Northern Endeavour FPSO Operations
Summary Environment Plan
01-HSE-PL12

Rev	Date	General Description	Prepared	Reviewed	Approved
0	22/12/16	Summary EP for NE FPSO Public	G. Pinzone	P. Shepherd	A. Gallatly
1	05/01/17	Summary Updated to incorporate Oil Spill Controls	G. Pinzone	P. Shepherd	A. Gallattly

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1 INTRODUCTION

The *Northern Endeavour* Floating Production Storage and Offloading (NE FPSO) facility has been in production since 1999. The NE FPSO is located offshore in the Timor Sea approximately 550 km west-northwest of Darwin and 250 km east-southeast of Kupang in West Timor. The NE FPSO is situated within the Scheduled Area for the Australian Commonwealth Territory of Ashmore and Cartier Islands. It produces oil from the Laminaria-Corallina fields located in petroleum production licence area AC/L5.

The NE FPSO was commissioned in November 1999 and is a purpose-built, non-propelled vessel/barge designed to extract, process, store and offload oil from the Laminaria and Corallina reservoirs. Well fluids from both fields are routed to dedicated three phase separators where oil, gas and water are separated.

The oil produced, stored and offloaded at the NE FPSO is classified a light crude oil. Crude oil produced from topsides processing is stored in 12 tanks, with a total capacity of 1.4 million barrels. Loading the crude oil tanks is a continuous process during normal operations. Produced water is treated by hydrocyclones before disposal to sea in accordance with the Oil in Water (OIW) requirements outlined in this Environment Plan (EP).

The NE FPSO is permanently moored by a Bottom Mounted Internal Turret (BMIT) mooring system that enables the FPSO to weather vane around the turret and remains on station in all weather conditions.

1.1 Purpose

This Summary EP has been prepared to comply with Regulations 11(3) and 11(4) of the Commonwealth *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (OPGGS(E)), as administered by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA). The contents of this Summary EP are consistent with NOPSEMA*'s Environment Plan Summaries Guideline* (N04750-GL1566, Revision 1, July 2016).

The purpose of the Summary EP is to demonstrate that potential adverse impacts on the environment associated with operation of the NE FPSO, during both routine and non-routine operations, are mitigated and managed to As Low As Reasonably Practicable (ALARP) and will be of an acceptable level.

1.2 Scope

This scope of this Summary EP covers the following activities associated with the NE FPSO:

- Routine production;
- Crude oil offloading activities;
- Routine inspection, maintenance and repair (IMR) of the FPSO and associated subsea infrastructure; and
- Non-routine and accidental activities and incidents associated with the above.

The infrastructure associated with these activities includes the:

- NE FPSO;
- Subsea infrastructure tied back to the NE FPSO (including wells, wellheads, manifolds, umbilicals, risers, flowlines, turret, etc.); and
- Support vessels assisting with activities defined above.

1.3 Titleholder

The NE FPSO and associated infrastructure is located in Production Licence Area AC/L5 with Timor Sea Oil and Gas Australia (TOGA) Pty Ltd (Laminaria and Corallina 100%) being the titleholder. TOGA is owned and operated by Northern Oil and Gas Australia (NOGA). NOGA on behalf of TOGA has appointed Upstream Production Solutions (UPS) as the Operator of the NE FPSO.

NOGA is an independent oil and gas production company established in 2015 and headquartered in Perth, Western Australia. NOGA's focus is to acquire and operate producing assets in the Australasian region.

Additional information about NOGA can be obtained from its website at: www.northernoil.com.au.

2 DESCRIPTION OF THE ACTIVITY

This section includes the location of the activity, general details of the layout of the NE FPSO and subsea structures, the operational details of the activity and additional information relevant to consideration of environmental risks and impacts.

2.1 Overview

The NE FPSO is a purpose-built, non-propelled vessel/barge commissioned in 1999 for the purpose of extraction, processing, storage and offloading of oil. The NE FPSO produces oil from the Laminaria and Corallina reservoirs. The development consists of subsea wells tied back to the permanently moored FPSO through a system of subsea manifolds, flowlines, umbilicals and dynamic risers. Stabilised oil is offloaded to trading tankers for export. Excess gas released during oil extraction is either re-injected back into the reservoir when possible or routed to the flare. Produced Formation Water (PFW) is treated by hydrocyclones before discharge to the ocean.

2.2 Location

The Laminaria and Corallina Fields are located in Production Licences AC/L5 and WA-18-L in Commonwealth waters in the Timor Sea. The NE FPSO and all associated field infrastructure are located exclusively in AC/L5 (Figure 2-1).

The location of the NE FPSO is approximately 550 km West North West of Darwin and 250 km East South East from Kupang in West Timor. Water depths range from approximately 350 m at Laminaria to 380 m at the NE FPSO and 410 m at Corallina. The NE FPSO and associated infrastructure are marked on nautical maps, and are surrounded and protected by a 500-m safety exclusion zone.

The NE FPSO Operational Area does not overlap with any established or proposed marine protected areas. The closest nearshore sensitive habitats to the NE FPSO are the Ashmore Reef Commonwealth Marine Reserve (CMR) 346 km to the southwest and the Cartier Island CMR approximately 333 km to the southwest. The closest offshore sensitive habitats to the NE FPSO are the submerged shoals and banks of the Sahul Shelf 11 km to the south and the Oceanic Shoals CMR approximately 94 km south.

The coordinates of the NE FPSO and associated infrastructure are presented in Table 2-1.

Table 2-1. NE FPSO and associated infrastructure locations within AC/L5

Structure	Latitude	Longitude
NE FPSO	10° 36’ 52.56”S	125° 59’ 8.18”E
Laminaria-2	10° 37’ 47.19”S	126° 2’ 30.80”E
Laminaria-4 (Suspended)	10° 37’ 29.45”S	126° 1’ 46.24”E
Laminaria-5	10° 37’ 30.71”S	126° 1’ 45.28”E
Laminaria-6 (Suspended)	10° 37’ 30.10”S	126° 1’ 44.79”E
Laminaria-7 (Suspended)	10° 37’ 32.26”S	126° 1’ 46.46”E
Laminaria-8	10° 37’ 30.86”S	126° 1’ 47.23”E
Laminaria Central manifold	10° 37' 30.06"S	126° 1' 45.75"E
Laminaria-2S manifold	10° 37’ 31.46”S	126° 1’ 46.86”E
Corallina-2	10° 35’ 28.62”S	125° 57’ 39.62”E
Corallina-3	10° 35’ 30.16”S	125° 57’ 39.22”E
Corallina manifold	10° 35' 29.36"S	125° 57' 39.39"E
Gas injection well (East Corallina)	10° 35' 25.83"S	125° 59' 16.11"E

GDA94, Map Zone 52.

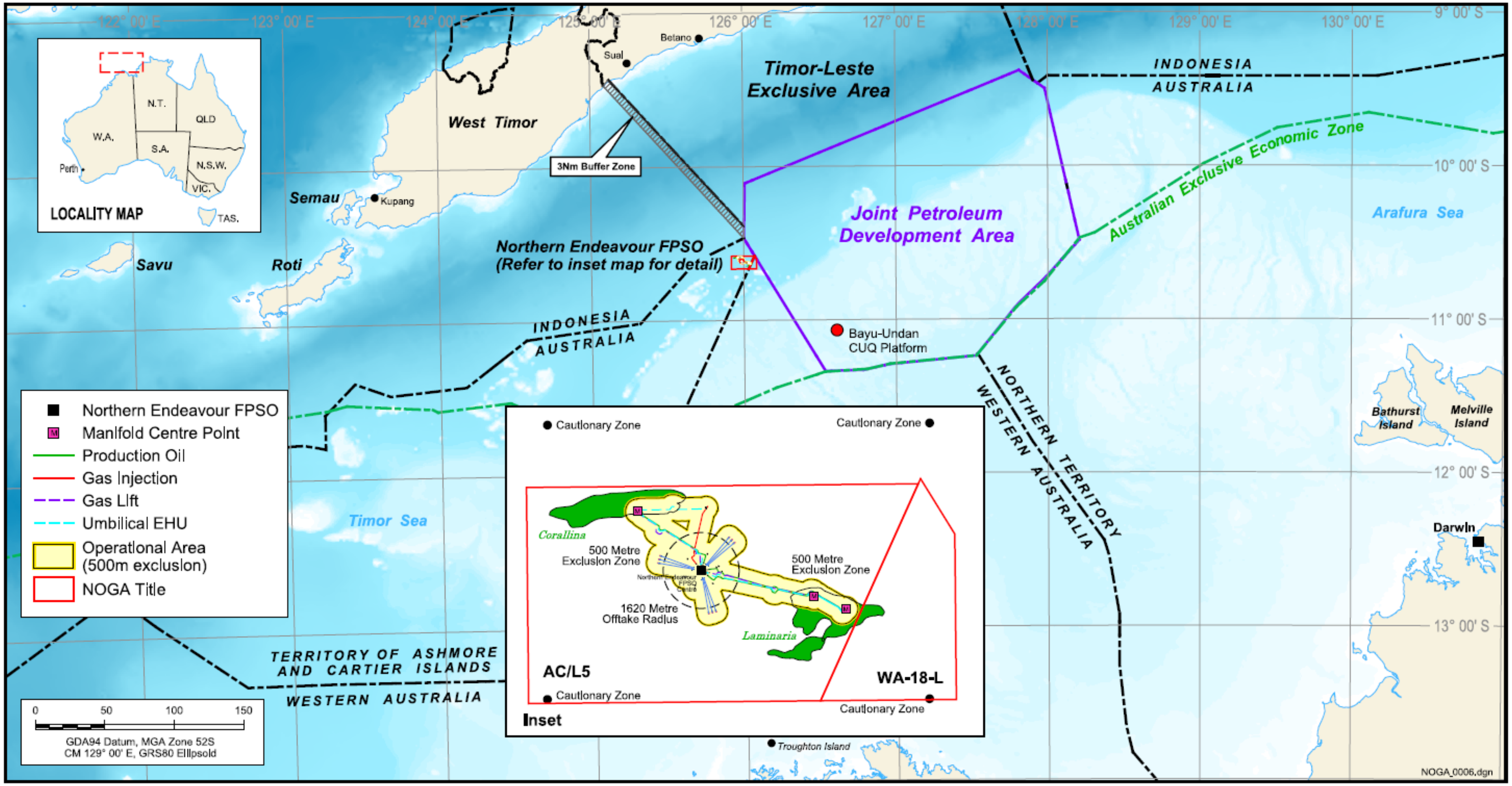

Figure 2-1: NE FPSO Operational Area

2.3 Operational Area

The Operational Area is shown in Figure 2-1. This area includes:

- The NE FPSO and the area within a 500 m exclusion zone around the facility and extending out to 1,500 m, to allow for offtake activities; and
- The NE FPSO subsea infrastructure, including wells and flowlines, and an area within 1,500 m around the infrastructure.

Vessel activities within the Operational Area are subject to the controls outlined in the EP. Vessels supporting the NE FPSO when outside the Operational Area will adhere to all applicable maritime regulations and other requirements. The EP applies to activities undertaken within the Operational Area.

2.4 Timing of the Activity

The NE FPSO operates 24 hours per day, 365 days per year. Supporting operations, subsea IMR and maintenance activities take place as required. The EP remains valid for 5 years from the date of acceptance, unless otherwise revised and resubmitted due to new or modified activities.

Any future decommissioning or tieback plans for the Laminaria and Corallina fields will be the subject of a separate EP.

2.5 Facility Layout and Description

This section provides a description of the NE FPSO and associated infrastructure as relevant to consideration of the environmental risks and impacts of the NE FPSO.

2.5.1 Topsides

The NE FPSO is a non-standard barge of double-hulled construction with an overall length of 273 m, breadth of 50 m and cargo capacity of approximately 1,400,000 bbl. The topsides processing facilities consist of oil, water and gas separation systems, and PFW and gas reinjection equipment (Figure 2-2).

The process and utility equipment on the topsides consists of 16 Pre-Assembled Units (PAUs). The PAUs are elevated above the FPSO deck, with a plated lower process deck and a combination of plated and grated upper process decks. Each PAU has its own primary structure, equipment, associated piping, valves and instrumentation. Process equipment is located towards the aft of the FPSO to provide the maximum separation from the accommodation, Primary Temporary Refuge (PTR) and Central Control Room (CCR). A number of laydown and supplies handling and storage areas are also provided.

The operation of the facility is carried out from the operator stations in the Central Control Room (CCR). The Integrated Control System (ICS) provides monitoring and control of operations over the entire facility. The ICS, field termination cabinets and unit control panels for the topside mechanical packages are located in the Central Equipment Room, one deck below the CCR. ICS components are also located in the Forward Equipment Room (FER) and the Turret Equipment Room (TER).

2.5.2 Laminaria and Corallina Reservoirs

Original oil production peaked at a combined rate of ~170,000 barrels per day (bbl/d), with respective contributions from Laminaria and Corallina of approximately 100,000 bbl/d and 70,000 bbl/d. Current rates are approximately ~3,000 bbl/d. Primary reservoir drive is provided by a strong regional aquifer. Both fields have been designed for gas lift to be provided to all wells to assist with high watercut production in later life. Corallina wells are currently unable to be gas lifted due to the failure of the Corallina gas lift riser in 2009.

At current production rates, the life of the fields is expected to be another 5 years, though with infill production drilling likely in the future, this is likely to be extended by at least 5 years.

The Laminaria Field is located in a water depth of ~350 m. The Laminaria reservoir is located at a depth of approximately 3,100 m below mean sea level. Crude oil produced from this reservoir is very light (approximately 60° API) with a high fraction of light components and a relatively low virgin gas/oil ratio (GOR).

The Corallina Field is located in a water depth of approximately 410 m. The Corallina reservoir is also located at a depth of approximately 3,100 m below mean sea level. Corallina crude oil is also very light (approximately 60º API) with a high fraction of light components. The original GOR at Corallina was also low but has increased over time due to the injection (disposal) of gas and LPGs into the Corallina aquifer. These light hydrocarbons have subsequently mixed with and created a gassier Corallina crude.

2.5.3 Well Configuration

Six subsea production wells have been drilled in the Laminaria Field and tied back to the NE FPSO. Four wells (Laminaria-2, -4, -5 and -6) are clustered around the Laminaria Central manifold approximately 5 km from the NE FPSO, while two wells (Laminaria-7 and -8) are clustered around the Laminaria-2C manifold, approximately 1 km to the south east of the central manifold. Only one well (Laminaria-8) is currently producing.

Two subsea production wells (Corallina-2 and Corallina-3) were drilled in the Corallina Field and tied back to the NE FPSO. The Corallina-2 producer has subsequently been side-tracked twice into new reservoir locations. Both wells are currently producing. The production wells are clustered around the Corallina manifold, approximately 3.8 km from the NE FPSO. A gas injection well, East Corallina-1, was drilled on the east flank of the Corallina structure, approximately 3.2 km from the FPSO. The purpose of this well is to dispose of excess gas and LPG into the Corallina aquifer. This single gas reinjection well has a dedicated flexible flowline from the NE FPSO and an umbilical runs between the well and Corallina manifold.

2.5.4 Flowline and Riser System

Produced fluids are transported from the main manifolds to the NE FPSO via three 10-inch flexible flowline and riser systems. In addition, each field has a 6-inch gas lift flexible flowline and riser system. Excess gas and LPGs are transported from the FPSO to the East Corallina-1 injection well via a 6-inch gas injection flowline and riser system.

2.5.5 Subsea Infrastructure

The scope of The EP includes all subsea infrastructure associated with production from the NE FPSO. The layout of the NE FPSO subsea infrastructure is shown in Figure 2-3. The NE FPSO subsea infrastructure consists of:

- Trees/wells;
- Manifolds;
- Rigid spools;
- Electric and Hydraulic Jumpers;
- Flexible Flowlines;
- Electro – Hydraulic Umbilicals;
- Flexible Risers;
- Umbilical Termination Basket;
- Risers; and
- Turret and mooring system.

The rigid spools transport hydrocarbons from the wells to the manifolds where the fluids flow through the flexible flowlines and risers to the FPSO for processing. After topside processing the produced gas is prioritised for use as topsides fuel and gas lift for the production wells. Excess gas is compressed and transported from the FPSO back to subsea via risers, flowlines and rigid spools for disposal via the East Corallina-1 injection well.

The subsea system is controlled from the NE FPSO through the ICS, with the following components:

- Umbilicals provide hydraulic services, electrical power and control services, and chemical injection services as required;
- Valves that control subsea operations and processes;
- Chokes that control pressure and flow rates of hydrocarbons; and

- Subsea Control Modules (SCM) that are sealed and pressure compensated electro-hydraulic units (found on the manifolds) and link the surface and subsea controls.

A number of subsea valves may be overridden manually from a Remote Operated Vehicle (ROV).

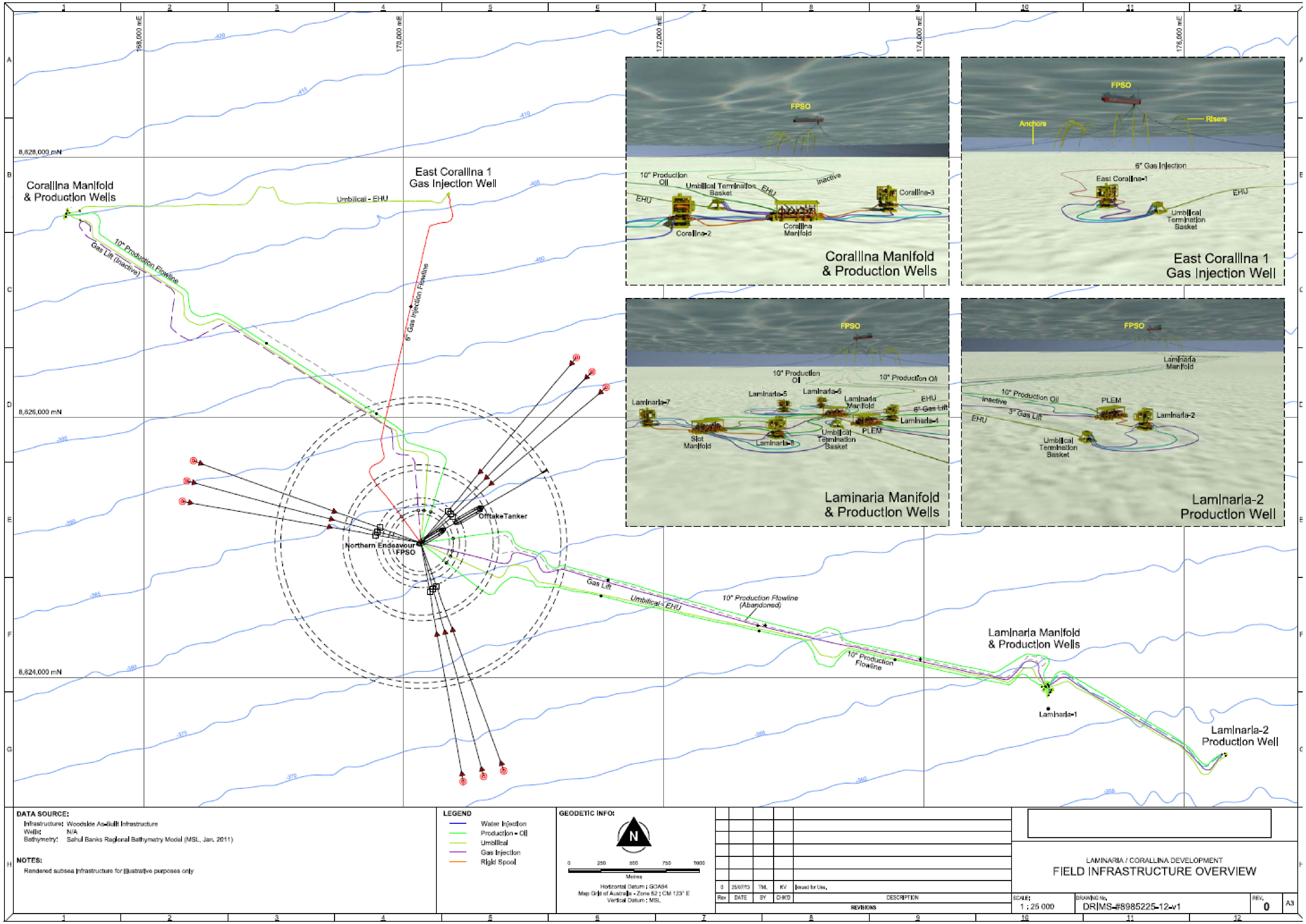

Figure 2-3. NE FPSO subsea layout

2.5.6 Turret Production and Mooring System

The NE FPSO is permanently moored between the Laminaria and Corallina fields. The NE FPSO is fitted with a BMIT mooring system that enables the FPSO to freely weathervane around the turret whilst continuing production from the reservoir. In the event of severe weather conditions, the FPSO has been designed to remain on station using a 3 x 3 catenary leg point mooring system. The mooring legs are fitted with suction anchors at the seabed and are connected to the BMIT at the chain table.

