs 2017).

## 8.3 Biological environment

### 8.3.1 Benthic habitats and communities

Regionally, the seabed generally comprises a relatively flat and featureless habitat, with numerous seamounts or banks along the perimeter of the Australian continental shelf. The shoals and banks in the NWMR share tropical marine biota consistent with that found on emergent reef systems of the Indo West Pacific region. These support a diverse range of benthic communities; algae, soft corals, hard corals and filter feeders. Bare sand and consolidated reef supporting turfing algae are features of all shoals and banks in the Timor Sea. Hard corals and macroalgae tend to be variable in abundance, while soft corals and sponges are often present. All banks and shoals in the region support comparable levels of biodiversity but vary in the abundance and diversity of dominant species (Heyward et al. 1997; 2017). Key locations of benthic and coastal/shoreline habitat are listed in Table 2.

In the Operational Area, surveyed benthic habitats were characterised by homogenous, flat, featureless soft sediment, predominately comprised of sand with small rubble/shell fragments. Sparse patches of epifauna were recorded and included hydroids, octocorals, black corals and ascidians. Macrobenthic faunal assemblages surveyed generally had a low, highly patchy abundance of individuals. Polychaete bristleworms (Phylum Annelida) contributed the highest relative abundance of macrobenthic assemblages, followed by *Malacostracan* crustaceans (shrimps, crabs etc).

Deep water soft sediment habitats are expected to be broadly similar in the wider EMBA to the surveyed locations in the *Montara* field and surrounding areas. In a study of benthic habitats on the continental shelf near the Big Bank Shoals (Heyward et al. (1997), the predominant benthic infaunal species were polychaetes and crustaceans (prawns, shrimp, crabs, etc.). These two groups made up 84% of the total species in sediment samples with a high diversity of species but a low abundance of each individual species. Epibenthic communities were sparse and species commonly associated with soft sediment habitats -sponges, gorgonians and sea fans, ascidians, echinoderms, crustaceans, bryozoans.

There are around 150 shoal/bank features across the Sahul Shelf and a high level of interconnectivity exists between them. The larval development rates of the species present, current speeds and the relatively short distance between the shoals, banks and reefs maintains this connectivity. The associated fish fauna is highly diverse but variable between shoals and banks but sharing of many species, which is influenced by depth, substrate, exposure to prevailing weather. There are more than 20 possible shoal features within a 100 km radius of the Operational Area and greater than 100 similar bathymetric features within 200 km (Heyward et al. 2010). The nearest shoals to the Operational Area are Goeree and Vulcan Shoals, about 30 km to the southwest. Other shoals in close proximity include Eugene McDermott Shoal and Barracouta Shoal.

### 8.3.2 Plankton and Invertebrates

Plankton is divided into phytoplankton and zooplankton (small animals that drift with the ocean currents e.g. larval stages of fauna that normally live on the seabed). Plankton populations have a high degree of temporal and spatial variability. Phytoplankton in tropical regions have marked seasonal cycles with higher concentrations occurring during June–August and low in December–March (Hayes et al., 2005). Zooplankton feed on phytoplankton and are subject to similar seasonality.

### 8.3.3 Shoreline Habitats

A wide variety of shoreline habitats occur within the EMBA, with key locations listed in Table 3.

**Table 2 Location of benthic and coastal/shoreline habitats**

| | Timor Province | Northwest Province | Northwest Transition | Northwest Shelf Province | Northwest Shelf Transition | Northern Shelf Province | Timor Transition | Christmas Island Province | Other (Indonesia, Timor Leste) |
|---|---|---|---|---|---|---|---|---|---|
| Coral | Ashmore Reef, Cartier Island, Hibernia, Scott and Seringapatam Reef, shoals and banks of the Sahul Shelf | Montebello Islands, Dampier Archipelago | Rowley Shoals | Browse Island | Big Bank Shoals | | | Christmas Island | Indonesia (west)<br>Rote Island<br>Timor-Leste (east - Coral Triangle) |
| Seagrasses | Ashmore Reef, Cartier Island, Scott Reef, Seringapatam reefs | Eighty Mile Beach,<br>Montebello Islands | Rowley Shoals | | Darwin Coast, Tiwi Islands | Arnhem Coast | | Present but no significant areas | Indonesia (west) Kepulauan Seribu National Park<br>Timor-Leste |
| Macroalgae | Ashmore Reef, Cartier Island, Scott Reef, Seringapatam Reef, shoals and banks of the Sahul Shelf, Barracouta Shoal | Dampier Archipelago, Shallow coastal and offshore waters of the Pilbara,<br>Montebello Islands | | Present but no significant areas | Big Bank Shoals | | | Present but no significant areas | Present but no significant areas |
| Non-coral benthic Invertebrates | Ashmore Reef, Cartier Island, Scott Reef, Seringapatam Reef, shoals and banks of the Sahul Shelf, Vulcan Shoal, Barracouta Shoal, Goeree Shoal | Present but no significant areas | Rowley Shoals | Dampier to Port Hedland | Big Bank Shoals, Van Diemen Rise | Present but no significant areas | Present but no significant areas | Present but no significant areas | Present but no significant areas |

**Table 3 Location of key shoreline habitats**

| | Timor Province | Northwest Province | Northwest Transition | Northwest Shelf Province | Northwest Shelf Transition | Northern Shelf Province | Timor Transition | Christmas Island Province | Other (Indonesia, Timor Leste) |
|---|---|---|---|---|---|---|---|---|---|
| Mangroves | Not present | Not present | Not present | North Kimberley Marine Park,<br>Port Hedland, Karratha | Darwin Coast, Tiwi Islands, Joseph Bonaparte Gulf, Kakadu | Cobourg Peninsula Kakadu | Not present | Present but no significant areas | Indonesia (west) |
| Intertidal sand/mud flats | Ashmore Reef | Not present | Not present | Eighty Mile Beach, Roebuck Bay | Darwin Coast, Joseph Bonaparte Gulf, Kakadu | Cobourg Peninsula Arnhem Coast, Kakadu | Not present | Present but no significant areas | |
| Intertidal platforms | Ashmore Reef, Scott Reef, Cartier Island | Not present | Not present | Eight Mile Beach | Darwin Coast, Joseph Bonaparte Gulf | Cobourg Peninsula Arnhem Coast | Not present | Present but no significant areas | Present but no significant areas |
| Sandy beaches | Ashmore Reef,<br>Sandy Islet (Scott Reef) | Not present | Not present | Eight Mile Beach | Darwin Coast | Arnhem Coast, Cobourg Peninsula | Not present | Present but no significant areas | |
| Rocky shorelines | Not present | Not present | Not present | North Kimberley Marine Park, Dampier to Point Samson | Present but no significant areas | | Not present | | Present but no significant areas |

### 8.3.4 Indonesia and Timor Leste

The Indonesian coastline is rich in tropical marine ecosystems such as sandy beaches, mangroves, coral reefs and seagrasses ecosystems with a wide variety of living communities and a high species diversity (Hutomo and Moosa 2005). Dense beds of seagrass in coastal waters include *Halophila ovalis* and *Halodule pinifolia* in intertidal zones, while *Thalassodendron ciliatum* dominate the lower subtidal zones. Fringing reefs are the most common reef types with scleractinian corals the most dominant.