Production fluids from the reservoir are transferred from the flexible risers to the topsides processing system through the turret, via the swivel stack fluid transfer system. The swivel stack also provides the transfer of electrical power hydraulics and chemicals from the FPSO to the subsea infrastructure.

The BMIT is integrated into the foredeck of the FPSO and in addition to providing the interface between topside and subsea equipment, houses the auxiliaries and sub-systems necessary for the safe operation of the turret process equipment. The well fluids flow from the reservoir to the subsea manifolds through valves, piping systems, jumper hoses and the swivel stack arrangement where the transition to hard pipe is made within the turret before the fluids arrive at the topsides processing systems.

2.6 Operational Details

This section provides a description of the main operations associated with the NE FPSO.

2.6.1 Manning and Modes of Operation

The total overnight Personnel on Board (POB) capacity for the NE FPSO is 66 persons. The CCR is manned 24 hours per day.

Production and Maintenance

Production and maintenance covers hydrocarbon receipt, processing, storage for offloading, offloading to export tankers, and supporting operations. IMR activities are undertaken concurrently to maintain production within the NE FPSO design constraints.

Production and Major Projects

Major projects involve refurbishment, modification or major maintenance on the facility. These changes are subject to the Management of Change (MoC) process and risk assessment processes.

2.6.2 Process Description

The NE FPSO receives well fluids (crude oil, gas and associated PFW) from the production wells for topside processing including:

- Separation of gas, crude oil and water;
- Gas compression and disposal; and
- PFW treatment and disposal.

The NE FPSO directly exports processed, stabilised crude oil via offloading to offtake tankers. The facility is designed to process 180,000 bbl of well fluids per day. The first stage of processing is separation of the well fluids in the dedicated Laminaria and Corallina first stage separators. A test separator is provided to allow production testing of diverted individual wells. Crude oil from the first stage separators is commingled and routed to the second stage separator and coalesced to achieve crude oil export specifications. The crude is then cooled and discharged into the FPSO oil storage tanks for export. Further detail is provided herein.

Flare and Gas Reinjection Systems

The NE FPSO has two flare systems, the High Pressure (HP) flare and the Low Pressure (LP) flare. The main purpose of the flare systems is to safely discharge gas streams during an emergency depressurisation. However, there are also a number of process streams that continuously pass gas to the flare, such as gas flashed from the PFW, and stripping gas used in the glycol regeneration process. Other streams intermittently flow to the flare, such as during maintenance activities and when vessels are depressurised and purged. Both the HP and LP systems have knockout drums that collect and remove liquids that condense during emergency relief and blowdown. The flow of gas through each of the HP and LP flare networks is measured using separate ultrasonic flow meters.

The HP and LP flare systems are continuously purged by LP gas from the fuel gas system to prevent air ingress through the flare tip. Two purge lines are provided to supply the two HP headers and one purge line supply for the LP header. In the event of a shutdown of the fuel gas system, the flare header purges are maintained by nitrogen back up supply provided from the nitrogen distribution system. Commissioning of the backup supply is a manual function. All lines in the flare system slope towards the knockout drums to ensure drainage of any liquids.

The HP and LP flare tips are mounted adjacent to each other on the 90 m-tall flare tower located forward of the process skids and turret. One flare tip ignition panel serves both flare tips, each having its own pilot line and ignition line. Fuel gas is used for pilots with propane gas bottles providing an automatic back up. The flare system is designed to operate within acceptable levels of flare heat radiation and noise while it is in operation. Operation of the pilot burners is monitored through the use of three thermocouples fitted with the pilot burners on the flare tip.

The HP and LP flare tips are mounted adjacent to each other on the flare tower located forward of the process skids and turret. One flare tip ignition panel serves both flare tips, each having its own pilot line and ignition line. Fuel gas is used for pilots with propane gas bottles providing an automatic back up. The flare system is designed to operate within acceptable levels of flare heat radiation and noise while it is in operation. Operation of the pilot burners is monitored through the use of three thermocouples fitted with the pilot burners on the flare tip.

The ‘flash gas’ (gas that is released in the separation process) may be routed to the gas compression systems for injection into the reservoir or disposed to the flare system during process upsets or outage of the recompressor. Flash gas from the LP separator/degasser is routed directly to the recompression train, while gas from the HP separators is routed to the lift gas compression system for use as fuel gas or reinjection into the reservoir. When the gas injection system is offline, this excess gas is diverted to the flare system.

The gas recompressor reinjection system also requires a minimum flow rate to be achieved, below which operation is not feasible. In this case, excess gas will be flared. Gas production is currently at a rate that is insufficient to operate the recompressor system. As the Laminaria and Corallina field’s age, gas production rates will continue to decrease. Therefore, the reinjection of excess gas into the reservoir is not expected to be possible in the future, resulting in some additional flaring.

High Pressure Flare System

The HP flare system collects vented hydrocarbons from process and utility systems. Hydrocarbons are vented to the HP flare from Pressure Safety Valves (PSV), manual blowdowns and automatic blowdowns. The flow of purge gas is collected from a network of feeder piping by two HP collection headers that merge before entering the HP flare knock-out (KO) drum. Liquids collected in the drum are pumped back into the process (upstream of the oil heaters) or to the cargo tanks via the closed drain system. Two pumps (duty and stand-by) are provided for this purpose.

Low Pressure Flare System

The LP flare system collects vented hydrocarbons from process and utility equipment with low pressures. The flow of purge gas is collected from a network of feeder piping by the main LP collection header before entering the LP flare KO drum. The LP flare KO drum collects the liquids carried over with gas into the LP flare header to prevent slugs of liquid reaching the flare tip. Liquids collected in the drum are pumped back into the process (upstream of the oil heaters) or to the closed drain header. Two pumps (duty and stand-by) are provided for this purpose.

Operational Flaring

Flaring occurs during normal operational activities. In addition, flaring may also occur during:

- Emergency blowdown as part of process safeguarding and subsequent restarts;
- Transient operations outside process specification;
- Depressurisation of subsea flowlines for hydrate management;
- Depressurisation of topsides and subsea flowlines for integrity management;
- Depressurisation for liquids management;

- Subsea well work-over and clean-up; and
- Depressurisation of the NE FPSO process for maintenance activities.

The key operational flaring events are explained in further detail in the following sections. Annual internal facility flare targets are set based on operational activities planned for the year. This target is used to assess facility flare performance.

Normal Operations

During normal operations, flaring from the HP/LP flare occurs from various sources listed below. To maintain safe operations, there is a need for continuous purge flow of gas to both the HP and LP flare headers. The estimated amount of gas continuously flared during normal operations is detailed in **Table 3-2**. A continuous flow may result from leaks in either the pressure safety or blowdown valves (BDV), this is however considered negligible and its contribution to annual flaring targets has not been estimated.

The continuous flows to the LP flare are:

- Flare pilot;
- LP flare header and storage tank purges; and
- Glycol regeneration process, including still column overheads.

The continuous flows to the HP flare are:

- Flare pilot;
- HP flare header purges; and
- Recompressor suction scrubber. The recompressor is currently isolated from the process as there is insufficient gas flows from the second stage separator to operate the gas reinjection system. Excess flash gas is currently flared continuously through the LP flare.

Flaring Volumes

The amount of gas that may be flared on an annual basis can be predicted by estimating the annual production volumes and associated continuous flaring and the number of process trips and facility blowdowns that may occur (planned and unplanned). Over the years 2016 to 2020 inclusive, the volumes of flaring are estimated to be:

- Continuous flaring (purge and pilot, passing valves, vents and operational flaring) – 9,125 tonnes/year;
- Planned flaring (facility trips, planned shutdowns, cyclone interruptions) – 2,120 tonnes/year; and
- Unplanned flaring (breakdowns) – 5,475 tonnes/year.

Produced Formation Water

The Laminaria and Corallina reservoirs are at a relatively mature stage of development and are producing a high proportion of water compared to oil. The current water production as a percentage of total liquids produced is approximately 95%.

The PFW separated from the crude oil is treated through the NE FPSO produced water treatment system which cools, degasses and removes residual oil. After treatment, PFW is disposed of directly to ocean and its flow-rate and OIW concentration is continuously monitored. The discharge quality performance standard is that the OIW concentration of NE PFW not exceed a daily (24-hour) average value of 30 mg/L. If the continuous system outlet analyser detects an instantaneous OIW concentration above 30 mg/l, a high-level alarm will trigger a field response to identify the cause and as necessary rectify the process.

In 2015, the NE FPSO discharged 4,119,883 m^3 of PFW. The total annual PFW discharge volume has been steady for the past two years with stable production from two wells in each field. Current discharge rates are relatively low due to the shut-in Laminaria-2 well. When Laminaria-2 is reinstated, the PFW is forecast to return to levels similar to the past two years. A daily average discharge rate of 13,500m^3 is expected to remain the maximum from the facility assuming continued production from the current well stock and based on firm activity plans.

PFW Discharge Monitoring Program

The OIW concentration in the PFW stream is monitored continuously during the treatment process and prior to its discharge to the ocean using two online Sigrist OIW Analysers 43-AT-037 (UV fluorescence photometers) in the overboard discharge lines. An analyser is located on the combined water flow from the hydrocyclones to the degasser, with an alarm at 70 mg/L and another analyser is located on the outlet prior to discharge to ocean, with an alarm at 30 mg/L. The measurements made by the degasser outlet online analyser (43AT037) are verified by weekly manual measurements using a Horiba OCMA 310 analyser. The maximum allowable OIW concentration of the water discharged to sea is 30 mg/L (time-based average) over a 24-hour period from midnight until midnight. In the event that the OIW does not meet these specifications, a high alarm will trigger a field response.

The analyser output readings from the degasser are transmitted and monitored at the NE FPSO CCR. A flow meter is located at the overboard outlet to monitor PFW discharge volumes.

Function tests and calibrations of the degasser online OIW analyser and flow meter are undertaken weekly.

The NE standard OIW calibration method is used on the facility to manually measure oil in water concentrations using the Horiba OCMA 310. The Horiba OCMA 310 reference instrument is calibrated every six months at a NATA-accredited laboratory.

PFW discharge from the NE FPSO is managed in accordance with the NE Offshore Marine Discharges Adaptive framework. This framework ensures the discharges are managed in a way that reduces the potential environmental risks and impacts to ALARP.

In addition to continuous flow-rate and OIW monitoring, PFW and seabed sediment are subject to periodic chemical characterisation and ecotoxicity assessments. This information, combined with dilution modelling, is used to ensure that the impacts from PFW discharge are ALARP and acceptable.

Drainage Systems

The NE FPSO drains system collects hydrocarbon-based and other liquid wastes (rain and wash water etc.) in all areas across the facility via two segregated sub-systems; open drains (hazardous and non-hazardous) and closed drains, described herein.

Open Drains

The NE FPSO open drains system consists of two separate collection systems; the hazardous open drain system and the non-hazardous open drain system. The open drains system is required for collection of water and hydrocarbons that are at atmospheric pressure (e.g., deck water). Drains from the hazardous areas are totally segregated from drains from non-hazardous areas in order to prevent ingress of hydrocarbons into a non-hazardous area via the drains system.

The hazardous open drains system is designed to remove and collect any oily water from hazardous areas on the FPSO, including wash down water and spillage of liquids on decks, equipment drip trays or bunded areas. Both open drain systems are directed to the port side slops tank located in the hull.

The non-hazardous open drains system collects rainwater, wash down water and spillage of liquids from decks located in non-hazardous areas of the facility. Water from the drainage system is routed to the slops tank where it is treated and discharged to the ocean if within OIW discharge criteria. Oil recovered in the slops tanks is routed to the cargo storage tanks.

The open drain system is designed to accommodate a maximum flow of 40 m^3/hr.

Closed Drains

The closed drains system collects liquids from normally pressurised and hazardous equipment prior to maintenance. Other sources that intermittently flow to the closed drain system include:

- LP flare drum liquids;
- Produced water degasser;
- Operational drainage from the oil separators;
- Liquid sampling draining from the oil separators; and
- Level bridle drains.

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

The vent line on the LP flare/closed drain drum ensures that the operating pressure in the tank is close to atmospheric pressure. The vapour in the drum flows to the LP flare header for flaring.

Machinery Space Bilges

The FPSO machinery space includes auxiliary machinery for the FPSO. Oily water mixtures and hydrocarbon residue generated in this area is drained to the machinery space bilge tank. When required, the contents of the bilge tank are pumped to the FPSO slops tank where it may be commingled with other drainage water for treatment and discharge in accordance with OIW criteria.

FPSO Slops Tank Management

In addition to the drainage processes discussed, the FPSO slops tank may receive other less frequent sources of drainage water, primarily from marine operational activities. This includes activities such as cargo tank de-bottoming, cargo tank stagger test water (for tank integrity testing), water washing of cargo tanks and heavy weather ballasting where the cargo tanks may need to be utilised for ballast purposes.

These sources will involve settling and collection of residue hydrocarbons via a skimming pump before discharge of the water in accordance with OIW requirements (30 mg/L). Oil recovered from the slops tanks is routed to the cargo storage tanks. The water from the slops tanks is then pumped to the clean (starboard) slops tank before discharge to the ocean via an overboard discharge point.

A Sigrist online OIW analyser (48AT672) is located at the slops tank outfall and is operated and monitored manually at source during discharge of slops water only with an alarm set at 30 mg/L and a flow meter recording measure discharge volumes. Function tests and calibrations of the slops tank online OIW analyser and flow meter are undertaken.

Cargo Tanks

The FPSO’s cargo tanks are designed to receive cooled stabilised crude oil from the topsides process system, and includes 24 crude oil tanks, arranged in pairs either side of the vessel centre line. Crude may be routed to any tank, transferred between tanks or offloaded to an offtake tanker via the cargo offloading system. The total operational storage capacity of the NE FPSO is 1.4 million bbls of crude. Each crude oil tank has an adjacent wing ballast tank protecting the tank from and direct impact.

The cargo pumps and offtake loading hose transfer the crude from the facility’s storage tanks to an offtake tanker for export. The crude is discharged from the cargo tanks via the section header by a vertically-mounted export pump, at the aft end of each tank. The discharge flow from all running pumps is combined in the suction header and then routed to the oil export pumps. The maximum offloading rate from the FPSO is 5,400 m^3 (or 34,000 bbl) per hour.

Control of the cargo loading and discharge is carried out from the CCR where the following can be controlled and monitored:

- Cargo planning using the ‘Mariner’ computer program;
- Control of cargo pumps and valves;
- Gauges displaying cargo tank levels, pressures and temperatures;
- Inert gas quality and pressure gauges;
- Gas detection system displaying levels of gas leakage into the ballast tanks; and
- Cargo tank overfill alarm system.

An independent overfill alarm is fitted to each cargo and slops tank and activated when the liquid level reaches a set point (normally 98% by volume). An inert gas system is in place during all cargo handling operations. An emergency shut down (ESD) valve is incorporated in the rundown line from the process plant.

Ballast System

The NE FPSO seawater ballast system is used to counteract sheer force and bending movement stresses on the FPSO's hull caused by the loading and offloading of crude oil in the vessel's storage tanks. Ballasting is also required to control the trim and heel of the vessel to ensure stability remains within design limits. Control of the ballast routing is determined using a system of hydraulically and manually operated valves.

The vessel ballast system is completely segregated from the crude oil storage system. Ballast is carried in 12 wing tanks, six located on each side of the vessel outboard of the crude oil tanks. The ballast pumps are interconnected to permit flexibility of operation.

The ballast valves on the FPSO can be controlled remotely from the CCR through the ICS and remotely at the solenoid valve cabinets or operated manually by portable hydraulic hand pumps.

Offloading System and Offtake Tanker Mooring

The NE FPSO has a tandem offloading system, providing handling facilities to non-dedicated tankers of up to Suezmax (150,000 t) size, in accordance with Oil Companies International Marine Forum (OCIMF) requirements.

Prior to gaining acceptance for offloading from the NE FPSO, export tankers are assessed by NOGA for their performance and quality (historic performance or incidents, documentation, systems and procedures). Quality assurance of tankers is provided by external bodies with access to extensive databases, which ensures thorough evaluation (for example, the OCIMF Ship Inspection Report Programme). A tanker will only be accepted by for offloading if it passes the assessment. This requirement applies to each tanker offload irrespective of the tanker flag, operator or the date of the last visit to a terminal.

Once accepted for offloading, the tanker must comply with requirements under the NE Terminal Handbook, which contains rules, information and operations guidelines. Vessel approach to the facility must first be approved by the NE Offshore Installation Manager (OIM) and then occurs under supervision of a Pilot, in accordance with the International Maritime Organisation and International Maritime Pilots Association Guidelines.

While the offtake tanker is making its approach to the NE FPSO, an Offshore Support Vessel (OSV) runs the messenger rope to the stern-mounted mooring hawser, and then assists in the berthing operation directed by the Pilot, including transfer of the hose to the offtake tanker connection. Following hose connection, line up for cargo operations begins under the direction of the Pilot with communications continuously maintained between the offtake tanker, FPSO and OSV. Separation between the FPSO and the offtake tanker is maintained by the OSV on static tow at the stern of the offtake tanker, which also controls movement of the tanker.

Offloading of crude to the offtake tanker is via a 16" diameter 300-m-long armoured, floating hose. It is comprised of a heavily reinforced material in sections approximately 10 m long, with flanged and bolted connections between sections. This allows each section to be independently tested and replaced if necessary. The hose is connected to the offloading header by a coupler and uses a Camlock type quick connector to attach the free end to the offloading tanker. Once the offtake tanker is securely moored astern, the hose is fitted with a breakaway coupling at a point approximately 100 m from the tanker tail end of the hose. The offtake loading hose is of a design that permits it to be kinked without change. The offtake hose releases at a predetermined tension and oil spillage is minimised by the closure action of the valves in each part of the dry break coupling.

The rate of offloading from the NE FPSO will directly rely on the production rate, which varies over time. Currently an offloading operation occurs approximately once every four months. Trading tankers have an oil storage capacity of 100,000 m^3, and a full loading operation takes up to 36-48 hours. Initial loading rates are conservative at approximately 1,000 m^3/hr; however, they may be increased to suit offtake tanker requirements, to a maximum loading rate of 4,800 m^3/hr.

Offloading to tankers is monitored by the NE FPSO's 'Mariner' program, which provides alarms if hull stresses exceed the allowable envelope. Hull stress is continuously calculated via measuring the stresses in the hull based on measured liquid levels and densities within the tanks.

2.6.3 Utility Systems

Facility Lighting

The NE FPSO has appropriate lighting to ensure a safe working environment during 24 hour operations, including normal, emergency and escape lighting on the hull and topsides. Lighting is split between emergency and normal lighting and is comprised of fluorescent and high pressure sodium luminaries. The flare tower is illuminated by narrow beam floodlights. The lighting design of the FPSO is in compliance with the International Association of Lighthouse Authority (IALA) requirements for offshore facilities.

Unless required to support over the side activities (such as re-fuelling and lifting operations), lighting on the platform is only directed to the work area, which limits light spill to the ocean. Lights directed towards the water for the crane and loading/offloading operations are switched off when not required.