The Timor Leste coastline features mangrove communities surrounding entrance to rivers primarily on the south coast, whilst the north and eastern coast feature a higher degree of coral reef communities.

### 8.3.5 Matters of National Environmental Significance (MNES)

Conservation values and sensitivities listed and protected under the EPBC Act include Matters of Environmental Significance (MNES) and Other Protected Matters. MNES occurring, or potentially occurring, in the EMBA are summarised in Table 4.

**Table 4 Summary of conservation values and sensitivities in the EMBA**

| MNES Protected under EPBC Act | Presence in EMBA | Number in EMBA | Description |
|---|---|---|---|
| World Heritage Places | ✓ | 1 | Kakadu National Park |
| National Heritage Places | ✓ | 3 | |
| Wetlands of International Importance (Ramsar) | ✓ | 9 | |
| Great Barrier Reef Marine Park | ✓ | | |
| Commonwealth Marine Areas | ✓ | 2 | |
| Threatened Ecological Communities | ✓ | 1 | |
| Listed Threatened Species | ✓ | 104 | |
| Listed Migratory Species | ✓ | 94 | |
| Nuclear actions, water resources (coal seam gas/coal mining) | × | 0 | |
| **Other Matters Protected under EPBC Act** | | | |
| Commonwealth Land | ✓ | 37 | Incl 25 defence sites |
| Commonwealth Heritage Places | ✓ | 43 | |
| Listed Marine Species | ✓ | 179 | |
| Whales and other cetaceans | ✓ | 31 | |
| Critical habitats | × | | |
| Commonwealth reserves terrestrial | × | | |
| Australian Marine Parks | ✓ | 14 | |
| **Other Areas of high conservation significance** | | | |
| State and Territory Marine Parks and Marine Management Areas | ✓ | 78 | 8 marine/coastal |
| Key Ecological Features (KEFs) (Marine) | ✓ | 15 | |

### 8.3.6 World Heritage Places

The shoreline of Kakadu National Park falls within the EMBA. Kakadu meets five criteria of outstanding universal values as set out in the World Heritage Convention and all nine criteria for identifying wetlands of international importance under the Ramsar Convention (see Table 5).

### 8.3.7 National Heritage Places

Kakadu National Park (described above) is also listed as a National Heritage Place.

The West Kimberley (173 km from *Montara*) significance includes indigenous, historic, aesthetic, cultural and natural heritage values with Roebuck Bay noted as a migratory hub for shorebirds. The area is characterised by a diversity of landscapes and biological richness.

The Dampier Archipelago (including the Burrup Peninsula) lying 1,181km from *Montara* contains one of the densest concentrations of Indigenous rock engravings in Australia and archaeological sites. It is of exceptional heritage interest for its array of rock engravings and stone arrangements and the importance of these within the traditions of the Ngarda-Ngarli peoples.

### 8.3.8 Wetlands of International Importance (Ramsar)

There are 9 "wetlands of international importance" under the Ramsar Convention bordering on the EMBA listed in Table 5.

**Table 5 Wetlands of International Importance (RAMSAR) within or bordering on the EMBA**

| Ramsar Wetland | Distance to *Montara* | Relevant Management Documents |
|---|---|---|
| Ashmore Reef Marine Park Ramsar site | 125 km | Environment Australia (2002)<br>DoEE (2018a)<br>Hale and Butcher (2013) |
| Cobourg Peninsula Ramsar site | 800 km | Cobourg Peninsula Sanctuary and Marine Park Board and Parks and Wildlife Service of the Northern Territory (2011) |
| The Dales, Christmas Island National Park | 2,093 km | |
| Eighty Mile Beach | 769 km | Environment Australia (2002) |
| Kakadu National Park | 798 km | |
| Ord River Floodplain | 500 km | |
| Pulu Keeling National Park, North Keeling Island | 2,963 km | DoNP (2015) |
| Roebuck Bay | 637 km | |

### 8.3.9 Commonwealth Marine Areas

The EMBA are within the Economic Exclusive Zone and Territorial Sea and the Extended Continental Shelf Commonwealth Marine Areas. Commonwealth marine areas are Matters of National Environmental Significance under the EPBC Act.

### 8.3.10 Threatened Ecological Communities

One Threatened Ecological Community, the Monsoon Vine Thicket on the Coastal Sand Dunes of Dampier Peninsula (432 km from *Montara*), was identified by the PMST search. It represents the most southern occurrences of rainforest type vegetation in WA and is of cultural significance. It is listed as Endangered under the EPBC Act and described in the Approved Conservation Advice for the Monsoon Vine Thickets on the coastal sand dunes of Dampier Peninsula. (DSEWPaC 2013). This community is also subject to the Threat Abatement Plan for Disease in Natural Ecosystems Caused by *Phytophthora cinnamomic* (DoE 2014c).

### 8.3.11 Listed Threatened and Migratory Species

The PMST search identified 104 Listed Threatened Species (LTS) and 94 Listed Migratory Species (LMS) as having the potential to occur within the EMBA. Sensitive habitat areas such as an aggregation, resting or feeding or known migratory routes for these species are shown as Biologically Important Areas (BIAs). Relevant management plans (e.g. recovery plans, Threat abatement plans) are also summarised below.

#### 8.3.11.1 Marine Mammals

**Blue Whale (*Balaenoptera musculus)* (Endangered/Migratory):** Blue whales are widely distributed throughout the worlds' oceans. The subspecies pygmy blue whales can be found north of 55° S, making it likely that any blue whales frequenting the waters of the Operational Area would be pygmy blue whales. Pygmy Blue whales appear to migrate south from Indonesian waters passing Exmouth through November to late December. Observations suggest most Pygmy Blue whales pass along the shelf edge out to water depths of 1,000 m. The northern migration passes Exmouth from April to August (McCauley and Jenner 2010). They are believed to calve in tropical waters in winter and births peak in May to June (Bannister et al. 1996).

The Operational Area does not include any recognised blue whale migratory routes or known feeding, breeding or resting areas. Low numbers migrating to and from Indonesian waters may occasionally pass through the Operational Area, most likely during the southern migration (October to November) (DoEE 2017b). The EMBA overlaps with the pygmy blue whale migratory route BIA off the Kimberley Coast. Blue whale activities occurring within the area of the BIA that overlap with the EMBA include migration, foraging, and 'distribution'.

**Humpback Whale (*Megaptera novaeangliae*) (Vulnerable/Migratory):** Humpback whales have been recorded from the coastal areas off all Australian states other than the Northern Territory. Humpback whales migrate north and south along the eastern and western coasts of Australia from calving grounds in the tropical north to feeding grounds in the Southern Ocean. Peak migration off the NW coast of Australia occurs from late July to early September. From June to mid-September, the inshore waters (landward of the 100 m isobath) between the Lacepede Islands and Camden Sound (~400 km from the Operational Area) are used as a calving area (Jenner et al. 2001).