Heating Ventilation and Air Conditioning (HVAC) System

The HVAC system is comprised of three subsystems (aft, forward and machinery space ventilation), as well as HVAC equipment, ductwork and associated pipework. It provides independent and inter-dependent subsystems with pressurised, conditioned, purged and exhaust air services to various areas, including accommodation and various modules that can be operated on an as required basis and others on a continuous basis.

Mechanical exhaust systems are provided to supplement ventilation and HVAC systems, fumes extraction and for any negatively pressurised areas.

Refrigerants associated with the HVAC system are recorded and managed via the NE Refrigerant Management Register available on the UPS intranet site [26/HSEQ/ENV/RG100].

Nitrogen System/Generation

The NE FPSO nitrogen system continually passes compressed air through the nitrogen generation package producing nitrogen that is used for compressor sealing, system blanketing, flare header purging and maintenance purging. The system consists of a nitrogen generation package and the main and back-up nitrogen distribution systems located in the skid bottom.

The nitrogen generation package is a membrane separation system. Under normal operations the nitrogen generator is supplied with a continual feed of compressed air from the instrument air distribution system. The inlet air stream to the package is routed through the feed air filters to remove solid particles and preheated through the feed air heater prior to entering the membrane separators. On entering the membrane separators, the oxygen enriched air is separated from the nitrogen and the nitrogen product is routed to the nitrogen receiver vessel.

The distribution system is provided with a backup distribution system, which is fed from the nitrogen receiver and the nitrogen bottle rack in the event of a nitrogen generator shut down. The nitrogen back-up distribution system consists of a HP and LP system. The heating medium expansion tank and lift gas compressor seals are the only consumers supplied from the HP back-up system. The nitrogen is only supplied to the high priority users (i.e. the compressor seal and flare headers) from the LP nitrogen back-up system.

Seawater Treatment Systems

Seawater System

The primary functions of the NE FPSO seawater systems are to provide process and HVAC cooling. Two main seawater systems are provided, one for the seawater marine system and the second for topsides.

The seawater marine system is serviced by the port and starboard sea chests and seawater inlet filters. These are connected by a header from which six branch lines feed the seawater pumps in the marine seawater service system. The water is then pumped to the hull central coolers (heat exchangers) where the closed loop freshwater cooling system transfers the waste heat from the hull machinery and utilities to the seawater. This system provides seawater for the hull equipment, including the central fresh water coolers, the marine growth protection system, fresh water generators and cooling for the inert gas generator burners. The heated seawater is then discharged back to sea via the overboard caisson.

The topsides seawater system is served by electrically-driven pumps fed from main power generation. The system draws water through seven vertical pumps. The water is then discharged through a seawater coarse filter package to the seawater supply distribution system. The heated seawater is then discharged back to sea via the overboard caisson.

Average discharge rates of heated seawater from the NE FPSO seawater system are 3,500 m^3 per hour at an average temperature of 5ºC above the ambient sea (inlet) temperature. The flow of cooling water is continuously metered and the OIW concentration is measured using an online Sigrist OIW analyser for the detection of hydrocarbons.

The seawater cooling system is segregated from the crude oil processing system. A hypochlorite generator package and distribution system provides chlorine dosing to the suction caisson of each running pump in the combined seawater/firewater system. In the marine seawater system, the Marine Growth Protection System (MGPS) protects the port sea chest, starboard sea chest and system pipework from fouling.

Heating Medium System

The heating medium system distributes heat from turbine exhaust to consumers in the main process and utility systems. The system is designed to supply a maximum 40.5 MW to the consumers, recovered from turbine exhaust in the Waste Heat Recovery Units (WHRU). The heating medium used on the FPSO is fresh water conditioned with chlorine and other necessary chemical additives. The heating medium is circulated through the WHRUs, to the consumers and back to the heating medium circulation pumps in a closed loop.

Potable Water

The freshwater system is designed to produce, store and distribute fresh and potable water supplied from the NE FPSO freshwater storage tanks in the hull to the various system consumers. During normal operations, fresh and potable water are manufactured on board the NE FPSO via two Reverse Osmosis (RO) Units. The system is also provided with a supply boat freshwater bunkering facility in the event that freshwater generation facilities are out of commission.

Each generator is a completely independent desalination unit, with separate seawater supply pumps, HP RO filters, pumps and salinity measuring instruments. In normal operations only one generator will be in service to produce fresh water at a rate of 30 tonnes per day, although both generators can be operated together to produce 60 tonnes per day if required. Freshwater produced by the generators is sterilised in the system before entering the freshwater storage tanks. The fresh water is stored in the freshwater storage tanks, which have a maximum capacity of 1,115 m^3.

Up to 30 m^3 of brine is discharged to the ocean from each unit per day via an overboard caisson approximately 10 m below the waterline (with the exact depth varying depending on ballast volumes). The salinity of the discharge water is approximately 84,000 μs/cm, which varies depending on the quality of the feed water. Freshwater is distributed throughout the NE FPSO via two separate pressurised hydrophore units.

The potable water hydrophore unit supplied domestic drinking and hot water to the accommodation (via de-chlorinating and re-hardening filters and a UV steriliser). The freshwater hydrophore unit supplies the engine room systems and topside safety showers. Freshwater is also used for wash-down and as make-up water to various utility systems.

Inert Gas System

Inert gas on the facility is used to maintain a positive pressure in the vapour space of the cargo tanks to prevent air ingress during offloading to an export tanker. The inert gas is also used in the slops and ballast tanks as required.

Inert gas is produced on the facility by the inert gas generators. The inert gas passes through a scrubber demister unit that cools and cleans the inert gas before being fed to the cargo tanks.

The inert gas is supplied to the tanks by the inert gas generator via the main inert gas supply header. In the event that the inert gas supply pressure is lost, the water immediately falls back and closes the seal, thereby preventing any back-flow of vapour from the tanks. The inert gas pressure is monitored and controlled by the

ICS and pressure control vent valve in the main inert gas header. Oxygen content higher than 3% triggers an alarm in the CCR and closes the supply of gas to the tanks.

During loading of the cargo tanks, the inflow of crude oil displaces the inert gas that is vented to atmosphere from the forward riser on the flare tower. The system is also capable of purging cargo tanks for maintenance and inspection purposes. The gas is purged through the vent headers that operate in conjunction with the purge gas supply header. Inert gas fans are used in fresh air mode to displace the gas to prepare for inspection or hot work.

Power Generation

The main power generation and distribution system for the NE FPSO is comprised of five separate but interdependent systems, including:

- Main 11 kV generation and distribution system;
- SW/FW 11 kV generation;
- 415 V distribution;
- 415 V emergency generation and distribution; and
- 415 V UPS distribution.

The power generation and distribution system has been designed to provide reliable, standalone power for the accommodation, utilities and process loads. The main power at 11 kV is supplied by four gas turbine driven generators. The NE FPSO operations require 7 mW of power under normal operating conditions; power is supplied by two of the gas turbines, with the third on standby. The generators are located in the topside area and supply power to the process, utility and marine consumers, including power for the turret and accommodation.

The generator units have the capability to operate on fuel gas or diesel or crude oil, with normal operations seeing the turbines run on fuel gas. Two of the generator units have been converted to allow operation with crude fuel, which will be utilized when fuel gas flows are insufficient.

Emergency power is supplied by a 415 V, 1.25 MW emergency diesel generator. The emergency generator is equipped with both air and electric starting systems. The generator is connected to three 415V emergency switchboards, which feed the emergency loads required to ensure the safety of personnel or to protect equipment.

The emergency generator can be synchronised to the main turbine generator, and can also run in parallel with the main turbine generators. This occurs by manual load sharing. The emergency generator is designed to withstand credible fire and explosion events and is located in a closed room. The emergency generator starts automatically in the event of loss of main power. If this occurs, power is expected to be restored to the emergency switchboard within 30 seconds, providing necessary power to run system critical equipment.

Should the emergency generator system fail an independent uninterruptible power system is provided for the hull and topside systems, turret compartment and forward equipment rooms and PCM system.

The power management system (PMS) provides supervisory control of the main power system, to ensure system stability and reliability. The PMS controls each of the turbine generators and load shedding and blocking start of heavy consumers in the following prioritised order:

- Non-essential services required for lighting and utilities;
- Essential services required to maintain production; and
- Vital services required for safety, provided with a primary and secondary power supply (navigational aids, foam pumps, emergency lighting, etc.).

The vessel PMS operates in periods where the main gas turbines are out of operation or when the topside 440V switchboard is fed from the main switchboard. The vessel PMS is designed to manage the marine diesel loads by sequencing generators on and off the switchboard and providing load sharing between marine generators.

Fuel Gas System

The main purpose of the facility's fuel gas system is to utilise excess gas from the process for use as fuel gas and/or blanketing gas directly from the reservoir. Fuel gas is utilised in the power generation turbines and gas compression turbines. The system also supplies fuel gas at low pressure to the flare pilots and flame front generator. Blanket gas is directed to the methanol storage vessel or the rich glycol flash separator, the LP or HP flare headers and closed drain drum.

The fuel gas system is used by the main power generators and the lift gas compressor turbines. The Fuel Gas System also supplies gas for pilot, blanket, stripping and purge purposes. Two of the three gas turbine driven generators are capable of running on tri-fuel (fuel gas, diesel and crude oil). These turbines will be run on diesel when process gas or oil is unavailable (i.e., upon facility start up) and are run on oil where fuel gas supply is insufficient to meet system demands.

During normal operations, the fuel gas system receives gas and liquid condensates from the following process sources:

- Wet gas scrubber;
- Dry gas from the glycol contactor;
- Glycol contactor filter/coalescer; and
- Train A/B third-stage lift gas compressor suction scrubber.

The system is designed to condition a maximum of 133 m^3/hr. of liquid condensate and 20,614 m^3/hr of gas. To achieve this, the fuel gas system includes fuel gas scrubbers (A/B), a fuel gas heater, and a fuel gas knock-out drum.

The gas lift turbines have the capacity to operate on duel fuels (fuel gas or diesel) and two of the power generation gas turbines are capable of tri-fuelling. Diesel is used in case of system start-up, or when fuel gas is not available.

Total fuel gas consumption on the facility is metered and reported internally via the NE FPSO daily production reports.

Diesel Fuel System

The NE FPSO's diesel fuel system is designed to receive, store, purify and distribute diesel to the main power generators, lift gas compressors, seawater/firewater pumps, pedestal cranes A/B, lifeboats, fast rescue craft, the emergency generator and inert gas generators.

Two diesel oil storage tanks receive diesel from supply boats through one of the bunkering hose reels on the upper decks. The fuel is purified before being transferred to the diesel oil service tanks located in the engine room. Fuel is pumped directly from the service tanks to the topside main power generators, using the supply pumps, or transferred via the transfer pumps top various daily service tanks.

The major components of the diesel system on the NE FPSO are as follows:

- Hull main diesel storage tanks (2 main tanks) – total volume 4,260 m^3;
- Hull diesel service tanks (2 in total) – total volume 1,050 m^3; and
- Day tanks (5 in total) – total volume of 30 m^3.

It is mandatory for all diesel sold in Australia to contain less than 500 ppm sulphur. This product is known as 'Low Sulphur Diesel'. Low sulphur diesel is transferred to the NE FPSO in bulk from supply vessels. Diesel usage is monitored and metered.

Crude Oil Fuel System

Two of the three gas turbine driven generators are capable of running on tri-fuel (fuel gas, diesel and crude oil).

Accommodation Sewage and Putrescible Wastes

A certified sewage treatment and pumping unit is installed on the NE FPSO with a capacity to treat black and grey water flow for the manning level of 66 persons.

The unit is a Hamworthy sewage treatment system and meets IMO Resolution and Marine Protection Environment Committee 2 (VI) criteria and operates via an aerated four chamber submerged bioreactor. Discharge of wastewater from the system is via the hull discharge line (below the water line).

Putrescible waste (food scraps) is either ground to less than 25 mm diameter and disposed overboard, or bagged and transported ashore for disposal as domestic waste.

Sand Management

Sand prediction modelling undertaken for the Laminaria and Corallina reservoirs indicates sand production is unlikely during normal operations. Even though no long-term sustained sand production is anticipated, the NE FPSO production system and subsea facilities have been designed to manage small amounts of sand production (up to 3 lb/1,000 bbls). This is considered sufficient to manage the small quantity of sand that may be produced during the initial well clean up and following shut-in activities.

The NE FPSO is equipped with jet washing capability to remove any accumulated sand if required. Sand and sludge with the potential to be contaminated with Naturally Occurring Radioactive Material (NORMs) is tested and disposed in accordance with the FPSO’s Waste Management Plan.

Blasting and Painting

Infrastructure over the side of the FPSO including the riser requires periodic repair due to rust and corrosion build-up. This typically involves grit blasting of existing paint and rust to reveal clean surface and re-application of paint. During grit blasting, as much sediment as possible will be collected where practicable, however this activity may potentially lead to discharge of paint flakes and rust sediment to the sea.

2.6.4 Facility Operations

Lifting Operations

Lifting operations on the NE FPSO includes routine lifting from OSVs.

The NE FPSO is equipped with three main rotating cranes, as well as numerous local handling/lifting provisions. Routine lifting operations primarily include transferring stores and equipment from a OSV to the facility. The types of ‘lifted equipment’ may vary but generally include containers or skips of various sizes.
Following the completion of offloading from the supply vessel, the facility will then backload to the supply boat any items to be returned to shore. These primarily include empty skips, containers or skips containing waste for onshore disposal.

Diesel Bunkering

Low-sulphur diesel is transferred to the NE FPSO in bulk from supply vessels via a hose reel and bunker connection located on the starboard side of the FPSO’s cargo deck. The bunker hose is handled by the provisions crane. Diesel oil is stored in tanks located in the hull of the FPSO.

The diesel is held in two storage tanks then purified and held in two service tanks prior to distribution for use. Diesel from the service tanks is reticulated around the hull and topside users via a diesel distribution ring main. The diesel ring main supplies the four power generation gas turbines and the two gas lift gas turbines. Outlet valves from the diesel tanks are fitted with hydraulically actuated, quick-closing valves remotely operated from the ship’s fire control station.

Offshore Support Vessel Operations

The NE FPSO receives regular visits by an OSV. The vessel also backloads materials and segregated waste for transportation back to the Darwin Supply Base.

OSVs are utilised in a support capacity for transferring personnel, material and equipment to and from the facility. OSVs are also used for project field work such as subsea intervention (e.g., IMR of subsea facilities), offloading and support activities. Vessels supporting offshore subsea activities may vary depending on operational requirements, vessel schedules, capability and availability. All OSVs are required to undergo a Marine Assurance Inspection to review compliance with marine laws and HSE requirements.

Helicopter Operations

Helicopters are the primary means of transporting passengers and/or urgent freight to and from the NE FPSO and OSVs. They are also the preferred means of evacuating personnel in the event of an emergency. Helicopter operations are considered for noise impacts only when inside the 500 m zone of the FPSO.

2.6.5 Hydrocarbon and Chemical Inventories and Selection

Hydrocarbons

There is 725 m3 of liquid and 750 m^3 of gases stored on the NE FPSO in major process equipment. There is a diesel storage capacity of 5,335 m^3.

Indicative Chemical Inventories

A list of bulk chemicals commonly used on NE FPSO, and indicative storage quantities, is summarised in Table 2-2. In addition to the chemicals listed, the NE FPSO may also maintain small volumes of various operational chemicals and facility maintenance chemicals as previously described.

Table 2-2. Bulk Inventories of Chemicals

Material	Storage Means	Storage Capacity (m^3)
Process biocide	1,500 L containers	3.0
Subsea scale inhibitor	1,500 L containers	15
Methanol	Dedicated storage vessel	25.0
Glycol (TEG)	Dedicated storage vessel	12.0
Subsea control fluid	Drums (205 L) and dedicated storage vessel	9.0
Enersyn RC S46	Drums (205 L) and dedicated storage vessel	7.0

Chemical Usage

Chemicals are utilised on the NE FPSO for a variety of purposes as described below.

Operational Process Chemicals

An operational process chemical is the active chemical added to a process or static system, which provides functionality when injected in produced fluid, utility system streams or for pipeline treatment. These chemicals may be present in routine or non-routine discharge streams from the NE FPSO. Examples include biocides, scale inhibitors, and demulsifiers.

Operational Non-process Chemicals

Operational non-process chemicals include chemicals that do not fall into the category described above but may be required for operational reasons and, by virtue of their use, may be intermittently discharged or have the potential to be discharged (e.g., required as a result of maintenance or intervention activities). Chemicals in this category include subsea control fluids, dyes and well intervention/workover chemicals.

Facility Maintenance Chemicals

Facility maintenance chemicals include chemicals required for general maintenance or 'housekeeping' activities and are critical for overall maintenance of the facility and its equipment. These include paints, degreasers, greases, lubricants, Aqueous Film Forming Foam Concentrate (AFFF), and domestic cleaning products. They may also include chemicals required for speciality tasks, such as laboratory testing and analysis. Facility maintenance chemicals generally present negligible risk to the environment as they are not discharged as a result of their use (e.g. paint) or are used intermittently and discharged in low volumes (e.g. domestic cleaning products).

Selection, Assessment and Approval of Chemicals

Chemical selection for the replacement of current chemicals (e.g., in the event of product substitution, or a superior product being released for sale), or introduction of new chemicals (e.g., for new process/production requirements) complies with NE Chemical Selection and Management Procedure 01-HSE-PC05. This procedure requires the selection of chemicals with the lowest practicable environmental risk.

The chemical selection and assessment procedure assesses chemicals based on toxicity, biodegradation and bioaccumulation based on the United Kingdom Offshore Chemical Notification Scheme (OCNS) (Table 2-3) in the absence of Australian standards.

The OCNS manages chemical use and discharge by the UK and Netherlands offshore petroleum industries. The scheme is regulated in the UK by the Department of Energy and Climate Change using scientific and environmental advice from CEFAS (the UK's Centres for Environment, Fisheries and Aquaculture Science) and Marine Scotland. The OCNS uses the Harmonised Mandatory Control Scheme (HMCS) developed through the Oslo-Paris (OSPAR) Convention 1992. This ranks chemical products according to Hazard Quotient (HQ), calculated using the Chemical Hazard and Risk Management (CHARM) model. The CHARM model requires the biodegradation, bioaccumulation and toxicity of the product to be calculated.

Under the Convention, organic-based compounds used in production, completion and workovers, drilling and cementing are subject to the CHARM model. The CHARM model calculates the ratio of the 'Predicted Effect Concentration' against the 'No Effect Concentration', and is expressed as a HQ, which is then used to rank the product. The HQ is converted to a colour banding to denote its environmental hazard, which is then published on the Definitive Ranked Lists of Approved Products (by the OCNS on its website, http://www.cefas.defra.gov.uk/industry-information/offshore-chemical-notification-scheme.aspx). Gold has the lowest hazard, followed by silver, white, blue, orange and purple (having the highest hazard).

Products not applicable to the CHARM model (i.e., inorganic substances, hydraulic fluids or chemicals used only in pipelines) are assigned an OCNS grouping A – E, with 'A' having the greatest potential environmental hazard and 'E' having the least. Products that only contain substances termed PLONORs (Pose Little or No Risk) are given the OCNS 'E' grouping. Data used for the assessment includes toxicity, biodegradation and bioaccumulation.

In the NE Chemical Selection and Management Procedure, chemicals are classified for use accordingly:

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

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

Table 2-3. Illustration of hazard ranking bands for chemical products classified under the OCNS

OCNS Hazard Groupings for CHARM and Non-CHARM Chemical Products						
CHARM	Gold	Silver	White	Blue	Orange	Purple
Non-CHARM	E	D	C	B	A	
	Lowest Hazard →					*Highest Hazard*

Any chemicals that do not meet the initial screening criteria stated in the NE Chemical Selection and Management Procedure and require ALARP demonstration must be recorded in the NE Offshore Chemical Register.

The procedure recognises the need to review particular chemicals in the register in the aim of continuous improvement. The register is reviewed on an annual basis as prompted by 'MyOSH' alerts.

Safety Data Sheets

The 'Chemalert' system provides a Workplace Register of specific information relating to hazardous chemical substances in respect of all NE facilities and is available online to all personnel.