The Operational Area is located outside of the recognised humpback whale migratory routes, which are usually within 30 km of the coastline. The EMBA overlaps with the humpback whale BIA identified for breeding and calving at Camden Sound Marine Park, adjacent to the Kimberley coast. As the Operational Area lies north of the northernmost point of the humpback whale migration, it is considered unlikely the species will be encountered. Individuals may be encountered within the wider EMBA.

**Sei Whale (*Balaenoptera borealis*) (Vulnerable/Migratory):** Sei whales are found in the waters off all Australian states (DoEE 2017b). The Australian Antarctic waters and Bonney Upwelling off South Australia are important feeding grounds, as are temperate, cool waters. Breeding is known to occur in tropical and subtropical waters. Currently, the movements and distributions of sei whales are not well documented. However, information suggests that sei whales have the same general pattern of migration as most other baleen whales, although timing is later in the season and such, high latitudes are not reached. Sei whales may be encountered in low numbers in the Operational Area. Individuals of the species may be encountered within the EMBA, although large numbers are unlikely.

**Fin Whale (*Balaenoptera physalus*) (Vulnerable/Migratory):** Fin Whales are found in the waters all around Australia and the Australia Antarctic Territory with Antarctic waters and Bonney Upwelling thought to be important feeding grounds. No known mating or calving areas are known in Australian waters. Currently, the migration routes and locations of winter breeding grounds for this species are uncertain (DoEE 2017b). Based on the cosmopolitan distribution of the species, fin whales may be encountered in low numbers within the Operational Area. Individuals of the species may be encountered within the EMBA, although large numbers are unlikely.

**Bryde's Whale (*Balaenoptera edeni*) (Migratory):** Bryde's Whales are found in the waters of all Australian states, including Christmas and the Cocos Islands (DoEE 2017b). Two forms of Bryde's whale are known: the coastal and offshore form. The coastal from appears to be limited to habitat within the 200 m depth isobar, moving along the coast in response to availability of suitable prey; the offshore form is known in deeper water (500 m to 1,000 m). Ambient noise monitoring by JASCO (2012) in the Southern, Cash-Maple and Oliver permits over 12-months, recorded whale calls attributed to Bryde's whales year-round at all three permits, with no seasonal cycle observed, suggesting individuals may occur within the Operational Area and are likely to occur in the EMBA.

**Orca/Killer Whale (*Orcinus orca*) (Migratory):** Orcas are a cosmopolitan species, found in the waters off all Australian states in oceanic, pelagic and neritic regions, in both warm and cold waters (DoEE 2017b). They likely follow regular migratory routes; however, little is known about either local or seasonal movement patterns of the species. Given the lack of known migration routes or areas of significance within the region, the species is not expected to be encountered in either the Operational Area or EMBA in significant numbers.

**Spotted Bottlenose Dolphin (*Tursiops aduncus*) (Migratory):** The spotted bottlenose dolphin is generally considered to be a warm water subspecies of the common bottlenose dolphin (Tursiops truncates) and known to exist in waters off all Australian states. The spotted bottlenose dolphin appears to be restricted to inshore areas such as bays and estuaries, nearshore waters, open coast environments, and shallow offshore waters including coastal areas around oceanic islands (DoEE 2017b). Due to the distance from the coast and deeper waters of the Operational Area, spotted bottlenose dolphins are not expected to occur, particularly given the preference for shallower, coastal waters. Given their cosmopolitan distribution, the species may be encountered within the EMBA.

#### 8.3.11.2 Marine reptiles

The EPBC Act Protected Matters database identified six species of marine reptiles (turtles) that may occur in or have habitat within the EMBA. The EMBA intersects with several BIAs as described below.

**Green Turtle (Vulnerable/Migratory):** The closest known significant breeding/nesting grounds to the Operational Area are the Ashmore Reef and Cartier Island CMRs ~125 and 84 km to the northwest of the Operational Area, respectively. In WA, the major nesting sites include the Dampier Archipelago, along the Ningaloo and Jurabi Coasts, Thevenard Island and the Barrow-Lowendal-Montebello island complex (DoEE 2017b). Green turtles migrate between breeding grounds and feeding grounds off the northwest coast, but due to the water depths the area does not provide foraging habitat.

The EMBA intersects green turtle BIAs at Scott, Ashmore and Cartier Reefs, in the Joseph Bonaparte Gulf, and around Melville Island, with the areas used for foraging, inter-nesting, and nesting. November through to February appears the preferred nesting period. Green turtles may feed around Barracouta Shoal based on the proximity of the shoal to Cartier Island.

**Flatback Turtle (*Natator depressus*) (Vulnerable/Migratory):** The flatback turtle is found in the tropical waters of northern Australia, Papua New Guinea and Irian Jaya. It is the most widely distributed nesting marine turtle species in the Northern Territory (Chatto and Baker 2008), also nesting in the Kimberley Region of WA (Cape Dommett, (Bowlay and Whiting 2007) and Lacrosse Island). The closest nesting sites to the Operational Area are approximately 500 km away (Lacepede Islands).

While flatback turtles make lengthy reproductive migrations (Limpus et al. 1983), movements are generally restricted to the continental shelf (DoEE 2017b). Flatback turtles nesting within the Pilbara region migrate to their foraging grounds in the Kimberley region along the continental shelf at the end of the nesting season. Due to their migrations between the Pilbara and the Kimberley regions of WA, individual flatback turtles may transit the Operational Area during migration, but given the distance from known aggregation areas, it is unlikely that significant numbers of flatback turtles will be encountered. Due to the water depths, the area does not provide foraging habitat.

The species will also be present in the wider EMBA. The EMBA intersects foraging BIAs at the Sahul Shelf off the WA coast and inter-nesting BIA in the coastal waters off Arnhem Land in the Northern Territory.

**Hawksbill Turtle (*Eretmochelys imbricata*) (Vulnerable/Migratory):** Hawksbill turtles are found in tropical, subtropical and temperate waters in all oceans of the world. There are no known nesting or breeding areas in or near to the Operational Area. In WA, the Dampier Archipelago is an important part of their migration route, as is Scott Reef and the Joseph Bonaparte Gulf. Hawksbill turtle nest year-round in WA, peaking in October and January (DoEE 2017b). In WA, the major nesting sites include the Dampier Archipelago, along the Ningaloo and Jurabi Coasts, Thevenard Island and the Barrow-Lowendal-Montebello island complex. In the NT, nesting occurs at Coburg Peninsula and between Nhulunbuy and northern Blue Mud Bay (East Arnhem Land) (DoEE 2017b). Hawksbill turtles are also feed all year off Ashmore Reef and Cartier Island. Due to the distance from nesting sites and the lack of foraging habitats in the Operational Area, only low numbers are expected in transit from WA to the NT.

The EMBA intersects with hawksbill turtle BIAs at Scott Reef, Ashmore Reef and Cartier Island, and in the coastal waters off Arnhem Land in the Northern Territory.