The system provides detailed information on chemicals in the form of Safety Data Sheets (SDS), which includes information relating to safe handling requirements, first aid, environmental information and disposal requirements etc.

2.6.6 Subsea IMR Activities

The NE FPSO subsea infrastructure is designed to require only minor degrees of intervention. The NE FPSO is faced with high pressures (both internally and externally) and naturally occurring metocean conditions in which subsea infrastructure and structures such as the vessel hull and risers that are exposed to the ocean must operate within. As the field is approaching the end of its production life, inspection and maintenance is regularly undertaken to ensure the integrity of the infrastructure. Intervention may be required to repair identified problems. Subsea activities are described in this section.

Inspection

Inspection of subsea infrastructure is the process of physical verification and assessment of components in order to detect changes to its as-installed state. Typical subsea inspection activities typically occur every three years and include visual surveys via ROV, side scan sonar (SSS) surveys, cathodic protection measurements, marine growth removal for access, interface with equipment via hotstabs and torque tools and ultrasonic wall thickness checks.

Monitoring

Monitoring of subsea infrastructure refers to the surveillance of the physical and chemical environment that a subsea system or component is exposed to in order to determine if/when damage may occur and (where relevant) predict the rate or extent of that damage.

Monitoring activities may include process composition testing, corrosion probes, corrosion mitigation checks, metocean and seismic monitoring.

Maintenance

Maintenance of subsea infrastructure is required at regular and/or planned intervals to maintain performance, reliability and prevent deterioration or failure of equipment. The most common maintenance activities include cycling of valves, and leak and pressure testing.

Repair

Repair and/or replacement of subsea infrastructure are included in detailed risk based maintenance plans. Repair activities are those required when a subsea system or component is degraded, damaged or has deteriorated to a level outside of acceptance limits as defined by design codes. Damage sustained may not necessarily pose an immediate threat to continued system integrity, but may present an elevated level of risk to HSE or production reliability. The most common repair activities may include change out of equipment, isolation of equipment, in situ repair and function/pressure/leak testing.

IMR Chemical Usage

Production chemicals are utilised in the NE FPSO subsea system for corrosion inhibition and prevention of bacterial growth. These may originate from the processing facilities located on the NE FPSO or from a chemical package on an OSV.

Minor planned chemical discharges may occur during a range of subsea IMR activities. The chemicals and volumes discharged will be specific to each activity, but commonly arise from depressurisation and/or flushing tasks. Typical volumes are the expected releases associated with the activity following depressurisation and flushing activities.

All chemicals are selected, assessed and approved in accordance with the NE Chemical Selection and Management Procedure to ensure they are of the lowest toxicity possible. Typical chemicals used in the Laminaria and Corallina subsea infrastructure are listed below (but are not limited to) and may be released during IMR activities.

Continuous use chemicals are those that are typically stored on and supplied from the NE FPSO and continuously added into the process. These include:

- **Control Fluid** - this subsea control fluid is a water-based product, with the major component being Ethylene Glycol.
- **Methanol** – used to prevent/remove hydrates in the production and gas manifolds. Methanol is ranked ‘E’ on the OCNS list of non-CHARMable products. It is also classified as a PLONAR chemical in the North Sea.

- **Scale Inhibitor** –used to prevent scale formation in the oil, PFW and water injection systems. Scale inhibitor is injected continuously, with injection points provided at each subsea wellhead and the produced water Injection pump.

Batch use chemicals typically originate from a chemical package located on board an OSV and include:

- **Monoethylene Glycol (MEG) and Triethylene Glycol (TEG)** - may be used in the chemical injection umbilicals for hydrate control, and have an OCNS Group E rating.
- **Biocide** - generally used to prevent the bacterial growth in subsea infrastructure that may cause corrosion.
- **Dye** - are used to identify the source of a flow or leak. Fluorescein Liquid Dye has a Gold CHARM rating but carries a CEFAS substitution warning.
- **Acid** - sulphamic acid is made up of hydrogen and sulphate and is water soluble and will readily biodegrade into the ocean. When the chemical is broken down in water it slowly hydrolyses to ammonium bisulfate. Ammonium bisulfate is listed on the CEFAS OCNS list as E, which is the lowest (i.e., most environmentally benign) ranking possible.
- **Grout** - the material used in grout, mattresses and rock is typically concrete-based and has a Group E OCNS rating.
- **Oxygen Scavengers** – absorb oxygen and are used as a corrosion protection in closed-in volumes of fluid.

IMR Offshore Support Vessels and Equipment

Subsea activities are typically undertaken from a diving or installation support vessel (support vessel) using one or more ROVs and/or divers. Typical support vessels use a Dynamic Positioning (DP) system to allow manoeuvrability and avoid anchoring when undertaking works due to the close proximity of subsea infrastructure. However, vessels are equipped with anchors that may be deployed in the event of an emergency.

The DP system requires the temporary deployment of up to six transponders on the seabed. Transponders are also used for monitoring the location of infrastructure/equipment during a repair. The transponders are attached to small recoverable moorings (metal clump weight or tripod) that are lowered to the seabed and placed in position by ROV. The transponders have a small footprint less than 0.5 m^2. The transponders and moorings are recovered using ROV at the end of the activity.

ROV operations often require tool baskets that are temporarily placed on the seabed. These baskets typically have a mesh base with a seabed footprint of approximately 15 m^2. The baskets are recovered to the vessel at the end of the activity.

Inspections

Subsea inspections are performed throughout the life of the field to determine any changes in condition, movement or integrity of subsea infrastructure. Table 2-4 provides a summary of typical subsea infrastructure inspections / surveys and associated activities.

Table 2-4. Typical inspections and surveys

Type of Inspection / Survey	Purpose
General Visual Inspections (GVI)	Check general infrastructure integrity.
Close Visual Inspections (CVI)	Investigate certain subsea infrastructure components.
Cathodic Protection (CP)	Check for corrosion.
Wall Thickness Surveys	Monitor the condition of subsea infrastructure (i.e. ultrasonic testing).
Side Scan Sonar (SSS)	Identify buckling, movement, scour and seabed features. Low frequency/intensity signals undertaken for approx. 5 days every 4 years.
Non-destructive Testing (NDT)	Evaluate the properties of material/items using electromagnetic, radio graphic, ultrasonic, or magnetic equipment.
Seabed sampling surveys including grabs/cores	Identify benthic fauna, sediment, etc. Grabs/cores typically 0.1 m^2 of seabed per sample.

Water sampling surveys	Determine water quality around the platform/subsea infrastructure.
Anode sampling	Samples taken of anode materials for testing.
Marine growth sampling	Samples taken of marine growth for testing.
Integrity testing	Monitor the condition of subsea infrastructure (i.e. pressure testing, Valve actuation, etc.)

2.6.7 Well Management and Maintenance Activities

NE facility subsea well interventions, and workovers require a suitable vessel or drill rig to accommodate and support intervention packages. Therefore, these activities do not form part of the scope of The EP. Unloading and clean-up from subsea wells via the platform may be required from time-to-time as described below.

Well Unloading and Clean-up

Following subsea interventions and workovers, the well may be unloaded and flowed via the process facilities to be cleaned up of any remaining chemicals and fluids in the wellbore or reservoir. During this phase, the products may be processed as follows:

- Gas: routed into the production process where possible, or flared if unsuitable;
- Fluids: routed to the HP flare KO drum which discharges liquids to the closed drain system; and
- Wastes (may include fluids and sand/solids): will be managed as appropriate based on composition. Solids will be separated for onshore disposal as required by the NE Offshore Waste Management Plan. An additional strainer may be placed in the flowlines prior to the main separators to remove any large debris that may be within the wellbore.

3 DESCRIPTION OF THE ENVIRONMENT

A description of the existing environment that may be affected by the planned and unplanned activities of the NE FPSO is presented in this section. It includes a description of relevant natural (physical and biological), cultural and socio-economic aspects of the environment, as well as details of relevant values and sensitivities.

Wherever possible, the Zone of Potential Impact (ZPI) for the worst-case loss of hydrocarbons is used to define the boundary within which the marine environment is described. The ZPI is defined as:

> *The predicted extent of exposure of sea-surface (10 g/m^2) and dissolved and entrained hydrocarbons (500 ppb), and shorelines with accumulated hydrocarbons ≥ 100 g/m^2, as a result of the loss of oil (40,706 m^3 over 24 hours) from two cargo tanks on the FPSO under annualised metocean conditions.*

The description covers the aspects of the receiving environment relevant for consideration of the environmental risks and impacts of planned and unplanned activities relating to the NE FPSO Operational Area and wider region.

3.1 Regional Setting

The NE FPSO Operational Area is located within the Commonwealth waters of the Timor Sea close to the Australian and Indonesian maritime boundary. It is located approximately 360 km north of the Kimberley coast, 340 km north east of Cartier Island and approximately 155 km south east of Timor Island, in water depths of approximately 380 m. The location is outside Australia's Exclusive Economic Zone (EEZ) in Australian territorial water classified as Extended Continental Shelf. The facility also lies outside areas defined under the Integrated Marine and Coastal Regionalisation of Australia (IMCRA v4.0). However, the adjacent Sahul Shelf area to the south of the facility is contiguous with that of the Northwest Shelf Transition Province, which straddles the North-West Marine Region and the North Marine Region (DSEWPaC 2012a; DSEWPaC 2012b)

This region is characterised by the following bio-physical features:

- Climatic conditions are humid tropical monsoonal;
- Strong seasonal winds and relatively low off-shore tropical cyclone activity;
- Surface ocean circulation is dominated by the Indonesian Through flow (ITF). The ITF dominates the majority of the water column and generally flows westwards through the Timor Trench (also known as the Timor Trough). During the summer, southwest winds associated with the cause a weakening of the ITF and may push some of its waters eastwards. During summer, mixing and upwelling processes can occur around the shelf break in the Timor Trench.
- Seabed geomorphology of the region is complex and includes the Timor Trench (running parallel to Timor Island), large shallow shelf area (such as the Sahul Shelf), a system of numerous submerged shoals (Sahul Shelf shoals which include: Karmt, Big Bank and Echo Shoals), large bank areas (such as the West Londonderry Rise), terraces, pinnacles (in the Josephe Boneparte Gulf), valleys (such as the Malita Shelf Valley) and basins (such as the Josephe Boneparte Basin).
- The seabed in the Northwest Shelf Transition Province consists of sediments that are dominated by carbonate sands and soft muds. The distribution and re-suspension of sediments on the inner shelf is strongly influenced by the strength of tides across the continental shelf as well as episodic cyclones.
- The region has high species richness, but a relatively low level of endemism. The majority of the region's species are tropical and are recorded in other areas of the Indian Ocean and western Pacific Ocean.
- Benthic communities range from nearshore benthic primary producer habitats such as seagrass beds, coral communities and mangrove forests to offshore, deepwater soft sediment seabed habitats (associated with low density sessile and mobile benthos such as sponges, molluscs and echinoids), and offshore submerged shoals (documented productive areas with primary producer habitats such as extensive macro-algal beds, coral communities and seagrass beds and associated reef habitat fish assemblages and sessile and mobile invertebrate biota.
- Presence of internationally significant migratory routes, resident and temporary populations, breeding and/or feeding grounds for a number of EPBC Act-listed threatened and migratory marine

species, including blue whales, marine turtles, whale sharks, great white sharks, green sawfish seabirds and migratory shorebirds.

- Key ecological features in the region include the carbonate bank and terrace system of the Sahul Shelf which likely enhance local productivity and the pinnacles of the Boneparte Gulf, and the Ashmore Reef, Cartier Island and Oceanic Shoals CMRs (CMRs), which provide hard substrate habitat for a diversity of species. Numerous offshore submerged shoals are also notable features in the region.

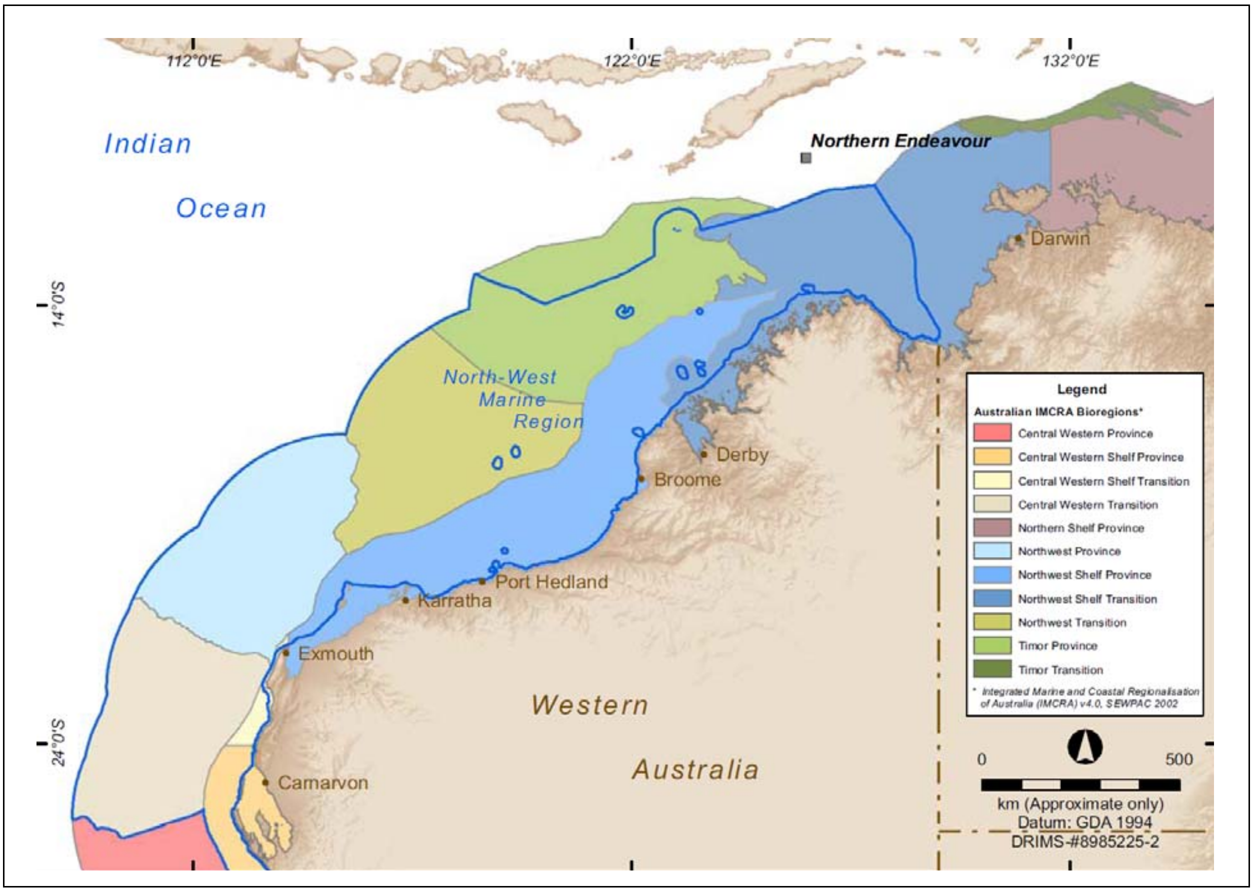

Figure 3-1. North West Marine Region and the location of the NE Facility

3.2 Physical Environment

3.2.1 Climate

The climate within the Timor Sea region is humid tropical, characterised by seasonal reversals of the prevailing wind. The region experienced a summer wet season from November to March and a milder drier winter season between April to September. There is a transition between these two seasons, generally in April and September/October.

Air temperatures in the region, as measured at the nearby Jabiru facility, follow seasonal trends. Average monthly temperatures recorded at the facility for the period 1983 to 1994 ranged from a minimum of 19.8 ºC to 34.2 ºC.

Winds vary seasonally, with a tendency for winds from the easterly quadrants to dominate in the winter dry season (April to September) and from the westerly quadrant in the summer wet season (November to March). Winds typically weaken and are more variable during the winter dry season.

Tropical cyclones generally form south of the equator in the eastern Indian Ocean and in Arafura and Timor Seas during the summer. In the Timor Sea most of the storms are tropical lows or developing storms passing to the south of the NE FPSO Operational Area. Tropical cyclone activity can occur between November and

April, with on average 1.24 storms per year pass within 300 km of the NE facility and an average of 3.99 storms per year pass within 1,000 km.

3.2.2 Oceanography

Throughout the year, water circulation in the region is dominated by the southwest flowing ITF and this is the predominant current flow affecting the NE FPSO Operational Area. The ITF dominates the majority of the water column and generally flows westwards through the Timor Trench (also known as the Timor Trough). During the summer, south westerly winds cause a weakening of the ITF by pushing some of its waters eastwards building a pressure gradient in adjacent the Banda and Arafura Seas. During this period, short lived mixing and upwelling processes can occur around the shelf break in the Timor Trench delivering cold deep water onto the shelf. At the end of the summer (March/April), this pressure is released, causing a south-westerly flow of water across the Sahul Shelf known as the Holloway Current. The Indonesian Through flow contributes to the westward flowing South Equatorial Current and the continued southward flow of currents along the coast of the North West Shelf via the Holloway Current or via the Eastern Gyral Current (Figure 3-2).

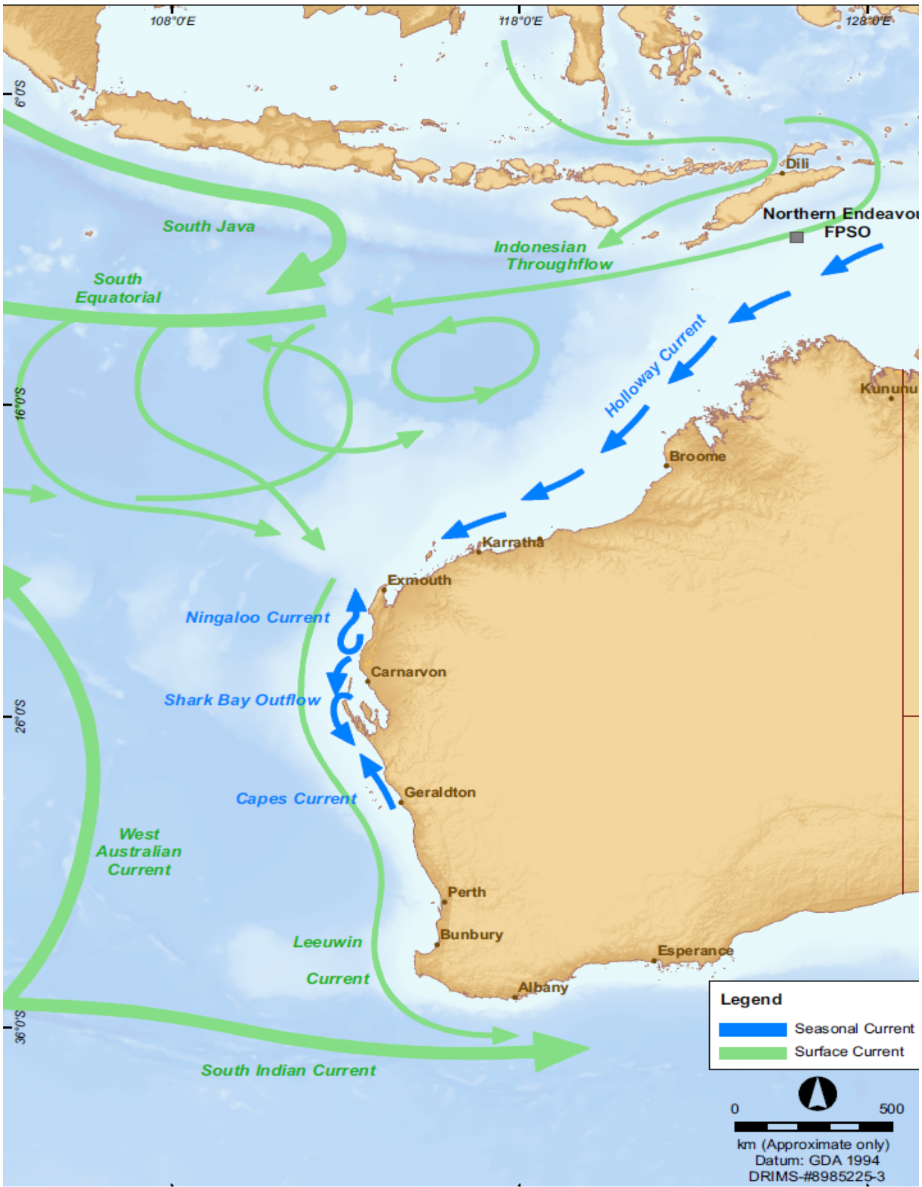

Figure 3-2. Generalised schematic of ocean circulation for the wider North West Marine Region

3.2.3 Water Quality

Mean monthly surface water temperatures in the region vary between about 26°C and 31°C. Seawater temperature records collected from Laminaria field over a one-year period show surface waters reached their maximum average temperatures in the period from November to April (average approximately 29.5°C) and were coolest in the period of July, August and September (average approximately 27.3°C). Similarly, near-seabed seawater temperatures (360 m water depth) were warmest in May (average approximately 10.4°C) and are coolest in September (average approximately 9.8°C).