**Leatherback Turtle (*Dermochelys coriacea*) (Endangered/Migratory):** The Leatherback turtle has the widest distribution of any marine turtle, and can be found in tropical, subtropical and temperate waters throughout the world (Marquez 1990). No major centres of nesting activity have been recorded in Australia, but scattered isolated nesting occurs in southern Queensland and Northern Territory (Limpus and McLachlin 1994). As such, it is expected that very few leatherback turtles will be encountered in the Operational Area. The species is likely to be present within the wider EMBA. The EMBA intersects with one leatherback turtle BIA, an internesting area, in the waters off Arnhem Land in NT waters.

**Loggerhead Turtle (*Caretta caretta*) (Endangered/Migratory):** The loggerhead turtle has a global distribution throughout tropical, sub-tropical and temperate waters. The closest known breeding/ nesting grounds are Muiron Island and Northwest Cape (Baldwin et al. 2003), > 1,500 km south-west of the Operational Area and outside the EMBA. Loggerhead turtles have been recorded in the reserves of Ashmore Reef (125 km) and Cartier Island (84 km) (Guinea 1995). They are unlikely to be encountered in the Operational Area in significant numbers, but is likely to be present in limited numbers within the wider EMBA. The EMBA intersects with one foraging BIA on the Sahul Bank off the Northern Territory.

**Olive Ridley Turtle (Lepidochelys *olivacea*) (Endangered/Migratory):** The Olive Ridley turtle has a circum-tropical distribution, with nesting occurring throughout tropical waters. No concentrated nesting has been found in Australia, although low density nesting occurs along the Arnhem Land coast of the Northern Territory (Chatto and Baker 2008). Therefore, Olive Ridley turtles are unlikely to be encountered within the Operational Area in significant numbers. This species may be encountered, in limited numbers within the wider EMBA which intersects several BIAs (foraging and internesting areas) off the Sahul Bank in the Joseph Bonaparte Gulf, and in NT waters near the Arnhem Land coast.

### 8.3.12 Sea snakes

**Short-nosed Seasnake (critically endangered)**

*Aipysurus apraefrontalis* is endemic to WA. It has been recorded from Exmouth Gulf, WA to the reefs of the Sahul Shelf, in the eastern Indian Ocean. This species has shown strong site fidelity to shallow coral reef habitats in less than 10 m of water, with most specimens collected from Ashmore and Hibernia reefs (Minton & Heatwole 1975, Guinea and Whiting 2005). Given reports that very few short-nosed seasnakes moved even as far as 50 m away from the reef flat (McCosker 1975, Cogger 2000), they are therefore unlikely to be expected in high numbers in offshore, deeper waters**.**

**Leaf-scaled Seasnake (critically endangered)**

The leaf-scaled seasnake, *Aprasia rostrate rostrata* occurs in shallow water <10 m depth, in the protected parts of the reef flat, adjacent to living coral and on coral substrates. The species is found only on the reefs of the Sahul Shelf in WA, especially on Ashmore and Hibernia Reefs (Minton and Heatwole 1975). They forage by searching in fish burrows on the reef flat and are unlikely to be present in high numbers in offshore, deeper waters.

### 8.3.13 Fish, Sharks and Rays

**Whale Shark (Vulnerable/Migratory)**

Whale sharks (*Rhincodon typus*) have a broad distribution in tropical and warm temperate seas. It is highly migratory and only visits Australian waters seasonally, aggregating at Ningaloo Reef ~1,500 km from the Operational Area between May and June, and in the Queensland Coral Sea ~ 2,400 km east of the Operational Area between November and December (DoEE 2017b). Neither location is within the EMBA. The whale shark foraging BIA intersects the EMBA.

**Great White Shark (Vulnerable/Migratory)**

The Great White Shark (*Carcharodon carcharias*) is widely, but sparsely, distributed in all seas. The species is known to undertake migrations along the WA coast, with individuals occasionally travelling as far north as North West Cape during spring, before returning south for summer (DoEE 2017b). Given a preference for cooler, southern waters inhabited by seals and sea lions, great white sharks are considered unlikely to be encountered in either the Operational Area or EMBA. No great white shark BIAs are intersected by the EMBA.

**Northern River Shark (Endangered)**

The Northern River Shark (*Glyphis garricki*) is known to inhabit rivers, tidal sections of large tropical estuarine systems, macrotidal embayments, as well as inshore and offshore marine habitats, although adults have only been recorded in marine environments (DoEE 2017b). Limited data suggests that the species displays a preference for highly turbid, tidally influenced waters with fine muddy substrate.

However, the presence of individuals in offshore areas suggests that northern river sharks undertake movements away from rivers and estuaries and are therefore likely to move between river systems (DoEE 2017b). Given the species' preference for turbid, inshore waters, it is likely that the species will be encountered in the EMBA.

**Grey Nurse Shark (vulnerable)**

The grey nurse shark (*Carcharias taurus*) is now restricted to two populations, one on the east coast from southern Queensland to southern NSW and the other predominantly around the southwest coast of WA but has been recorded on the NWS Shelf (DoEE 2014d, Pogonoski et al. 2002). It is believed that the east and west coast populations do not interact. The status of the west coast population is poorly understood; but they are reported to be widely distributed along the WA coast and are still regularly encountered albeit with low and indeterminate frequency. Grey nurse sharks are often observed just above the seabed, in or near deep sandy-bottomed gutters or rocky caves, and in the vicinity of inshore rocky reefs and islands at varying depths, generally 15–40 m. They have also been recorded in the surf zone, around coral reefs, and to depths of ~ 200 m on the continental shelf (Pollard et al. 1996).

**Dwarf Sawfish (Vulnerable/Migratory)**

The dwarf sawfish (*Pristis clavata*) is thought to be restricted to Australia (DoEE 2017b) and is listed as a Priority 1 conservation species in WA. The Australian distribution of the dwarf sawfish is considered to extend across northern Australia and along the Kimberley and Pilbara coasts (Last and Stevens 2009, Stevens *et al.* 2005). However, the majority of records of dwarf sawfish in WA have come from shallow estuarine waters of the Kimberley region which are believed to be nursery (pupping) areas, with immature juveniles remaining till three years of age. Adults are known to seasonally migrate back into inshore waters; buy it is unclear how far offshore the adults travel as captures in offshore surveys are very uncommon. The species range is restricted to brackish and saltwater (Thorburn *et al.* 2007).

The Recovery Plan identifies pupping as known to occur in the King Sound, the Cambridge Gulf and 80 Mile Beach, with pupping likely to occur at a number of locations along the Pilbara and Kimberly Plan. Under the associated recovery plan, all areas where aggregations of individuals have been recorded displaying biologically important behaviours such as breeding, foraging, resting or migrating are considered critical to the survival of the species unless population data suggests otherwise.

**Freshwater/Largetooth Sawfish (Vulnerable/Migratory)**

The freshwater, or largetooth, sawfish (*Pristis pristis*) occurs in large rivers of northern Australia from the Fitzroy River, WA, to Cape York Peninsula, Queensland. In northern Australia, this species is thought to be confined to freshwater drainages and the upper reaches of estuaries yet is occasionally found as far as 400 km inland. Few records exist of adults at sea, occurring mostly in fresh or weakly saline water (DoEE 2017b). Given the species' known distribution, individuals are likely to be found within the EMBA.

**Green Sawfish (Vulnerable/Migratory)**

Green sawfishes (*Pristis zijsron*) inhabit the coastal waters from Broome, WA to Jervis Bay, NSW. This species inhabits muddy bottom habitats and enters estuaries, inshore marine waters, estuaries, river mouths, embankments and along sandy and muddy beaches, usually in shallow waters (DoEE 2017b). Based on the known distribution of the species, individuals are known to exist within the EMBA.

**Shortfin and Longfin Mako Sharks (Migratory)**

The shortfin mako (*Isurus oxyrinchus*) and the longfin mako (*Isurus paucus*) are both offshore epipelagic species found in tropical and warm-temperate waters (DoEE 2017b). Both species occur in Australia in coastal waters off WA, NT, QLD and NSW at depths ranging from shallow coastal waters to at least 500 m. These species may be found within the wider EMBA.

**Reef Manta Ray (Migratory)**

The reef manta ray (*Manta alfredi*) is commonly sighted inshore, but also found around offshore coral reefs, rocky reefs and seamounts, tending to inhabit warm tropical or sub-tropical waters. Long-term sighting records at established aggregation sites suggest reef manta are more resident to tropical waters and may exhibit smaller home ranges, philopatric movement patterns and shorter seasonal migrations than the giant manta ray (Marshall et al. 2011a). Given the EMBA overlaps with a number of coral and rocky reefs in the region, it is possible the species may be encountered within the EMBA.

**Giant Manta Ray (Migratory)**

The giant manta ray (*Manta birostris*) inhabits tropical, marine waters worldwide. In Australia, the species is recorded from south-western WA, around the north coast to the southern coast of NSW. The species is commonly sighted along productive coastlines with regular upwelling, oceanic island groups, offshore pinnacles and seamounts. Nearer to shore, the giant manta ray is commonly seen on shallow reefs being cleaned or feeding at the surface inshore and offshore. It is also occasionally observed in sandy bottom areas and seagrass beds. Given the EMBA overlaps with a number of coral and rocky reefs in the region, it is possible that the species may be present in the EMBA.

**Narrow Sawfish (Migratory)**

Based on the species' habitat preference it is highly unlikely to be found within the Operational Area, although may be encountered within certain areas of the EMBA.

**Sygnathids**

Three offshore banks assessment surveys were undertaken in the region of the Vulcan Shoal, Barracouta Shoals, Echuca Shoal, Eugene McDermott Shoal, Goeree Shoal, Heywood Shoal, Shoal 25 and Wave Governor Bank. No individuals from the Syngnathidae family were reported (Heyward et al. 2010, 2011a, 2013).

### 8.3.14 Avifauna

Numerous species of birds frequent the Timor Sea area or fly through the area on annual migrations. Seabird feeding grounds, roosting and nesting areas are found at the offshore atolls in the wider region, particularly Ashmore Reef. Many species are listed under the Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA) or Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA). Most seabirds breed at offshore sites, such as Ashmore Reef, Cartier Island and Browse Island, from mid-April to mid-May. Peak migration time of migratory shorebirds is between October and December (Clarke 2010). It is expected that some individuals of these species may pass through the EMBA during their annual migrations.

**Red Knot (Endangered/Migratory)**

The red knot species includes five subspecies, including two found in Australia; *Calidris canutus piersmai* and *Calidris canutus rogersi*. It undertakes long distance migrations from breeding grounds in Siberia in summer, to the southern hemisphere during the austral summer (Bamford et al. 2008). The species occurs in coastal wetland and intertidal sand or mudflats, where they feed on intertidal invertebrates, especially shellfish (Garnet et al. 2011). They are likely to be found in these habitats throughout the EMBA but is unlikely to occur frequently in the Operational Area, aside from individuals occasionally transiting through during migrations, due to the lack of emergent habitat.

**Australian Lesser Noddy (Vulnerable)**

The Australian lesser noddy (*Anous tenuirostris melanops*) is usually only found around its breeding islands (e.g Houtman Abrolhos Islands, Ashmore Reef, Barrow Island) (DoEE 2017b). This species may forage out at sea or close to breeding islands and fringing reefs (Johnstone and Storr 1998; Storr et al. 1986; Whittell 1942). Given the distribution of the species and the breeding population at Ashmore Reef and Cartier Island, this species occurs in the Operational Area, although likely in low numbers. Based on known distribution and the location of rookeries the species is known to occur within the EMBA.

**Curlew Sandpiper (Critically Endangered/Migratory)**

Curlew sandpipers (*Calidris ferruginea*) occur around the coasts and are also quite widespread inland. In WA, they are widespread around coastal and subcoastal plains from Cape Arid to south-west Kimberley, albeit rarely encountered in the north-west of the Kimberley region (DoEE 2017b). Given the offshore location of activities and habitat preferences, the species is unlikely to be encountered within the Operational Area other than occasional numbers during migration, although may be present within the EMBA.

**Eastern Curlew (Critically Endangered/Migratory)**

Within Australia, the eastern curlew (*Numenius madagascariensis*) have a continuous distribution from Barrow Island and Dampier Archipelago in WA, through the Kimberley, along the NT, Queensland and NSW coasts and the islands of Torres Strait. The species does not breed in Australia and is most commonly associated with sheltered coasts (TSSC 2015). Given the offshore location of activities and habitat preferences, the species is unlikely to be encountered within the Operational Area other than occasional numbers during migration but may be present within the EMBA.

**Abbott's Booby (Endangered/Migratory)**

In Australia, Abbott's booby (*Papasula abbotti*) is only found on Christmas Island, where it nests in tall rainforest trees. It is a pelagic feeding species, spending long periods at sea and often foraging hundreds of kilometres from land (Yorkston and Green 1997). Given the offshore location of activities and habitat preferences, the species is may be present foraging within the Operational Area and EMBA.

**Great Knot (Critically Endangered, Migratory)**

The great knot is a migratory shorebird with a global distribution, breeding in Siberia and spending the non-breeding season along coasts from Arabia to Australia. Nonbreeding birds migrate to inlets, bays, harbours, estuaries and lagoons with large intertidal mud and sand flats (Higgins & Davies 1996 in Garnet et al. 2011).

**Western Alaskan Bar tailed Godwit (Vulnerable) and Northern Siberian Bar tailed Godwit (Critically Endangered)**

The western Alaskan Godwit occurs largely on the north and east coasts of Australia whilst the northern Siberian subspecies occurs along the coasts of north Western Australia (DoEE 2017b). Nonbreeding birds visit coastlines, estuaries, inlets, mangrove-fringed lagoons and sheltered bays (Garnet *et al.* 2011).

**Southern Giant-Petrel (Endangered, Migratory)**

The southern giant petrel is a highly migratory bird with a large natural range, occurring from Antarctic to subtropical waters and breeds on the Antarctic continent, peninsular and islands and on subantarctic islands and South America. The National Conservation Values Atlas (DoEE 2017b) and the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC 2011) do not identify BIAs for this species within the EMBA.