The region is influenced by the delivery of warm lower-salinity waters via the ITF. Recorded salinities in the Timor Sea attain 34.51 to 34.75 Practical Salinity Unit PSU and average salinity in the North West Shelf Transition is 34.8 PSU.

Offshore waters, such as those around the NE FPSO Operational Area, are generally very clear. Nearshore waters are highly turbid particularly in summer, because of the interaction of high tides with increased inputs of sediments, organic material and freshwater from summer rains, in addition to the influence of cyclones.

3.2.4 Bathymetry and Seabed Composition

The Timor Sea encompasses the Sahul Shelf and Timor Trench and is a region of complex bathymetry. The Sahul Shelf is characterised as a large shallow platform extending across the inner and middle continental shelf approximately 300 km out from and parallel to the northern Australian coastline. It has complex bathymetry consisting of a series of rises, depressions, banks, terraces and channels as a result of Pleistocene sea level changes. In its centre is a broad depression called the Bonaparte Basin, where numerous pinnacles (up to 50 m high and 50 to 100 km long) and submerged shoals/banks occur. The edge of the Sahul Shelf is bounded by extensive areas known as the Van Diemen Rise on its northeast side of the shelf and the Londonderry Rise on the northwest side of the shelf. The Sahul Shelf also has numerous submerged shoals and banks including a series of shoals that rise sharply from the continental slope along its northern outer edge. The Sahul Shelf is separated from the island of Timor by the Timor Trough (also known as the Timor Trench), where water depths drop to in excess of 2,000 m.

The NE FPSO Operational Area itself lies on the outer shelf/continental slope in an area of uniformly smooth seabed ranging in depth from approximately 330 to 390 m, with an average slope of 1:120 (Figure 3-3). Surface sediments at the NE FPSO Operational Area are composed primarily of calcium carbonate material (approximately 80%) typically comprising approximately 50% silt, 30% clay and 20% sand particles. These surficial sediments, consisting of soft marine clays, form a layer tens of metres thick within the licence area. ROV footage collected in May 2001 indicated that the muddy seabed immediately around the NE FPSO is characterised as flat and featureless.

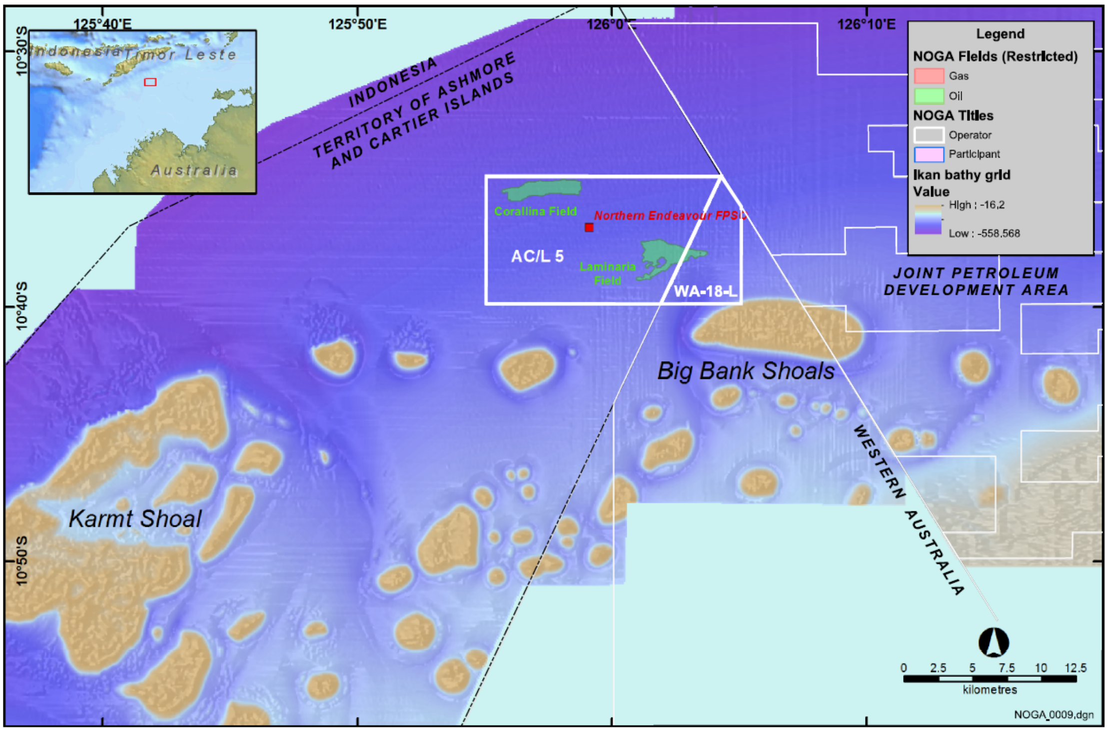

Figure 3-3. NE FPSO Operational Area and surrounds with the submerged shoal features in proximity to the licence area

3.3 Biological Environment

No critical habitats or Threatened Ecological Communities (TECs), as listed under the EPBC Act, occur within the NE FPSO Operational Area or ZPI, as indicated by the EPBC Act Protected Matters Report.

3.3.1 Benthic Communities

The benthos in the deeper continental slope waters to the north of the Sahul Shelf are characterised by sparse invertebrate assemblages. A number of targeted surveys to investigate epibenthos and infauna of the slope and shelf environments of the Timor Sea were carried out by Woodside as the previous Titleholder and Operator. In 1996 a survey found deep areas were characterised by low abundance, low diversity benthic infauna dominated by polychaetes and crustaceans, which were generally characteristic of the region. A similar sampling program has since been conducted in the adjacent AC/P8 permit where low abundance benthic fauna was also recorded.

Much of the outer mid-shelf is covered by a relatively featureless, sandy-mud seabed with a sparse covering of sessile organisms dominated by filter-feeding heterotrophs such as gorgonians, sponges, soft corals, echinoderms, ascidians and bryozoans and supporting mobile invertebrates such as echinoderms, prawns and detritus-feeding crabs.

Sea floor communities in deeper shelf waters receive insufficient light to sustain ecologically sensitive primary producer habitats and communities such as seagrasses, macroalgae or zooxanthellate scleractinian (reef building) corals. Given the depth of water of the Operational Area, and as indicated by the results of seabed surveys, these benthic primary producer groups do not occur in the Operational Area. Nonetheless, infrastructure in the upper water column and euphotic zone may support the photo-dependent sessile benthos such as macroalgae in the upper water column.

Sedimentary infauna associated with soft unconsolidated sediments of the NE FPSO Operational Area is widespread and well represented along the continental shelf and upper slopes in the region (Brewer *et al*, 2007). Consequently, in the context of the contiguous extent of habitats across the region, benthic habitat within the NE FPSO Operational Area, which consists primarily of soft unconsolidated sediments, is considered to be of relatively low environmental sensitivity.

3.3.2 Planktonic Communities

Plankton refers to marine flora and fauna that comprise the primary producing phytoplankton (cyanobacteria and other microalgae) and secondary consuming zooplankton (animal) comprising crustaceans (copepods), and the larvae and eggs of fish and invertebrates (meroplankton). Plankton blooms ('productivity events') are triggered by seasonal and sporadic upwelling events in the offshore waters of the Timor Sea. Productivity events are associated with the north and south continental edge of the Timor Trench and includes the area of the Sahul Shelf shoals. These productivity events are a key process in supporting the foundational trophic functional group driving many of the region's offshore marine ecosystems.

The ITF current delivers oligotrophic (nutrient-poor) waters to the offshore waters of the region (which include that of the NE FPSO Operational Area) supporting low phytoplankton biomass and low primary productivity. Seasonal upwelling of deeper nutrient-rich water and mixing results in localised and sporadic high phytoplankton productivity along the Sahul Shelf, particularly along channels that allow water to flow onto the shelf and immediately offshore of the shelf. The euphotic zone of the outer shelf extends to 100 m depth and diatoms and cyanobacteria are the predominant phytoplankton contributors. It is expected that the dominant primary consumers are copepods, with a wide range of secondary consumers, comprising larger planktonic taxa. Zooplankton recorded from several shoal locations on the outer Sahul Shelf were dominated by copepods with a diverse, abundant and spatially variable assemblages present at the time of sampling.

Chlorophyll (and inferred phytoplankton) levels are low in summer months (December to March) and higher in winter months (June to August).

3.3.3 Species Listed under the EPBC Act

A search using the Department of the Environment and Energy (DoEE) EPBC Act protected matters search tool (PMST) was carried out encompassing the NE FPSO Operational Area in July 2016. The threatened, migratory and listed species identified in the PMST are listed in Table 3-1 below.

The PMST for the NE Operational Area identifies a total of 27 EPBC Act listed marine species that may occur within the area. There are ten threatened marine species and 15 migratory species. Critical life stages of listed species

Table 3-1. EPBC Act PMST results for the NE FPSO Operational Area

Species	Common Name	Status
Birds		
Calonectris/Puffinus leucomelas	Streaked Shearwater	Migratory
Marine mammals - whales		
Balaenoptera musculus	Blue whale	Endangered/Migratory
Megaptera novaeangliae	Humpback whale	Vulnerable/Migratory
Balaenoptera bonaerensis	Antarctic minke whale	Migratory
Balaenoptera edeni	Bryde's whale	Migratory
Physeter macrocephalus	Sperm whale	Migratory
Orcinus orca	Killer whale	Migratory
Feresa attenuate	Pygmy killer whale	Listed marine species
Globicephala macrorhynchus	Short-finned pilot whale	Listed marine species
Kogia breviceps	Pygmy sperm whale	Listed marine species
Kogia simua	Dwarf sperm whale	Listed marine species
Peponocephala electra	Melon-headed whale	Listed marine species
Pseudorca crassidens	False killer whale	Listed marine species
Ziphius cavirostris	Cuvier's beaked whale	Listed marine species
Marine mammals – dolphins		
Delphinus delphis	Common dolphin	Listed marine species
Grampus griseus	Risso's dolphin	Listed marine species
Stenella attenuata	Spotted dolphin	Listed marine species

Stenella coeruleoalba	Striped dolphin	Listed marine species
Stenella longirostris	Long-snouted spinner dolphin	Listed marine species
Steno bredanensis	Rough-toothed dolphin	Listed marine species
Tursiops truncates	Bottlenose dolphin	Listed marine species
Fish		
Carcharodon carcharias	Great white shark	Vulnerable/Migratory
Pristis zijsron	Green sawfish	Vulnerable/Migratory
Reptiles - turtles		
Caretta	Loggerhead turtle	Endangered/Migratory
Chelonia mydas	Green turtle	Vulnerable/Migratory
Dermochelys coriacea	Leatherback turtle	Endangered/Migratory
Eretmochelys imbricata	Hawksbill turtle	Vulnerable/ Migratory
Lepidochelys olivacea	Olive Ridley turtle	Endangered/Migratory
Natator depressus	Flatback turtle	Vulnerable/Migratory
Reptiles - seasnakes		
Acalytophis peronei	Horned seasnake	Listed marine species
Aipysurus duboisii	Dubois' seasnake	Listed marine species
Aipysurus laevis	Olive seasnake	Listed marine species
Astrotia stokesii	Stokes' seasnake	Listed marine species
Diseira kingie	Spectacled seasnake	Listed marine species
Disteira major	Olive-headed seasnake	Listed marine species
Emydocephalus annulatus	Turtle-headed seasnake	Listed marine species
Hydrophis atriceps	Black-headed seasnake	Listed marine species
Hydrophis coggeri	Slender-necked seasnake	Listed marine species
Hydrophis elegans	Elegant seasnake	Listed marine species
Hydrophis ornatus	Spotted seasnake	Listed marine species
Lapemis hardwickii	Spine-bellied seasnake	Listed marine species
Pelamis platurus	Yellow-bellied seasnake	Listed marine species

Table 3-2 presents the periods of the year coinciding with key threatened species of the region identified through the EPBC PMST potentially occurring within the region.

Table 3-2: Sensitivities and timings for fauna adjacent to or within the NE FPSO Operational Area (indicating spatial overlap)

Sensitive Fauna	J	F	M	A	M	J	J	A	S	O	N	D
Blue Whales – Northern Migration *McCauley and Jenner, 2010*												
Blue Whales – Southern Migration *McCauley and Jenner, 2010*												
Killer Whales* *DEP 2001*												
Green Turtles – (nesting/hatchlings) *DSEWPAC, 2012c, DEWHA 2008*												
Hawksbill Turtles (peak nesting) *DSEWPaC 2012c, DEWHA, 2008*												
Flatback Turtles (nesting) *DSEWPaC 201c, DEWHA, 2008*												
Loggerhead Turtles (nesting) *DSEWPAC, 2012c, DEWHA, 2008*												

Sensitive Fauna	J	F	M	A	M	J	J	A	S	O	N	D
Olive Ridley Turtles (nesting) *DSEWPAC, 2012c*												
Leatherback Turtles (nesting) *DSEWPAC, 2012c*												

* Killer whale seasonality represents feeding on dugong in Shark Bay

Seasonality legend (months are indicative only)

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

3.3.4 Seabirds

The NE FPSO Operational Area may be occasionally visited by migratory and oceanic birds but does not contain critical habitats for any species.

No roosting or nesting habitat exists within the NE FPSO Operational Area, and there are no Ramsar Convention protected sites in the surrounding area. The nearest Ramsar sites, Ashmore Reef National Nature Reserve and the Cobourg Peninsula, are located over 300 km to the west and approximately 700 km to the southeast respectively.

There are a number of notable offshore island locations that include important seabird (e.g. terns, shearwaters, boobies and tropicbirds) and shorebird (e.g. sandpipers and greenshanks) feeding, breeding and nesting sites including Ashmore Reef, Cartier Island, Adele Island and Browse Island. The NE FPSO is located over 300 km from the closest of these locations.

The streaked shearwater (*Calonectris/Puffinus leucomelas*) (the only bird listed on the PMST) breeds in East Asia, migrating south to overwinter and is recorded regularly foraging in offshore northern Australian waters generally from October to March. The NE FPSO Operational Area is not critical habitat for the species but it may over fly the area during the Australian summer. There is no approved conservation advice and no recovery plan in place for this species.

3.3.5 Marine Mammals

Cetaceans

The PMST lists 20 cetacean species that may occur within the NE FPSO Operational Area, including two threatened and six migratory species. The endangered pygmy blue whale and the vulnerable humpback whale are two whale species that undertake seasonal migrations as they travel between northern breeding grounds and southern feeding grounds.

Humpback Whales

The humpback whale (*Megaptera novaeangliae*) is the most commonly sighted whale along the WA coastline. The species is observed annually completing their seasonal northern and southern migrations to and from the Camden Sound area of the west Kimberley in the winter and spring months, after feeding in Antarctic waters during the summer months.

The Kimberley coast from the Lacepede Islands to north of Camden Sound is the main breeding and calving area for the Western Australian population of humpback whales. Large concentrations of humpbacks area observed in Camden Sound and Pender Bay between July and October each year. Satellite tracking shows that migratory areas do not extend as far as north or west as the NE FPSO Operational Area. Records from 2011 until mid-June 2016 indicate no sightings of humpback whales have occurred within the NE FPSO Operational Area. The likelihood of humpback whales in NE FPSO Operational Area is therefore remote.

The humpback whale migration routes are reported to be within the continental shelf boundary (200 m bathymetry) (Figure 3-4 and Figure 3-5) and migrations occur between June and October each year. Tagged humpback whale data confirm the northerly migration route is located close to the WA coastline, often within a few tens of kilometres from shore and the width of the migratory corridor is generally less than 60 km.

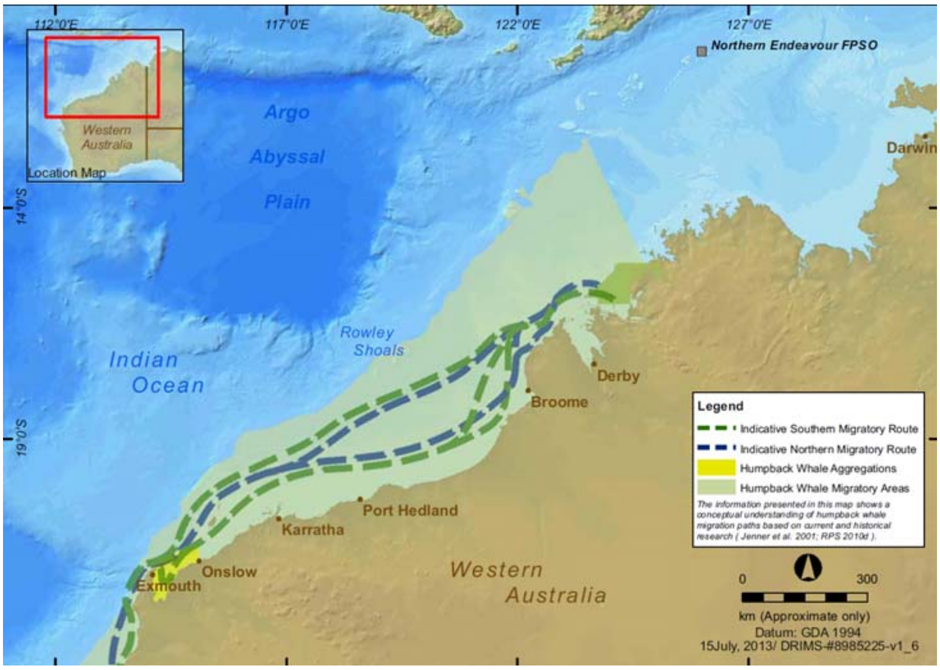

Figure 3-4. Humpback whale migration routes in North West Australia in relation to the NE FPSO Operational Area

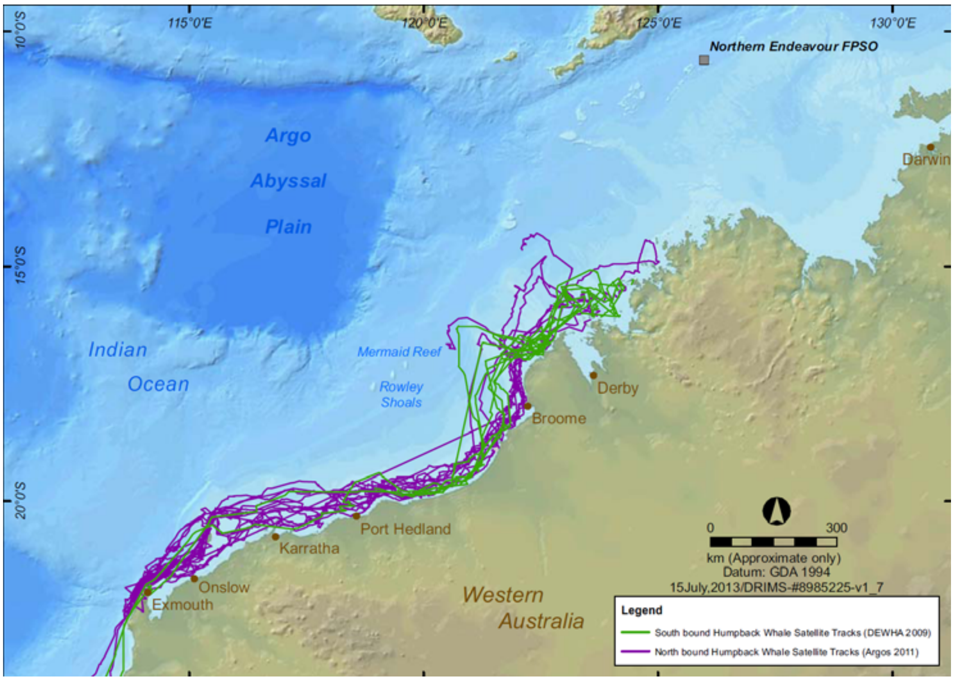

Figure 3-5. Humpback whale northern migratory tracks as recorded by satellite tracking

The Humpback Whale Recovery Plan 2005-2010 is no longer in force. Mapping in the current conservation advice for the humpback whale indicates that there is no key habitat in the NE FPSO operational area (or ZPI), with the humpback whale's core range, calving and resting grounds located a significant distance to the southwest of the FPSO. While the NE FPSO operational area and ZPI overlaps the 'likely species range' (where humpback whales may be present on a seasonal basis), so too do most Australian waters (and those beyond the Australian EEZ), so FPSO planned and unplanned activities will not limit the habitat available to this species.

Blue whales

There are two recognised subspecies of blue whale in the Southern Hemisphere, which are both recorded in Australian waters. These are the southern (or 'true') blue whale (*Balaenoptera musculus intermedia*) and the 'pygmy' blue whale (*Balaenoptera musculus brevicauda*). In general, southern blue whales occur in waters south of 60°S (close to Antarctica) and pygmy blue whales occur in waters north of 55°S. On this basis, nearly all blue whales in the northwest region are likely to be pygmy blue whales.

Pygmy blue whales are highly mobile species that exhibit seasonal migratory movements between Australia and Indonesia (Figure 3-6). Satellite telemetry results showed pygmy blue whales migrating from the Perth Canyon and Naturaliste Plateau region in March/April and reaching Indonesia in June where they remain until at least September. They then migrate south along the edge of the WA continental slope and finish by December in the subtropical frontal zone. Satellite tagging conducted in 2011 confirmed the Perth Canyon/Naturaliste Plateau and possibly North West Cape/Ningaloo Reef as areas of activity off the WA coast where pygmy blue whales aggregate to feed with some predictability. Geographe Bay in southern WA (approximately 2,500 km south of the NE FPSO Operational Area) is also a known resting place from October to December. Anecdotal observations of potential feeding aggregations on the outer continental shelf of the Timor Sea south of Timor-Leste was reported by marine mammal observers on a marine seismic survey during September and December 2007, though the area is not noted as a foraging region. Eighteen individuals (13 pods) positively identified in the September survey period confirmed the presence of Pygmy Blue whales off the southern coast of Timor-Leste. The whales exhibited deep diving feeding behaviour in waters between approximately 1,000-2,500 m depth.

In general, sightings of transiting pygmy blue whales are likely to be uncommon within the NE FPSO Operational Area, however, migratory routes and opportunistic feeding aggregations at frontal formations (upwellings) in offshore, deepwater areas to the south of Timor and Timor-Leste indicate pygmy blue whales may be present in the wider region, particularly the winter months (June to September).

A Biologically Important Area (BIA) (distribution) for the pygmy whale overlaps the NE FPSO Operational Area. The nearest BIA for foraging occurs around the Scott Reef complex (570 km to the southeast of the FPSO).

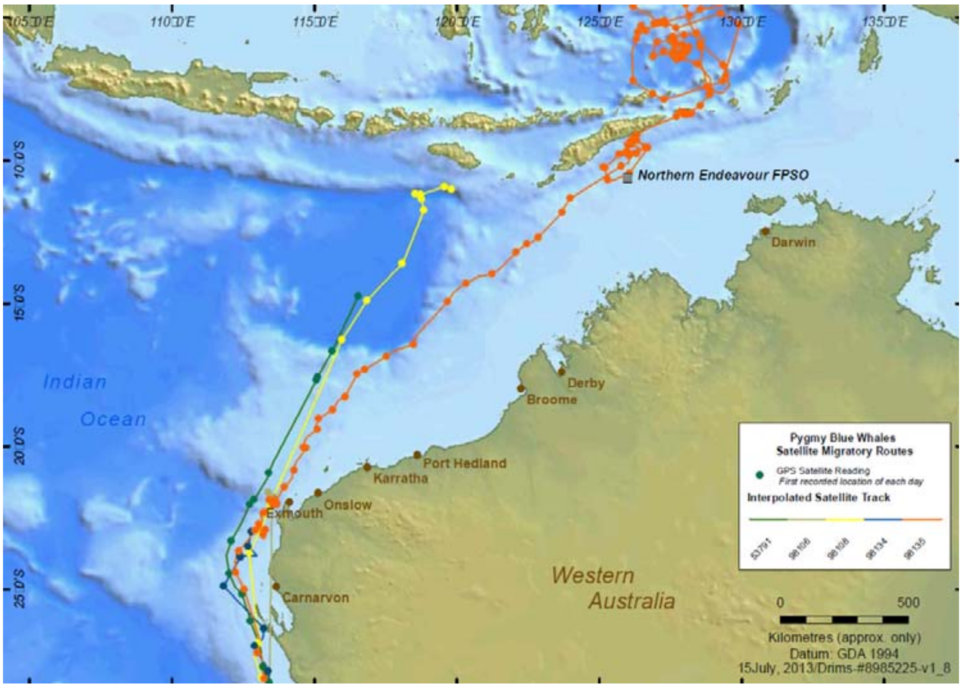

Figure 3-6. Pygmy blue whale satellite tracks showing migration routes between Australia and Indonesia in relation to the NE FPSO location

Antarctic mink whale

The Antarctic minke whale (*Balaenoptera bonaerensis*) is distributed worldwide in oceanic habitats, feeding in cold waters and migrating to warmer waters to breed. Detailed information on timing and location of north and south bound migrations, and location of breeding grounds is not well known. Antarctic minke whales have been recorded off all Australian states and are thought to migrate up the Western Australian coast to approximately 20°S to feed and possibly breed in winter.

It is unlikely that Antarctic minke whales occur within the NE FPSO Operational Area. There is no BIA for this species around the NE FPSO Operational Area.

Bryde's whale

Bryde's whale (*Balaenoptera edeni*) is restricted to tropical and temperate waters and has been recorded off all Australian states. Bryde's whales occur in both oceanic and inshore waters with the only key localities recognised in Western Australia being in the Abrolhos Islands and North of Shark Bay. Two forms of the species are recognised: inshore and offshore. The offshore form is thought to migrate seasonally, heading towards warmer tropical waters during the winter.

Given there are only three key localities for Bryde's whale in Australia (the Abrolhos Islands, North Shark Bay and off Queensland (Bannister *et al*, 1996)), the likelihood of occurrence of Bryde's whales within the NE FPSO Operational Area is remote, possibly limited to a few individuals transiting the area. There is no BIA for this species around the NE FPSO Operational Area.

Killer whale

The killer whale (*Orcinus orca*) is widespread from polar to equatorial regions of all oceans and has been recorded off all states of Australia. This species undertakes seasonal movements related to food supply and appear to be more common in cold, deep waters. However, they have been observed along the continental slope and shelf, as well as in shallow coastal areas of Western Australia. The only recognised key localities for killer whales in Australia are Heard and Macquarie Islands. There is no BIA for this species around the NE FPSO Operational Area.

Given the widespread distribution of killer whales and their preference for colder regions, the NE FPSO Operational Area is unlikely to represent an important habitat for this species, although they may occasionally be observed transiting the area.

Sperm whale

Sperm whales (*Physeter macrocephalus*) are distributed worldwide in deep waters (greater than 200 m) off continental shelves and sometimes near shelf edges, averaging 20 to 30 nm offshore. The species is known to migrate northwards in winter and southwards in summer. However, detailed information on the distribution of sperm whales off Western Australia is not available for the timing of north and south-bound migrations. The only key locality recognised in WA for sperm whales is along the southern coastline between Cape Leeuwin and Esperance.

There is no BIA for this species around the NE FPSO Operational Area. The likelihood of occurrence of sperm whales within the NE FPSO Operational Area is remote, possibly limited to a few individuals transiting the area.

Other whales

Seven other whale species listed under the EPBC Act as 'listed marine species' may occur around the NE FPSO Operational Area, though they are unlikely to be present in high numbers or at predictable times of the year.

Dolphins

There are seven dolphins listed under the EPBC Act PMST that may occur around the NE FPSO Operational Area, all of which are listed as 'listed marine species.'

Common dolphins (*Delphinus delphis*) are recorded in all Australian waters and are not thought to be migratory. The species is associated with high topographical relief of the ocean floor, escarpments and upwelling areas, and there are no known key localities in Australia.

Risso's dolphin (*Grampus griseus*) is distributed through all oceans, occurs inshore and offshore, but is generally considered pelagic and oceanic, and Fraser Island in Queensland has the only known 'resident' population.

The bottlenose dolphin (*Tursiops truncatus*) is a cosmopolitan species found in all Australian waters (except the Northern Territory), and is coastal, estuarine, pelagic and oceanic in nature.

3.3.6 Marine Reptiles

Marine Turtles

All six marine turtle species recorded for the North West Transition province are listed in the EPBC Act PMST and identified as possibly occurring within the NE FPSO Operational Area. These are the green turtle (*Chelonia mydas*), leatherback turtle (*Dermochelys coriacea*), loggerhead turtle (*Caretta caretta*), hawksbill turtle (*Eretmochelys imbricata*), Olive Ridley turtle (*Lepidochelys olivacea*) and flatback turtle (*Natator depressus*).

Five of the turtle species (green, hawksbill, flatback, leatherback and Olive Ridley) have significant nesting beaches along the mainland coast and islands in the region including Ashmore Reef, the Tiwi Islands and Coubourg Peninsula.

Table 3-3 provides additional details of the marine turtle species identified, including breeding and nesting seasons, diet and key habitats.

There are no documented turtle feeding, nesting or foraging areas in the NE FPSO Operational Area. Given the distance offshore (approximately 360 km north of the Kimberley coastline and 155 km south east from Timor Island), distance from shallow shoals (10 km), depth range of surrounding offshore waters (330 to 390 m), and absence of potential nesting or foraging sites (i.e., no emergent islands, reef habitat or shallow shoals), the NE FPSO Operational Area is not considered an important habitat for marine turtles.

Post-nesting migratory routes recorded for green and flatback Turtles at the Lacapede Islands and green turtle tracking for post-nesting individuals from Scott Reef indicate no overlap with the NE FPSO Operational Area.

Seasnakes

Seasnakes occur in the Northwest Shelf Transition Province in waters up to approximately 100 m depth and are reported to occur in offshore and nearshore waters. Ashmore Reef and Cartier Island have been recognised for their high diversity and density of seasnakes. Seasnakes of the families Hydrophidae and Laticaudidae are widespread in the region. The PMST lists 13 species of seasnake under the EPBC Act that may occur in the NE FPSO Operational Area, none of which are listed as threatened or migratory.

3.3.7 Sharks

Great White Shark

The great white shark *(Carcharodon carcharias)*, listed as Vulnerable under the EPBC Act, may occur within the NE FPSO Operational Area. Great white sharks are known to live for 30 years or more and with a range extending from central Queensland, around the southern coastline and up to the North West Cape in Western Australia. Great white sharks are highly mobile apex predators, with a low density and a widely dispersed population.

This species may transverse the NE FPSO Operational Area infrequently throughout the year.

Table 3-3. Key Information on marine turtle's ecology in northwest Australia

Species	Key Season	Diet	Key Habitats	BIA
Green turtle	Breeding: Approximately September to March. Nesting: November to April. Peak period from January to February. Year-round nesting occurs at South Scott Reef and Ashmore Reef (peaks in summer).	Seagrasses and algae.	Nearshore reefal habitats in the photic zone. Major nesting sites: Tiwi Islands (Melville and Bathurst Islands), Cobourg Peninsula (Garig Gunak Barlu National Park, NT, offshore islands between Croker Island and Goulburn Island, Lacepede Islands, North West Cape, Barrow Island, Montebello Islands, Muiron Islands and some islands of the Dampier Archipelago. Smaller rookeries occur adjacent to the Kimberley region (such as Browse Island, Maret Island, Cassini Island and other islands of the Boneparte Archipelago) and Sandy Islet (Scott Reef). Nesting also occurs Casaurina Beach (Darwin). Ashmore Reef is a significant breeding area. Records show it is a critical nesting and inter-nesting habitat as well as supporting significantly large feeding aggregations of green turtles.	Inter-nesting areas around offshore islands in the region, with foraging area through the Bonaparte Gulf.
Loggerhead turtle	Breeding: Approximately September to March Nesting: Late October to late March. Peak period from late December to early January.	Carnivorous - feeding mainly on molluscs and crustaceans.	Nearshore and island coral reefs, bays and estuaries in tropical and warm temperate latitudes. Distribution: Shark Bay to North West Cape and as far north as Muiron Islands and Dampier Archipelago. Nesting not reported from the North Marine Region.	Foraging area in the northwestern part of the Bonaparte Gulf and around Broome.
Hawksbill turtle	Nesting: All year round with peak in September to January.	Mainly sponges – also seagrasses, algae, soft corals and shellfish.	Nearshore and offshore reefal habitats. Major nesting sites: coasts and islands off east Arnhem Land (such as Groote Eylant and surrounds). Small numbers nest at Ashmore Reef. Small numbers nesting in the Kimberley Also (such as at One Arm Point in King Sound). Small numbers recorded at Melville Island and Oxley Island (offshore Coubourg Peninsula, east of Melville Island).	Inter-nesting around Scott Reef and Ashmore Reef, along with east Arnhem Land.
Flatback turtle	Nesting: November to March with peak period in January. (in the far north, nesting occurs in dry season winter months).	Carnivorous - feeding mainly on soft bodied prey such as sea cucumbers, soft corals and jellyfish.	Nearshore and offshore sub-tidal and soft-bottomed habitats of offshore islands. Major nesting sites: Melville and Bathurst Islands and to the east at Coubourg Peninsula. Smaller rookeries occur in Camden Sound (at Slate Island), on numerous islands of the Buccaneer and Boneparte Archipelago as well as at coast and island locations along the Josephe Bonaparte Gulf. Nesting habitat areas are distributed from the Lacepede Islands to Exmouth. Other significant rookeries include Eighty Mile Beach, Roebuck Bay, Thevenard Island, the Montebello Islands, Varanus Island, the Lowendal Islands, and islands of the Dampier Archipelago.	Foraging area in the northwestern part of the Bonaparte Gulf, with inter-nesting areas around many Australian mainland coastlines.
Leatherback turtle	Nesting: December to January.	Carnivorous - feeding mainly in the open ocean on jellyfish and other soft-bodied invertebrates.	Nearshore, coastal tropical and temperate waters. Significant nesting area at Danger Point (Coubourg Peninsular). Low numbers recorded nesting at Cobourg Peninsula and northwest Arnhem Land. This species may be encountered within the NWS but noted that there are no known nesting sites within WA.	Small inter-nesting area at the northern tip of northwest Arnhem Land.
Olive Ridley turtle	Nesting: All year round with peak in April to November.	Carnivorous – feeding mainly on crustaceans and molluscs.	Nearshore and offshore tropical and subtropical waters. Low intensity nesting in Northern Territory and possibly North Kimberley. Significant nesting habitat: north-west Arnhem Land (including Melville Island, Bathurst Island, Coubourg Peninsula, McCluer Island Groups and Grant Island).	Foraging area through the Bonaparte Gulf, with inter-nesting areas around Darwin and east around Arnhem Land.

Green Sawfish

The NE FPSO EPBC PMST lists the green sawfish (*Pristic zijsron)* as a Vulnerable species that may occur within the NE FPSO Operational Area. Green sawfish are commonly found in freshwater rivers and estuarine environments, most frequently being found in very shallow water to offshore grounds of up to 70 m. Green sawfish are found in Indonesian and Australian waters and may migrate between the two countries.

The NE FPSO is located in approximately 380 m of water far removed from freshwater and estuarine environments, so the likliehood of green sawfish occurring in the nearby vicinity of the FPSO is remote, though possible, due to their migration between Australia and Indonesia. Only adults are known to occur in waters this deep, with juveniles restricted to coastal areas.

3.3.8 Fish

No teleost fish species that are listed under the EPBC Act were identified as potentially occurring within the NE FPSO Operational Area by the PMST, however it is possible that listed species such as seahorses and pipefish species occur in shallow, nearshore waters.

Pelagic scalefish that occur in the Timor Sea region include billfish, tunas and mackerels. Key species are swordfish (*Xiphius gladus*), blue marlin (*Makaira mazara*), black marlin (*Makaira indica*), sailfish (*Istiophorus platypterus*), yellowfin tuna (*Thunnus albacares*), long tail tuna (*Thunnus tonggol*), grey mackerel (*Scomberomorus semifasciatus*) and Spanish mackerel (*Scomberomorus commerson*). Demersal species found in the region include red emperor (*Lutjanus sebae*), goldband snapper (*Pristipomoides multidens*) and a range of other snappers (Lutjanidae), emperors (Lethrinidae) and cods (Serranidae). The likelihood of occurence of any large or significant populations of these species residing within the deep waters of the region is remote, as these species are strongly associated with shallow environments such as nearshore shelf systems and offshore reefs and atolls.

The NE FPSO Operational Area comprises featureless, flat soft sediment seabed, and consequently the fish fauna are not expected to be abundant and diversity is expected to be limited due to the lack of habitat complexity. It is noted however that fish abundance and diversity increases with presence of artificial infrastructure.

3.3.9 Cultural and National Heritage

There are no known sites of Indigenous or European cultural or heritage significance within or in the vicinity of the NE FPSO Operational Area. The islands of several oceanic reef systems, namely Ashmore Reef and Cartier Island do contain Indonesian artefacts (ceramics and graves) within the protected reserve areas.

There are no listed historic and other shipwrecks or heritage sites within the NE FPSO Operational Area.

3.3.10 Tourism Activity and Recreational Fishing

Given the remote offshore and deepwater location of the NE FPSO Operational Area, no tourism activities are known to take place in or around the NE FPSO Operational Area. Recreational fishing generally tends to be concentrated in state waters adjacent to coastal population areas. Commercial tour operators and recreational fishing charters visit the Ashmore Reef and Cartier Island areas intermittently, primarily for scuba diving and bird watching and game fishing.

3.3.11 Other Users – Petroleum Exploration and Production

The NE FPSO Operational Area is located within an area of established oil and gas operations, with the Bayu-Undan field and FPSO infrastructure located 85 km to the southeast (operated by ConocoPhillips) and the Montara field and unmanned wellhead platform infrastructure located 280 km to the southwest (operated by PTTEP).

3.3.12 Commercial Fishing

The NE FPSO Operational Area is located outside the limit of the Australian Fishing Zone (AFZ) and adjacent to a number of Commonwealth- and State-managed fishery areas.

Figure 3-7 provides a general indication of the fishing grounds for the Commonwealth and State fisheries in relation to the location of the NE FPSO. These fisheries are described in further detail in the following sub-sections.