**Round Island Petrel (Critically Endangered)**

In Australia, this species has only been recorded on North Keeling Island, where it may breed, the breeding season is usually between February and July (DEH, 2003). The Round Island Petrel usually only visits land to breed.

**Australian Painted Snipe (Endangered)**

The Australian painted snipe has been recorded at wetlands in all states of Australia (Lane and Rogers 2000). It generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans, waterlogged grassland or saltmarsh, dams.

**Australian Fairy Tern (Vulnerable)**

The fairy tern has a large geographic range between Australia, New Zealand and New Caledonia. One sub species occurs along the coasts of Victoria, Tasmania, SA and WA; occurring as far north as the Dampier Archipelago (DoEE 2017a). Australian fairy tern nest on sheltered sandy beaches, spits and banks above the high tide line and below vegetation. The National Conservation Values Atlas (DoEE 2017b) identifies the vicinity of the lower north-west coast (north to Dampier Archipelago) and west coast (south to Peel inlet) as BIAs for foraging. Breeding BIA were also identified scattered along the coast between Shark Bay and the Pilbara.

**Common Noddy (Migratory)**

The common noddy (*Anous stolidus*) occurs mainly in oceanic waters off the Queensland coast, but is also known from the north-west and central WA coast. The species is rarely encountered off the coast of the NT with only one listed breeding location (DoEE 2017b). During the breeding season, the species is usually seen on or near islands, rocky islets, shoals or cays. During the non-breeding period, the species occurs in groups throughout the pelagic zone. Based on the distribution and habitat preferences the species may be encountered within the Operational Area and EMBA.

**Streaked Shearwater (Migratory)**

The streaked shearwater (*Calonectris leucomelas*) is usually found over pelagic waters and is known to breed on the coast and offshore islands mainly around Japan and Korea (Ochi et al 2010). The species migrates south during winter to Australia. Streaked shearwaters are known to forage in areas of high

concentrations of subsurface predators in tropical oceans during non-breeding periods (Yamamoto et al 2010). Given the distribution of streaked shearwaters, this species may be present in the Operational Area, albeit in low numbers, and will occur within the EMBA.

**Lesser Frigatebird (Migratory)**

The lesser frigatebird (*Fregata ariel*) is considered the most common and widespread frigatebird over Australian seas, breeding on remote islands (Marchant and Higgins 1990). A BIA has been identified at Ashmore Reef and Cartier Island to highlight breeding and foraging behaviours in the area (DoEE 2017b). The Operational Area does not overlap with the BIA, but the BIA overlaps with the wider EMBA. Given its distribution and the large breeding population at nearby Ashmore Reef and Cartier Island, this species may be encountered within the Operational Area and the wider EMBA.

**Great Frigatebird (Migratory)**

Great frigatebirds (*Fregata minor*) are found in tropical waters globally. A breeding and foraging BIA has been identified at Ashmore Reef and Cartier Island. The Operational Area does not overlap with this BIA, but the EMBA does. Breeding is known to occur between May to June and in August. Given the distribution of the species and its low population in nearby Ashmore Reef and Cartier Island, this species may be present in the Operational Area in low numbers and will be present within the EMBA.

**Common Sandpiper (Migratory)**

The common sandpiper (*Actitis hypoleucos*) is a small, migratory species with a very large range through which it undertakes annual migrations between breeding grounds in the northern hemisphere and non-breeding areas in the Asia-Pacific region (Bamford et al. 2008. The species congregates in large flocks and forages in shallow waters and tidal flats between spring and autumn. Specific critical habitat in Australia has not been identified due to the species' broad distribution. The common sandpiper may be present in coastal wetland and intertidal sand or mudflats throughout the wider EMBA, but is unlikely to occur in the Operational Area, aside from individuals occasionally transiting through during migrations, due to the lack of emergent habitat.

**Sharp-tailed Sandpiper (Migratory)**

The sharp-tailed sandpiper (*Calidris acuminata*) is a migratory wading shorebird, undertaking long distance seasonal migrations between breeding grounds in the northern hemisphere and over-wintering areas in the southern hemisphere (Bamford et al. 2008). The species may occur in Australian between spring and autumn. The species is unlikely to occur within the Operational Area due to the lack of suitable habitat but may occur seasonally in coastal wetland and intertidal sand or mudflats throughout the wider EMBA.

**Pectoral Sandpiper (Migratory)**

The pectoral sandpiper (*Calidris melanotos*) breeds in the northern hemisphere during summer, before migrating to feeding grounds in the southern hemisphere (Bamford et al. 2008). The species occurs throughout mainland Australia between spring and autumn, preferring coastal and near-coastal environments (wetlands, estuaries, mudflats). Given the species' preferred habitat the pectoral sand piper is not expected to occur within the Operational Area but is expected to occur in suitable habitats within the wider EMBA.

## 8.4 Australian Marine Parks

Fourteen Australian Marine Parks (AMPs) lie in or border on the EMBA but none intersect the Operational Area:

- Cartier Island AMP
- Kimberley AMP
- Ashmore Reef AMP
- Oceanic Shoals AMP
- Joseph Bonaparte Gulf AMP
- Argo-Rowley Terrace AMP
- Roebuck AMP
- Mermaid Reef AMP
- Eighty Mile Beach AMP
- Arafura AMP
- Arnhem AMP
- Dampier AMP
- Montebello AMP
- Wessel AMP

## 8.5 Key Ecological Features

The KEFs that intersect the EMBA are described in Table 6.

**Table 6 Description of Key Ecological Features within the EMBA**

| **Key Ecological Feature, Distance from *Montara*** | **Description and Values** |
|---|---|
| Continental Slope Demersal Fish Communities - 82 km | High degree of endemism as the diversity of demersal fish assemblages is high compared to elsewhere along the continental slope |
| Ashmore Reef and Cartier Island and Surrounding Commonwealth Waters – 84 km | Regionally important for feeding and breeding aggregations of birds and other marine life<br>Areas of enhanced primary productivity in an otherwise low-nutrient environment<br>Supports the highest number of coral species of any reef off the WA coast |
| Seringapatam Reef and Commonwealth Waters in the Scott Reef Complex - 279 km | Coral communities occur across shallow (<30 m) and deep (>30 m) habitats<br>306 hard coral species from 60 genera and 14 families identified<br>Coral species diversity comparable to other reefs in region e.g. Ashmore, Seringapatam<br>Green turtle nesting at Sandy Islet<br>Shallow atoll reef forms an intertidal platform at low tide<br>High primary productivity relative to other parts of the region and coral communities are largely self-seeded and rely on the reproductive output of resident corals<br>Relatively pristine, high species richness which applies to both the benthic and pelagic habitats, attracting aggregations of marine life including whale and dolphin species |
| Canyons Linking the Argo Abyssal Plain with | Scott Plateau connects with the Argo Abyssal Plain via a series of canyons. Canyons may be linked to small, periodic upwellings - enhance biological productivity that |