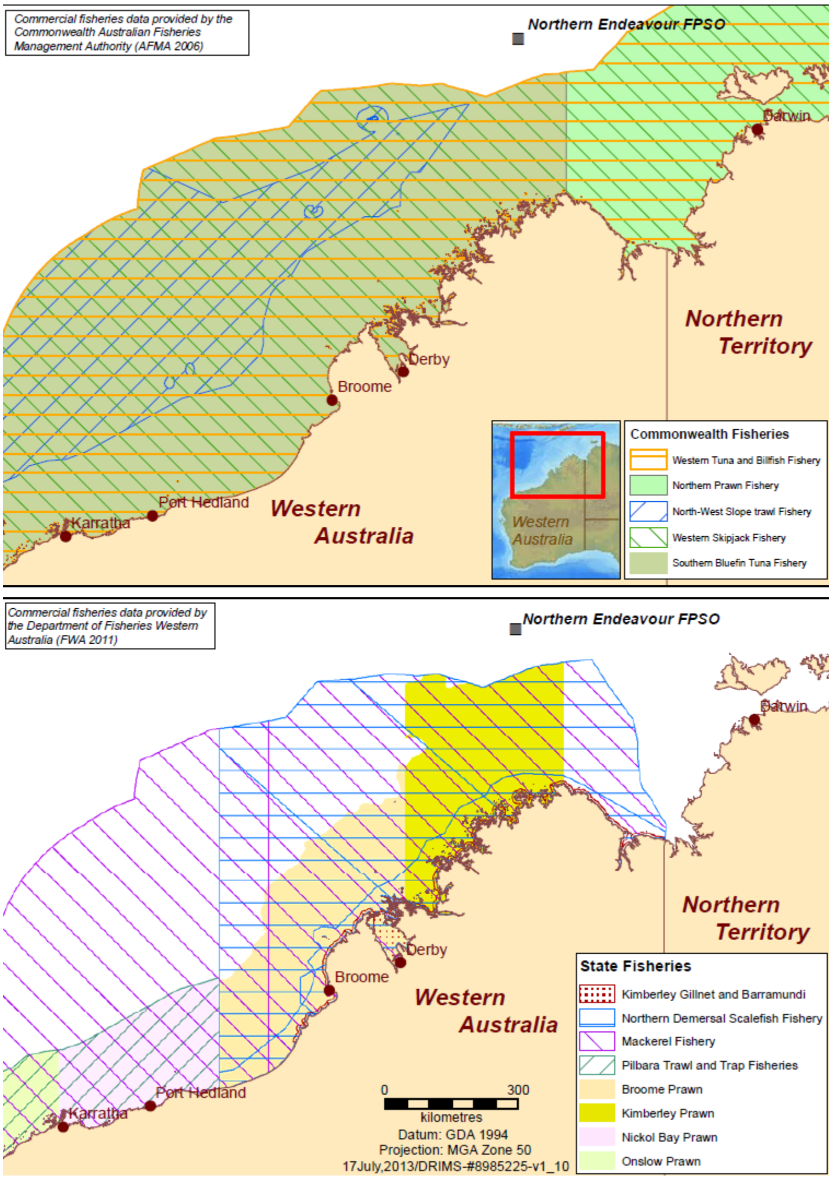

Figure 3-7. North Western Commonwealth (top) and State (bottom) Fisheries in relation to the NE FPSO Operational Area

Commonwealth Fisheries

Commonwealth-managed fisheries include all commercial fisheries operating within the AFZ, which extends 200 nm from the mainland coast. The NE FPSO Operational Area is located in an offshore area outside the AFZ. Five Commonwealth-managed fisheries are licensed to operate adjacent to the operational area, these being the:

- North West Slope Trawl Fishery;
- Western Tuna and Billfish Fishery;
- Western Skipjack Tuna Fishery;
- Southern Bluefin Tuna Fishery; and
- Northern Prawn Fishery.

None of these fisheries operate within or around the NE FPSO Operational Area, though the ZPI overlaps the North West Slope Fishery.

State Fisheries

A number of Western Australian-fisheries, as outlined here, operate in the region, though they do not operate in or around the NE FPSO Operational Area:

- Mackerel Fishery;
- North Coast Demersal Scalefish Fishery (NCDSF) (Kimberley sector);
- Northern Prawn Managed Fishery;
    - Kimberley sector; and
    - Broome sector.

The WA Fishing Industry Association (WAFIC) advised NOGA that due to the location of the NE FPSO, state-managed fisheries will not be affected by the operation of the FPSO. The Mackeral Fishery and NCDSF may be overlapped by the ZPI.

3.3.13 Australia-Indonesia MoU 74 area

Indonesian fishers have sailed to and actively fished Australia's northern shore for more than three centuries, targeting trepang (sea cucumber), shark fin and other marine resources such as trochus shells. During the last 30 years, access to Australian waters has been restricted and an area designated for Indonesian fishers to fish was established in 1974. The MoU 74 was agreed between the Australian and Indonesian governments and permits fishing by traditional methods and is located on the northwest continental shelf, including the emergent reefs and associated cays/islands of Ashmore Reef, Cartier Island, Seringapatam, Scott Reef and Browse Island.

Scott Reef is the principal reef to which Indonesian fishers regularly sail on a seasonal basis. The majority of Indonesian fishers travel to Scott Reef from the islands of Roti (near West Timor) and Tonduk and Rass (in East Java) during July to October. Target marine resources fished were shallow water lagoon trepan and trochus shells, and some finfish taken primarily for consumption. Estimates of the monetary value of the resources gathered were as much as 50% of the fishers' total annual income and hence the fishing trips to Scott Reef are a major source of income.

Indonesian fishermen may travel through the NE FPSO Operational Area on the way to the MoU 74 area.

3.3.14 Shipping

The region supports commercial shipping activity, the majority of which is associated with the mining, oil and gas industry, particularly the NE FPSO facility itself. Major shipping routes in the area are associated with entry to the ports of Darwin, Port Hedland and Dampier. Shipping activities in the region include:

- International bulk freighters/tankers arriving and departing from Dampier, Port Hedland and Darwin, including mineral ore, hydrocarbons (LNG, liquefied petroleum gas, condensate) and salt carriers;
- Domestic support/supply vessels servicing offshore facilities;
- Construction vessels/barges/dredges; and
- Offshore support vessels.

The AMSA has introduced a network of commercial shipping fairways on the NWS in order to reduce the risk of vessel collisions with offshore infrastructure. The NE FPSO Operational Area is distant from these fairways.

3.4 Environmental Values and Sensitivities

The environmental values and sensitivities of the receiving environment for the wider region in which the NE FPSO is located are described in this section. The offshore environment of the Timor Sea and surrounds contains environmental features of high value or sensitivity. These include Commonwealth offshore waters, Ramsar sites, Commonwealth Marine Reserves (CMRs), State Marine Parks, shoals and the key areas of importance for critical life stages (such as feeding and breeding) for listed marine species (resident and temporary visitors). These features include habitats or species that are particularly vulnerable or that provide valuable ecological services such as coral reefs, mangroves, seagrass meadows and macroalgae.

A summary of the conservation values of relevance to the NE FPSO ZPI are presented in Table 3-4.

Table 3-4. List of conservation values in the NE FPSO ZPI

Conservation values in the ZPI
MNES under the EPBC Act
CMRs
World Heritage Properties
National Heritage Places
Wetlands of International Importance
Nationally threatened species and ecological communities
Migratory species
Commonwealth marine areas
Other areas of national importance
Commonwealth heritage places
Key Ecological Features
Nationally important wetlands
Threatened ecological communities
Non-protected areas
Submerged shoals/banks of the Sahul Shelf
Hibernia Reef
Timor Leste (Indonesia)
Timor Island (Indonesia)
Roti Island (Indonesia)

3.4.1 Commonwealth Marine Reserves

In 2012, the Commonwealth government established a number of marine reserves within the North and North West bioregions. These CMRs are currently under transitional arrangements until management plans come into effect. Transitional arrangements involve no changes in use for marine users, so requirements for class approvals for petroleum activities have not yet come into effect.

The CMRs within the ZPI are the Oceanic Shoals, Kimberley, Ashmore Reef and Cartier Island CMRs (Figure 3-8), which are described here.

Oceanic Shoals CMR

The Oceanic Shoals CMR covers an area of 71,744 km^2 with its northern boundary on the edge of Australia's EEZ, and waters depths ranging up to 300 m in the deepest parts. Its nearest boundary is located 99 km (53 nm) south of the NE FPSO. Major conservation values of the reserve include:

- Important resting area between egg laying (inter-nesting area) for the Flatback Turtle and Olive Ridley Turtle;
- Important foraging area for the threatened Loggerhead Turtle and Olive Ridley Turtle;
- Examples of the ecosystems of two provincial bioregions: The Northwest Shelf Transition Province and the Timor Transition Province. Key ecological features include:
    - Carbonate bank and terrace system of the Van Diemen Rise (unique sea-floor feature);
    - Carbonate bank and terrace system of the Sahul Shelf (unique sea-floor feature);
    - Pinnacles of the Bonaparte Basin (enhanced productivity, unique seafloor feature); and
    - Shelf break and slope of the Arafura Shelf (unique sea-floor feature).

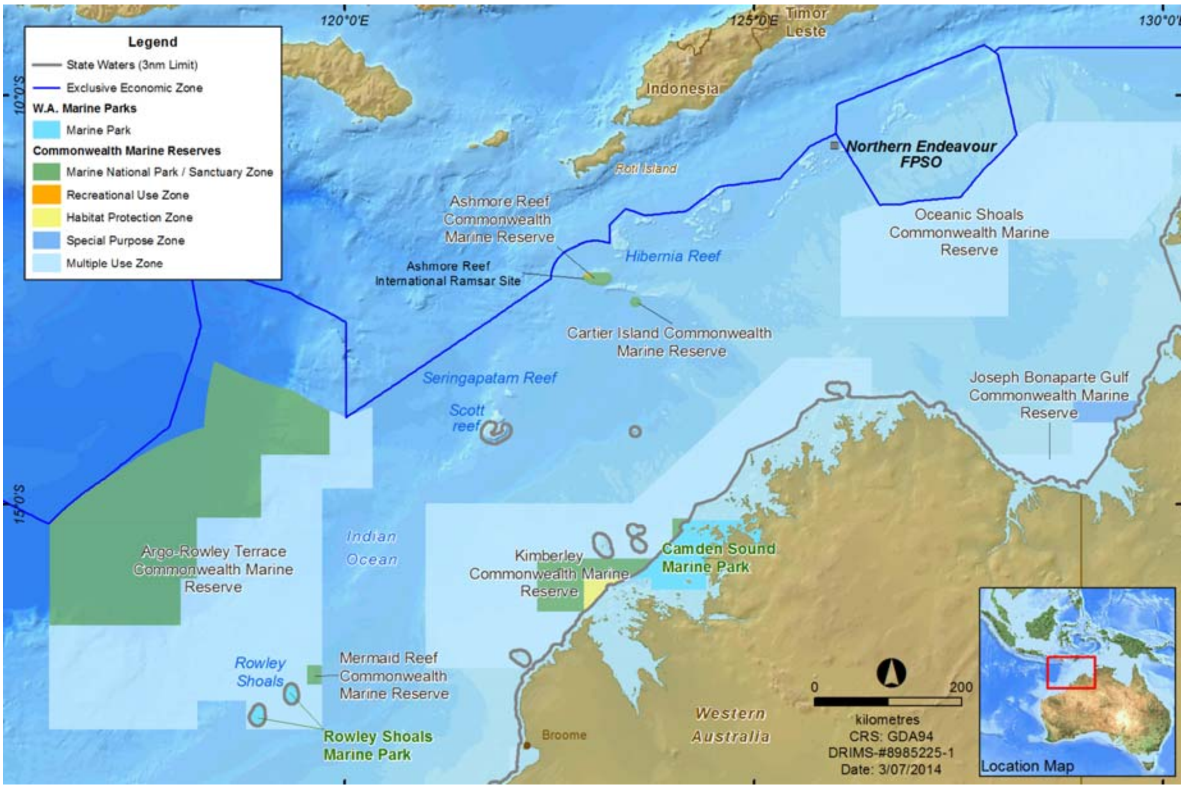

Figure 3-8. Commonwealth CMRs and WA marine parks in relation to the NE FPSO

Ashmore Reef CMR

The Ashmore Reef CMR covers an area of 583 km^2 and the majority is classified as a Strict Nature Reserve. The island is also a designated Ramsar Wetland. Its nearest boundary is located 346 km (187 nm) southwest of the NE FPSO. Key conservation values of the reserve include:

- Covers an area of 583 km^2 and includes two extensive lagoons, shifting sand flats and cays, seagrass meadows and a large reef flat (covering an area of approximately 239 km^2.
- Its islands providing a resting place for migratory shorebirds and supporting large seabird breeding colonies such as brown booby and great frigatebird.
- Biologically rich habitat including primary producer habitat (mangroves, seagrass beds and coral reefs) and their associated benthic communities, fishes and other biota.
- Regionally important nesting, inter-nesting, foraging areas for marine turtles (particularly green but also hawksbill and loggerhead). An estimated 11,000 marine turtles feed in the area throughout the year.
- Isolated, small dugong population of less than 50 individuals that breed and feed around the reef. This population is thought to be genetically distinct from other Australian populations.
- Important seabird rookeries and staging points/feeding areas for migratory sea/shorebirds (including: colonies of bridled terns, common noddies, brown boobies, eastern reef egrets, frigatebirds, tropicbirds, red-footed boobies, roseate terns, crested terns and lesser crested terns).
- International significance for seasnake abundance and diversity.
- Importance cultural and heritage sites: Indonesian artefacts and grave sites.

Cartier Island CMR

The Cartier Island CMR covers an area of 167 km^2 and its nearest boundary is located 332 km (179 nm) south of the NE FPSO. It is classified as a strict nature reserve and the CMR's key conservation values include:

- The reserve covers an area 167 km^2 and includes an unvegetated sand island, extensive reef flat and subtidal reef system surrounding the island, a small submerged pinnacle (Wave Governor Bank and two shallow pools to the northeast of the island).
- Internationally significant for its abundance and diversity of sea snakes.
- Large and significant feeding populations of green, hawksbill and loggerhead turtles occur around the reefs.
- Supports some of the most important seabird rookeries on the NWS including colonies of bridled terns, common noddies, brown boobies, eastern reef egrets, frigatebirds, tropicbirds, red-footed boobies, roseate terns, crested terns and lesser crested terns.
- Important staging points/feeding areas for many migratory seabirds.
- Cultural and heritage site: *Ann Millicent* historic shipwreck.
- Ashmore and Cartier CMR areas have historical and cultural significance. In particular, traditional Indonesian fishers have an historic and ongoing cultural and economic association with the islands and reefs of the region.

Kimberley CMR

The Kimberley CMR covers approximately 74,469 km^2 with water depths ranging from less than 15 m up to 800 m. Its nearest boundary is located 289 km (156 nm) south of the NE FPSO. The reserve excludes the Lacepede Islands and Adele Island. The reserve contains several conservation values including:

- Foraging areas for migratory seabirds, migratory dugongs, dolphins and turtles.

- Migratory pathway and nursery areas for the humpback whale.
- Adjacent to areas used for foraging and pupping by sawfish and nesting areas for green turtles.
- Wide variety of seafloor features in the reserve, including continental shelf, slope, pinnacle, terrace and shoals.
- Continental slope demersal communities (the second-richest area for demersal fish species in Australia).
- Ancient coastline (an area of enhanced productivity).

3.4.2 National Heritage Places

The National Heritage List is Australia's list of natural, historic and Indigenous places of outstanding significance to the nation.

There are no National Heritage Places within the ZPI of the NE FPSO, with the nearest marine National Heritage Place being the Dampier Archipelago, WA (1,460 km to the southwest of the NE FPSO).

3.4.3 Wetlands of International Importance

The Convention on Wetlands of International Importance (the Ramsar Convention) aims to halt the worldwide loss of wetlands and to conserve, through wise use and management, those that remain.

The Ashmore Reef National Nature Reserve is the only Ramsar wetland occurring within the ZPI of the NE FPSO. Its values are summarised in Section 3.4.1.

3.4.4 Commonwealth Heritage Places

The Commonwealth Heritage List is a list of natural, Indigenous and historic heritage places owned or controlled by the Australian Government. These include places connected to defence, communications, customs and other government activities that also reflect Australia's development as a nation.

There are 19 Commonwealth Heritage List sites in WA and 12 in the NT, along with 49 in external territories. Within the ZPI of the NE FPSO are the 'Scott Reef and surrounds', 'Seringapatam Reef and surrounds' and 'Ashmore Reef National Nature Reserve'. The values of these places are briefly described in Table 3-5.

Table 3-5. Commonwealth Heritage Places in the NE FPSO ZPI

Commonwealth Heritage Place	Distance from NE FPSO	Description
Scott Reef and surrounds	576 km southeast	Scott Reef is listed because it is a significant component of a disjunct chain of shelf edge reefs separated from Indonesia by the Timor Trough. The place is regionally significant both because of its high representation of species not found in coastal waters off WA and for the unusual nature of its fauna that has affinities with the oceanic reef habitats of the Indo-West Pacific as well as the reefs of the Indonesian region. Scott Reef is important for its contribution to understanding long-term geomorphological and reef formation processes and past environments. Scott Reef is the region's best-understood reef from the point of view of resident communities and how they function and change. A diverse assemblage of hard coral species has been recorded from the shallow and deepwater environments at Scott Reef, with 306 species from 60 genera and 14 families. Two hundred and ninety-five species have been recorded from shallow-water environments (<30 m) and 51 species from deepwater habitats (>30 m).
Seringapatam Reef and surrounds	550 km southeast	The reef has a similar geomorphological structure to Scott Reef and is very similar in terms of coral and fish diversity, trophic functional groups and representation of tropical species which all contribute to the reef system listing as a site of natural

Commonwealth Heritage Place	Distance from NE FPSO	Description
		heritage significance. Benthic assemblages at Seringapatam are dominated by algae and hard corals and lesser contributions from other benthic groups such as soft corals and sponges. Coral diversity is high and the most diverse and abundant habitats are located on the outer reef slopes. The oceanic atoll reefs provide important biophysical environments in the region that support diverse aggregations of marine life as well as high primary productivity and species richness
Ashmore Reef National Nature Reserve	346 km southwest	It has major significance as a staging point for wading birds migrating between Australia and the northern hemisphere, including 43 species listed on one or both of the China Australia Migratory Bird Agreement (CAMBA) and the Japan Australia Migratory Bird Agreement (JAMBA). The reef provides habitat for three species of sea snakes with very restricted distributions, with the seasnake *Aipysurus fuscus* being endemic to the reef. The islands were also significant for phosphate mining, and are important for the provision of seabird rookeries.

3.4.5 Key Ecological Features

Key Ecological Features (KEFs) are elements of the Commonwealth ocean that are considered to be of regional importance for either a region's biodiversity or its ecosystem function and integrity. Thirteen KEFs are identified within the North-west Marine Region, and five of these KEFs occur within the ZPI for the NE FPSO, as described in Table 3-6.

Table 3-6. KEFs present within the NE FPSO ZPI

KEF	Description
Carbonate banks in the Joseph Bonaparte Gulf	The key value of this KEF is its unique seafloor features. Little is known about the bank and terrace system of the Sahul Shelf but it is regionally important because of its likely ecological role in enhancing biodiversity and local productivity relative to its surrounds. The banks are thought to support a high diversity of organisms including reef fish, sponges, soft and hard corals, gorgonians, bryozoans, ascidians and other sessile filter feeders. The banks are known to be foraging areas for loggerhead, olive ridley and flatback turtles, and cetaceans and green and freshwater sawfish may occur in the area.
Carbonate bank and terrace system of the Van Diemen Rise	The key value of this KEF is its unique sea-floor feature with ecological properties of regional significance. This KEF part of the larger system associated with the Sahul Banks to the north and Londonderry Rise to the east. It is characterised by terrace, banks, channels and valleys. The variability in water depth and substrate composition may contribute to the presence of unique ecosystems in the channels. Species present include sponges, soft corals and other sessile filter feeders associated with hard substrate sediments of the deep channels. Epifauna and infauna include polychaetes and ascidians. Olive ridley turtles, sea snakes and sharks are also found associated with this feature.
Ashmore Reef and Cartier Island and surrounding Commonwealth waters	The key value of this KEF is its high productivity and aggregations of marine life. Ashmore Reef is the largest of only three emergent oceanic reefs present in the north-eastern Indian Ocean and is the only oceanic reef in the region with vegetated islands. Ashmore Reef and Cartier Island and the surrounding Commonwealth waters are regionally important for feeding and breeding aggregations of birds and other marine life, and are areas of enhanced primary productivity in an otherwise low-nutrient environment. Ashmore Reef supports the highest number of coral species of any reef off the west Australian

KEF	Description
	coast.
Continental Slope Demersal Fish Communities	The key value of this KEF is its high levels of endemism. The diversity of demersal fish assemblages on the continental slope in the Timor Province, the Northwest Transition and the Northwest Province is high compared to elsewhere along the continental slope.
Seringapatam Reef and Commonwealth waters in the Scott Reef complex	The key value of this KEF is the high productivity and aggregations of marine life. Seringapatam Reef and the Commonwealth waters in the Scott Reef complex are regionally important in supporting the diverse aggregations of marine life, high primary productivity and high species richness associated with the reefs themselves. As two of the few offshore reefs in the north-west, they provide an important biophysical environment in the region.