| Key Ecological Feature, Distance from *Montara* | Description and Values |
|---|---|
| the Scott Plateau - 540 km | support important demersal communities. Canyons likely to be important features due to their historical association with sperm whale, Scott Plateau may be a breeding ground for sperm and beaked whales<br><br>High productivity of the region |
| Mermaid Reef and Commonwealth Waters Surrounding Rowley Shoals - 700 km | The Rowley Shoals comprise 3 atoll reefs—Clerke, Imperieuse and Mermaid reef (29 km north of Clerke and Imperieuse reefs and is totally submerged at high tide)<br><br>Regionally important in supporting high species richness, higher productivity and aggregations of marine life. 214 coral species and approximately 530 species of fishes, 264 species of molluscs and 82 species of echinoderms. |
| Pinnacles of Bonaparte Basin - 284 km | The Pinnacles rise steeply from depths of ~80 m to within 30 m of the water surface. Supported communities include sessile benthic invertebrates, including hard and soft corals, sponges, whips, fans, bryozoans and aggregations of demersal fish species (e.g. snappers, emperors)<br><br>Recognised as a unique seafloor feature and a biodiversity hotspot for sponges |
| Ancient Coastline at 125 m Depth Contour - 57 km | A unique seafloor feature with ecological properties of regional significance<br><br>Migratory pelagic species (e.g. humpback whales, whale sharks) may use this escarpment as a guide<br><br>The topographic complexity of escarpments associated with this feature may facilitate vertical mixing of the water column, providing nutrient-rich localised environments |
| Carbonate Bank and Terrace System of the Sahul Shelf - 46 km | Regionally important - likely ecological role in enhancing biodiversity and local productivity relative to its surrounds<br><br>Forms a unique seafloor feature; banks that rise to at least 45 m and to within 30 m water depth, allow light dependent organisms to thrive and support more biodiversity<br><br>Supports a high diversity of organisms including reef fish, sponges, soft and hard corals, gorgonians, bryozoans, ascidians and other sessile filter feeders<br><br>Known to be foraging areas for loggerhead, olive ridley and flatback turtles<br><br>Cetaceans and green and largetooth sawfish are likely to occur in the area |
| Shelf Break and Slope of the Arafura Shelf - 578 km | Situated in a major biogeographic crossroad where biota is largely affiliated with the Timor–Indonesian–Malay region<br><br>Area is characterised by continental slope, patch reefs and hard substrate pinnacles |
| Carbonate Bank and Terrace System of the Van Diemen Rise - 408 km | Unique seafloor feature with ecological properties of regional significance<br><br>While reef-forming corals are sparse throughout the region, some locally dense hard corals can be found on the banks of the Van Diemen Rise. These include near threatened, vulnerable and endangered species on the IUCN Red List. Coral communities on the Van Diemen rise are believed to be genetically distinct from those elsewhere in northern Australia.<br><br>Pelagic fish such as mackerel, red snapper and a distinct gene pool of gold band snapper are also found on the Van Diemen rise |
| Exmouth Plateau - 1,302 km | Unique seafloor feature with ecological properties of regional significance<br><br>Serves an important ecological role by acting as a topographic obstacle that modifies the flow of deep waters that generate internal tides, causing upwelling of deeper water nutrients closer to the surface (water depths range from 800 to 4,000 m) |

| Key Ecological Feature, Distance from *Montara* | Description and Values |
|---|---|
| | Sediments on the plateau suggest that biological communities include scavengers, benthic filter feeders and epifauna<br><br>Whaling records suggest the Plateau may have supported large sperm whales populations. Fauna in the pelagic waters above the plateau are likely to include small pelagic species and nekton |
| Tributary Canyons of the Arafura Depression - 964 km | High productivity, high levels of endemism and biodiversity<br><br>The canyons are approximately 80–100 m deep and 20 km wide.<br><br>Primary productivity likely to be associated with movements of water through the canyons and surface water circulation driven by seasonal monsoon winds<br><br>The steep topography of the canyons, their diverse current regimes, nutrient enrichment and entrapment, detritus funnelling and diverse substrate types form widely divergent ecosystems which, in combination with the regional setting and geological origins of the area, strongly influence species biodiversity. |
| Glomar Shoals - 1,118 km | Submerged feature at a depth of 33–77 m, ~ 150 km north of Dampier<br><br>Consist of a high percentage of marine-derived sediments with high carbonate content and gravels of weathered coralline algae and shells<br><br>The area's higher concentrations of coarse material compared to surrounding areas are indicative of a high energy environment subject to strong seafloor currents<br><br>Biological communities have not been comprehensively studied but known to be an important area for several commercial and recreational fish species<br><br>Regionally important - potentially high biological diversity and localised productivity<br><br>Biological data specific to the Glomar Shoals is limited, however the fish of the shoals are probably a subset of reef-dependent species and anecdotal evidence suggests they are particularly abundant |
| Gulf of Carpenteria Basin - 1,343 km | Regarded as one of the few remaining near-pristine marine environments in the world<br><br>Primary productivity in the gulf's basin is mainly driven by cyanobacteria that fix nitrogen but is also strongly influenced by seasonal processes<br><br>Soft sediments characterised by moderately abundant, diverse communities of infauna and mobile epifauna (polychaetes, crustaceans, molluscs and echinoderms)<br><br>Supports pelagic fish species and top predators such as shark, snapper, tuna and mackerel, important migratory route for seabirds, shore birds and marine turtles |

## 8.6 Social Values

### 8.6.1 Commercial Fishing

Several fisheries are licensed to operate within the EMBA (noting that some may not currently operate, or target species may not exist within the EMBA, but state-wide licensing extends the licence area to overlap the EMBA). In addition to the fisheries listed in Table 7, other fisheries in the EMBA are listed below.

| Commonwealth |
|---|

| | | |
|---|---|---|
| Christmas Island and Cocos (Keeling) Island fisheries | Northern Prawn Fishery | North-West Slope Trawl Fishery |
| **Western Australia** | | |
| Abalone Area 4 and 8 | Beche de Mer | Kimberley Developing Mud Crab |
| Broome Prawn Managed Fishery | Onslow Prawn | Nickol Bay Prawn |
| West Coast Deep Sea Crustacea | Kimberley Gillnet & Barramundi | WA North Coast Shark Fishery |
| Mackerel Managed Fishery Area 2 | Pilbara Line | Pilbara Trawl |
| Northern Demersal Scalefish Managed Fishery (Area 1) | Marine Aquarium Fish Managed Fishery | Pearl Oyster Managed Fishery (Zone 4) |
| Trochus | Pilbara Trap | |
| **Northern Territory** | | |
| Off-shore Net and Lines Fisheries | Pearl Oyster Fishery | Spanish Mackerel Fishery |
| Trepang Fishery | Mud Crab Fishery | Demersal Fishery |
| Coastal Net Fishery | Aquarium Fishery | Mollusc Fishery |
| Barramundi Fishery | Timor Reef Fishery | Coastal Line Fishery |
| Bait Net Fishery | | |

A number of fisheries are permitted to operate in the Operational Area, but it is either not an appropriate area for the collection method/gear or habitat for the species targeted. Table 7 identifies the Commonwealth, State and Territory fisheries that overlap the Operational Area.

**Table 7 State and Commonwealth commercial fisheries within the Operational Area**

| Value/Sensitivity | Description |
|---|---|
| **Commonwealth Managed Fisheries** | |
| Western Tuna and Billfish Fishery | • Targetsbigeye tuna (*Thunnus obesus*), yellowfin tuna (*Thunnus albacares*), broadbill swordfish (*Xiphias gladius*) and striped marlin (*Tetrapturus audax*).<br>• The fishery targets areas of reef which are present within the EMBA. |
| Southern Bluefin Tuna | • No fishing within Operational Area but spawning grounds/migration route of Southern Bluefin Tuna overlaps with Operational Area. |
| Western Skipjack Tuna Fishery | • Not currently operational |
| **State and Territory Managed Fisheries** | |
| Mackerel Managed Fishery (WA) | • Near-surface trolling gear from vessels in coastal areas around reefs, shoals and headlands.<br>• Targets a range of tropical and temperate pelagic species, including Spanish mackerel (*Scomberomorus commerson*) and grey mackerel (*Scomberomorus semifasciatus*). |
| Northern Demersal Scalefish Managed Fishery (WA) | • Since 2002 a trapped based fishery (7 vessels in 2016/2017).<br>• The NDSMF principally targets the higher-value species such as the goldband snapper and red emperor resulting in an economic value of $5-10 million. |

| Value/Sensitivity | Description |
|---|---|
| | • High local social amenity value and a key target of charter operations.<br>• Isolated geographic location limits interaction and no disruption to fishing activities would be expected.<br>• Less than 3 vessels a year have returned catch from the Operations Area or its immediate vicinity (2015 – 2017). Catch data is confidential. |
| Northern Shark Fishery (NSF) Joint Managed Fishery Area | • Comprises the State-managed WA North Coast Shark Fishery (Pilbara, western Kimberley) and the Joint Authority Northern Shark Fishery (eastern Kimberley)<br>• No activity has been recorded in this fishery since 2009 |
| Pearl Oyster | • Licenced but water depth at Operational Area too deep for collection method |
| Kimberley Prawn | • Licenced but habitat and water depth unsuitable |
| Specimen Shell | • Licenced but water depth at Operational Area too deep for collection method unless ROV used (given remoteness of site this is unlikely) |

### 8.6.2 Recreational and Charter Fishing

Recreational fishing is popular in the Kimberley region, but effort is concentrated around regional centres due to the remoteness. Transiting recreational vessels passing through the EMBA often undertake recreational fishing activities. A small group of recreational fishing and charter vessels occasionally visit the Ashmore Reef and surrounds and other reefs within the EMBA.

### 8.6.3 Customary

Customary fishing occurs in the Dambimangari IPA, Djelk IPA and Uunguu IPA for personal, domestic, ceremonial, educational or non-commercial needs.

### 8.6.4 International Subsistence

Fisheries form a significant socio-economic sector in Indonesia. As in Timor-Leste, the vast majority of fishery production (up to 95%) comes from artisanal fishing practices (FAO 2017). The fisheries management area 573 (South of Java – East Nusa Tenggara), encompasses the Lesser Sunda Ecoregion and is a particularly productive area with a variety of target demersal and pelagic fisheries. Many of these fisheries are under pressure from overexploitation, unsustainable fishing practices, under regulation and poor management/monitoring, nevertheless they significantly contribute to the economy and social fabric within coastal communities in the region (FAO 2009).

Coral reefs are vital sources of food and income for coastal communities; more than one-third of the Indonesians living in coastal areas depend on nearshore fisheries for livelihood (Hughes et al. 2012).

### 8.6.5 Aquaculture

Aquaculture in the region is undertaken within estuarine and marine waters focusing on a variety of species, including prawns, fish and seaweed and methods. Trochus at Cape Leveque and Barramundi at Cone Bay are two larger scale operations along the Australian coastline within the EMBA. In Indonesia and Timor Leste, aquaculture activities often contribute significantly to local employment and food production within the region (Hughes et al. 2012).

### 8.6.6 Shipping and vessel movements

Heavy vessels following the charted Osborn Passage will pass through both permits to the north of the *Montara* Venture FPSO. The area may also be utilised by support vessels from oil and gas operations in the Timor Sea Area. Occasional interaction with Australian Commercial Fishing vessels, illegal foreign fishing vessels or other illegal vessels is also possible.

### 8.6.7 Defence

The two closest defence training areas to the Operations Area are the North Australian Exercise Area (~ 370 km to the east) and the Curtin Air-to-Air Air Weapons Range (~ 280 km south west). Defence estate also exists along the Kimberley shoreline.

### 8.6.8 Oil and Gas Industry

Numerous oil and gas exploration and production operators are in the region, the closest to the Operational Area being Shell's Auriga West 1 (34 km) and PTTEP's Maple wells (59km) (Table 8).

**Table 8 Titleholders in vicinity of EMBA**

| Titleholder | Titleholder |
|---|---|
| Bounty Oil & Gas NL | Octanex Bonaparte Pty Ltd |
| Carnarvon Petroleum Limited | Santos Limited |
| Cornea Resources Pty Ltd | SGH Energy Pty Ltd |
| ConocoPhillips Pty Ltd | Shell Australia |
| Eni Australia Limited | Sinopec O&G Pty Ltd |
| Finder Exploration Pty Ltd | Timor Sea Oil & Gas Australia Pty Ltd |
| INPEX | Total E&P Australia Exploration Pty Ltd |
| IPB Petroleum Limited | Vulcan Exploration Pty Ltd |
| Murphy Australia Pty Ltd | |

### 8.6.9 Tourism

The remoteness and water depth of the Operational Area makes it is not likely to be accessed for tourism activities which tend to be focussed around nearshore waters, islands, coastal areas, and nearby islands and reefs (e.g. Scott Reef, Ashmore Reef). Tourism is important to the economy and livelihood of Indonesia with tourist centres in Bali, Flores, Lombok, Komodo and the Gili Islands (Hughes et al. 2012). The marine environment (beach, snorkelling, surfing, diving and fishing) within these centres are major attractions. Tourism in Timor-Leste represents a small percentage of the country's economy at present, but the Government regards growth in tourism as critical to future economic development.

### 8.6.10 Population Centres

The nearest major Australian population centres to the Operational Area are Broome and Darwin and closest coastline on the Australian mainland is the Kimberley Coast. Kupang, the capital of the Indonesian province East Nusa Tenggara, is the closest major population centre to the Operational Area (~295 km) and Suai the closest major population area in Timor-Leste.

### 8.6.11 Cultural Heritage

A search of the Department of Planning, Lands and Heritage Aboriginal Heritage Inquiry System did not identify within the Operational Area any registered Aboriginal sites, heritage sites, registered land use agreements or Native Title Determinations or historical shipwrecks (DoEE 2018). Within Australian waters and coastline that may be affected in the broader EMBA, there are many values of cultural significance, with numerous shipwrecks and heritage sites. Along the Kimberley Coast and the Northern Territory there are many Native Title Determinations and Indigenous Land Use Agreements.