3.4.6 Important Wetlands in Australia

The Directory of Important Wetlands in Australia identifies more than 900 nationally important wetlands, including the flora and fauna species that depend on them, their social and cultural values and the ecosystem services and benefits they provide.

The Directory of Important Wetlands in Australia database indicates there are no marine or coastal important wetlands within the ZPI of the NE FPSO.

3.4.7 Threatened Ecological Communities

The EPBC Act PMST and TEC database indicates that there are no TECs in or around the NE FPSO Operational Area or within the ZPI.

3.4.8 Non-protected Areas

Submerged Shoals of the Sahul Shelf

There are an extensive series of submerged shoals/banks that occur in a northeast/southwest alignment along the outer edge of the Sahul Shelf spanning between Ashmore Reef in the southwest to Sunset Shoal in the north-east. Major shoal complexes along the outer shelf include the Sahul Shoals, East Sahul Shoals, Karmt Shoals, Big Banks Shoals and Echo Shoals. On the mid-Sahul Shelf, other shoals/banks of the Sahul Shelf include Echuca, Heywood, Vulcan and Barracouta.

The closest shoals to the NE FPSO Operational Area are the Big Banks Shoals that have been surveyed and found:

- Upper submerged flats of Big Bank mainly comprised (90%) of macroalgal habitats, mostly comprised of the coralline alga *Halimeda*, with outer shoal dominated by corals.
- Most (80%) of the submerged flats of Bank 2 comprised *Acroprid*-dominated coral habitat
- Benthic communities of the bank slopes were characterised by the presence of sessile filter feeders including large erect sponges, gorgonians, bryozoans, ascidians and featherstars that were reported to be typical of a relatively nutrient rich and strong current environment.
- Shoals are sedimentary formations with sediment on the shoals derived from coralline algal growth (*Halimeda*) and may comprise consolidated rocky substrate, rubble and sand.
- Epibenthic communities at the different shoals varied but were categorised as *Halimeda* and encrusting sponges (the most common type), coral-dominated banks, deeper water filter-feeding communities and soft-bottomed continental shelf communities.
- Minimum depth of the surveyed shoals ranges from 15 to 70 m, with most in the 20 to 40 m range.

- Major physical disturbance to *Halimeda* communities was observed in unconsolidated sediment area, thought to be caused by cyclone damage.
- The main coral taxonomic groups (genera) identified were *Acropora*, *Montipora*, *Favia*, *Fungia*, *Palauastrea*, *Seriatopora* and *Pachyseris*.
- Support species-rich fish and shark populations.

Hibernia Reef

Hibernia Reef is located 42 km northeast of Ashmore Reef and the extensive reef has no permanently dry land area, although large parts of the reef flat become exposed at low tide. Along with the other surrounding reef systems (Ashmore Reef and Cartier Island), Hibernia Reef is notable for the high biodiversity associated with the shallow reef ecosystem, habitats and communities. Hibernia Reef protects critical habitat for an unusually high diversity and abundance of sea snakes and diverse sponge community.

Timor and Roti Islands

The islands of Timor and Roti are included in the Lesser Sunda Ecoregion – an area encompassing the chain of islands from Bali in the west to Timor Leste in the east and the islands of Sumba, Savu and Roti to the south. The Lesser Sunda Ecoregion is a subregion identified within the hotspot marine diversity coral triangle region. This area of the Lesser Sunda Ecoregion is characterised by the following features;

- High-energy coastlines with predominant east-west current flows on the southern shores of these islands and seasonal-upwelling-driven productivity in April to May.
- Upwelling and ocean swell have a strong influence over the composition of corals and associated fish communities and provide critical feeding habitat for both resident and migratory megafauna species (whales, dolphins, dugongs and turtles).
- Timor, Savu and Roti near-shore habitats include fringing reefs, seagrass, mangrove and sandy beaches important for turtle nesting. Fringing reefs are located around the islands but are less well-developed on the southern, more wave-exposed areas.
- There are several existing conservation areas located along the Timor coast (Indonesia and Timor Leste) including areas 61, 62, 63, 66, 67, 68 and 83. The largest conservation area encompassing the south west Timor Island and Roti islands are within the National Park of Tirosa Batek Marine Area (Laut Sawu) established in 2009 encompassing approximately 29,454 km^2 and managed by the Ministry of Marine Affairs and Fisheries, Indonesia.

4 STAKEHOLDER CONSULTATION

NOGA recognises that stakeholder consultation goes beyond informing individuals or groups. NOGA has opened the channels of communication with the Asset's interested and affected parties to provide an opportunity for open and honest communication that promotes integration of stakeholder values into its decision-making process. This provides the means for NOGA to identify interested individuals and groups as well as their needs, ideas, values, and issues of concern regarding the environmental and/or social impacts of activities related to the Asset. Stakeholder engagement also provides information that can help avoid conflicts about locally important matters and help NOGA to identify who must be contacted in the unlikely event of an emergency situation.

In keeping with NOGA's HSE Policy and APPEA's Principles of Conduct, NOGA is also committed to open, on-going and effective engagement with the communities in which it operates and providing information that is clear, relevant and easily understandable. This section of the EP defines:

- Requirements for stakeholder consultation;
- Objectives of stakeholder consultation;
- Who needs to be considered in decision-making;
- When decisions must be completed;
- The on-going consultation schedule; and
- How commitments are documented and tracked to closure.

4.1 Regulatory Requirements

Section 280 of the OPGGS Act states that a person carrying out activities in an offshore permit area should not interfere with other users of the offshore area to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the first person. In order to determine what activities are being carried out and whether petroleum activities may interfere with existing users, consultation is required.

In relation to the content of an EP, more specific requirements are defined in the OPGGS(E) Regulation 11A. This regulation requires that a Titleholder consult with 'relevant persons' in the preparation of an EP. A 'relevant person' is defined in Regulation 11A as:

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

Further guidance regarding the definition of functions, interests or activities is provided in NOPSEMA's *Assessment of Environment Plans: Deciding on Consultation Requirements* Guidelines (N-04750-GL1629, Rev 0, April 2016), as follows:

- Functions – a person or organisation's power, duty, authority or responsibilities;
- Activities – a thing or things that a person or group does or has done; and
- Interests – a person or organisation's rights, advantages, duties and liabilities; or a group or organisation having a common concern.

Regulation 14(9) of the OPGGS(E) also defines a requirement for consultation in relation to the Implementation Strategy defined in the EP. In addition, Regulation 16(b) of the OPGGS(E) requires that the EP contain a summary and full text of this consultation.

4.2 Stakeholder Consultation Objectives

The principal objectives of the consultation strategy are to:

- Confirm existing stakeholders and identify additional stakeholders to those identified during Woodside's previous stakeholder communications;
- Initiate and maintain open communications between stakeholders and NOGA;
- Identify, establish and implement stakeholder engagement methods for introductory and on-going communications;
- Establish an open and transparent process for input;
- Proactively work with stakeholders on recommended strategies to minimise negative impacts and maximise positive impacts of the Asset's operation; and
- Provide a means for recording all initiatives in which communication and/or consultation is undertaken, and to track any commitments made by NOGA through to closure.

It should be noted that consultation with NOGA contractors who will assist with the execution of activities associated with Asset operation is not included here. This also includes organisations that NOGA has a contract, agreement or MoU with for assistance in the event of oil spill response or operational and scientific monitoring. The 'functions, interests or activities' of these organisations are only triggered if NOGA elects to involve them in an emergency response. Consultation with these contractors and organisations is undertaken in accordance with Regulation 14(5) of the OPGGS(E), which requires measures to ensure that each employee or contractor working on, or in connection with the activity, is aware of his or her responsibilities in relation to The EP and has the appropriate competencies and training.

4.3 Stakeholder Identification

NOGA has established contact with stakeholders previously identified by Woodside, and others, to establish a working relationship with stakeholders. NOGA identifies a stakeholder as:

> *Any affected persons, interested persons or organisations that are impacted by, or can impact, a project.*

Determining who the stakeholders for this Asset are has involved the following:

- Reviewing Woodside's existing NE Operations EP;
- Reviewing Woodside's NE Decommissioning Project Consultation Plan;
- Reviewing Commonwealth and state fisheries jurisdictions and fishing effort (within the envelope of the ZPI); and
- Determining the Titleholders of nearby exploration permits and production licences through the NOPTA website.

Based on this review, areas of stakeholder interest were expected to include:

- Marine pollution;
- Location of the facility with respect to existing marine reserves;
- Vessel traffic in the area and proximity to shipping fairways;
- Hydrocarbon spill response plans and capabilities; and
- Potential conflict with commercial fishing activities in the region.

Stakeholders identified for the NE Asset are listed in Table 4-1.

Table 4-1. Stakeholders identified for the NE FPSO Facility

Department or agency of the Commonwealth to which the activities to be carried out under the EP may be relevant	
Department of the Environment (DoE) - Parks Australia	National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA)
National Offshore Petroleum Titles Administrator (NOPTA)	
Australian Maritime Safety Authority (AMSA)	Department of Defence (DoD)
Maritime Border Command (MBC)	Australian Hydrological Service (AHS)
Australian Fisheries Management Authority (AFMA)	Department of Agriculture, Fisheries and Forestry (DAFF)/ Australian Quarantine Inspection Service (AQIS) – Seaports Program
Department of Industry (DoI)	
Department of Foreign Affairs and Trade (DFAT)	
Each Department or agency of a State or the Northern Territory to which the activities to be carried out under the EP may be relevant	
WA Department of Fisheries (DoF)	NT Department of Primary Industries and Fisheries (DPIF)
The Department of the responsible State Minister, or the responsible Northern Territory Minister	
WA Department of Mines and Petroleum (DMP)	NT Department of Mines and Energy (DME)
A person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the EP	
Fisheries	
Commonwealth Fisheries Association	Amateur Fisherman's Association NT (AFANT)
WA Fishing Industry Council (WAFIC)	RecFish West
Game Fishing Association Australia (WA)	NT Seafood Council (NTSC)
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	JAMACLAN (for Commonwealth Trawl operations and Westmore Seafoods)
NT Trawler Owners Association (NTTOA)	Northern Prawn Fishery Industry Pty Ltd
Northern Prawn Fishery Trawl Association	WA Seafoods
Australian Council of Prawn Fisheries	Pearl Producers Australia (PPA)
Kimberley Professional Fishermen's Assoc.	A. Raptis & Sons Pty Ltd
Northern Fishing Companies Association	Northern Prawn Fishery (Qld) Trawl Assoc. Inc.
Oil spill preparedness and response agencies	
AMSA – Ocean Pollution	WA Department of Parks and Wildlife (DPW)
NT Department of Transport (DoT) – Marine Safety Branch	WA DoT – Oil spill response coordination
Australian Marine Oil Spill Centre (AMOSC)	Oil Spill Response Ltd (OSRL)
Nearby petroleum Titleholders	
PTTEP Australasia (Ashmore Cartier) Pty Ltd	Bounty Oil and Gas NL
ENI Australia Ltd	ConocoPhillips Australia Exploration Pty Ltd
Woodside Energy Ltd	Murphy Oil Australia Pty Ltd
Total E&P Australia	MEO Australia Ltd
Shell Australia Pty Ltd	Finder Exploration Pty Ltd
Inpex Operations Australia Pty Ltd	
Any other person or organisation that the titleholder considers relevant	
Marine conservation interests	
Centre for Whale Research (CWR)	WA Marine Science Institution (WAMSI)
Australian Institute of Marine Science (AIMS)	Australian Marine Conservation Society (AMCS)
Australian Conservation Foundation (ACF)	The Wilderness Society

International Fund for Animal Welfare (IFAW)	WWF
Other interests	
Australian Petroleum Production and Exploration Association (APPEA)	

4.4 Stakeholder Engagement

NOGA is committed to timely and on-going consultation with stakeholders. Stakeholder engagement commenced for this project on the 16th of June 2016 when an information flyer was issued by email to stakeholders. The information flyer provides details about the Asset, an introduction to NOGA and details on why the Asset was purchased from Woodside, and contact details if further information should be required. This information flyer is also available on the NOGA website (http://www.northernoil.com.au/stakeholder-engagement). A follow up email to stakeholders who hadn't responded to the initial email was issued on 7 July 2016, with follow up phone calls made to stakeholders through the second half of July.

NOGA considers this consultation period (two months ahead of EP submission to NOPSEMA) provides an adequate timeframe in which stakeholders can assess potential impacts of the facility and provide feedback to NOGA and is commensurate with Government public review periods.

In undertaking this consultation, NOGA has taken into account the consultation guidelines (Table 4-2) released by various Commonwealth and WA government agencies and industry associations in response to the consultation requirements of the OPGGS(E).

Table 4-2. Stakeholder consultation guidance required by industry-related agencies

Agency	Guidance	Requirements	NOGA action
Commonwealth level			
NOPSEMA	Assessment of Environment Plans: Deciding on Consultation Requirements (N-04750-GL1629, Rev 0, April 2016) *https://www.nopsema.gov.au/environmental-management/stakeholder-engagement-and-transparency/*	This guideline describes NOPSEMA's consideration of consultation requirements when assessing EPs, and identifies NOPSEMA's position on key regulatory requirements. It also describes the five categories of relevant persons outlined in the OPGGS(E).	NOGA has used the descriptions of the five categories of relevant persons to categorise stakeholders for this project, and also provided information specified in the guideline within this chapter.
AMSA	Advisory Note for the Offshore Petroleum Industry Consultation with Respect to Oil Spill Contingency Plans and Environmental Plans (no date) *https://www.amsa.gov.au/navigation/shipping-management/offshore-activities/documents/guidance-to-offshore-industry-oscp.pdf*	To assist offshore petroleum Titleholders, address their oil spill preparedness and response requirements, AMSA invites them to enter into a Memorandum of Understanding ('MoU') between Titleholders and AMSA. This MoU sets out an understanding of respective roles and responsibilities when responding to ship-sourced and non-ship-sourced marine pollution incidents. The MoU is the sole method through which AMSA consults on Titleholder's EPs.	NOGA has entered into an MoU with AMSA to provide support for oil spill preparedness and response.
State level			
WA DoF	Guidance statement for oil and gas industry consultation with the Department of Fisheries	The DoF expects to be consulted as a 'relevant person' for activities that may potentially affect commercially and	NOGA has provided the information flyer to the DoF.

	(July 2013) *http://www.fish.wa.gov.au/ Documents/occasional_ publications/fop113.pdf*	recreationally important fish species, their prey and habitats and the business activities of the fishers who harvest these resources.	The DoF asked that they be informed if activities are planned in the future
WA DoT	Marine Oil Pollution: Response and Consultation Arrangements (Version 0, April 2016) *http://www.transport.wa.gov.au /mediaFiles/marine/MAC_P_ Westplan_MOP_OffshorePetr oleumIndGuidance.pdf*	Consultation with DoT for offshore petroleum activities is required if the Titleholder's activities have the potential to cause a marine oil pollution emergency in WA state waters.	NOGA has provided the information flyer to the DoT, as there is potential for an oil spill from several spill scenarios to impact state waters. However, none of these scenarios is predicted to result in surface oil or shoreline accumulations that require an on-site response by the DoT. The DoT hasn't replied yet The OPEP has been revised to take into account advice provided in the DoT's revised guidance.
WA DMP	Consultation Guidance Note for the OPGGS(E) Regulations 2009 (April 2012) *http://www.dmp.wa.gov.au/ Documents/Environment/ENV-petroleum_guidlines-consultation_guidance-0012.pdf*	The DMP considers any petroleum activity that occurs in Commonwealth waters adjacent to the WA coastline to be an activity whereby it should be consulted, in accordance with the level of risk posed by the activity.	NOGA has provided the information flyer to the DMP. In accordance with DMP's guidance, because the likelihood associated with the highest potential risk to land or water under DMP's jurisdiction is 'negligible the consultation is limited to the provision of general notification (which is satisfied by the content of the information flyer). The DMP stated that they reviewed the flyer and do not have any comments or requirements for further information. They asked to be kept informed of activities
Industry associations			
APPEA	Consultation guidelines are currently under preparation (in cooperation with NOPSEMA) for offshore petroleum activities.	Not applicable.	Not applicable.
AMOSC	AMOSC and Industry Consultation under the OPGGS Act 2011 (August 2012) * *Guidance no longer current.*	AMOSC expects to review all EPs and OPEPs in which AMOSC is named as part of the support mechanisms.	NOGA has been working closely with AMOSC in the revision of the OPEP to ensure that spill response capabilities are readily available.

The project stakeholders, a summary of consultation and an assessment of merit of their feedback are presented in Table 4-3.

Correspondence with stakeholders has been a combination of email exchanges and phone conversations. No concerns or objections have been raised with regard to the continued operation of the Asset. NOGA believes that the low rate of feedback (i.e., replies to initial and follow up emails and return phone calls) and the low level of concern from stakeholders expressed to data is due to the following considerations:

- Remoteness of the Asset;
- Location outside of the AFZ (no Commonwealth or State/Territory fisheries operating around the Asset);
- Distance from CMRs and state marine parks;
- No intersection with shipping fairways; and
- The Asset has been operating since 1999 without any major incidents.

NOGA will continue to accept feedback from all stakeholders during the assessment of The EP and throughout the five-year duration of the accepted EP.

NOGA recognises that the relevance of stakeholders identified in The EP may change in the event of a non-routine event or emergency. Every effort has been made to identify stakeholders that may be impacted by a non-routine event or emergency, the largest of which is considered a Level 3 hydrocarbon spill. Therefore, any stakeholders known or likely to have operations within or be affected by a spill within the Asset's ZPI is included in NOGA's list of stakeholders.

NOGA acknowledges that other stakeholders not identified in The EP may be affected, and that these may only become known to NOGA in such an event.

4.5 Ongoing Consultation

NOGA elected not to define a 'reasonable period' (as specified in Regulation 11A (3) of the OPGGS(E)) in the consultation flyer for stakeholders to provide comments. This is because consultation for this activity relates to a change of Titleholder and the ongoing operation of the Asset, so NOGA believes stakeholders are unlikely to see any urgency in engaging (as demonstrated in Table 4-3). The long-standing and well established industry practice is to allow 30 days as the 'reasonable period' for stakeholders to respond to consultation material, after which time the EP can be submitted to NOPSEMA. In this instance, there were two months between the dissemination of the consultation flyer and the initial submission of the EP.

Stakeholder consultation will be ongoing during Asset operations. Key milestones that will trigger further consultation include:

- EP acceptance and the availability of the EP Summary on the NOPSEMA website;
- Any significant incidents (e.g., large hydrocarbon spill);
- Future optimisation activities (e.g., drilling of additional production wells); and
- When a decision is made to decommission the Asset.

Any claims or objections from stakeholders will be assessed and the EP then modified if required. If this relates to the identification of a new or significantly increased risk, the revised EP will be submitted to NOPSEMA for assessment.

The stakeholder consultation database remains a live document and will be updated on an as-required basis.

Table 4-3. Summary of stakeholder consultation

Stakeholder	Functions, interests and/or activities	Method and date of consultation	Concerns, impacts or claims raised by stakeholder	NOGA assessment of merit and feedback to stakeholder
Department or agency of the Commonwealth to which the activities to be carried out under the EP may be relevant				
NOPSEMA	Administers the OPGGS(E).	April to Nov – Meetings and phone calls 3rd November Meeting 6th December Phone call	Various Meetings/phone calls to discuss EP submission requirements. RFI Meeting discussion in NOPSEMA Office to clarify RFI Requirements RFI Phone discussion to clarify OWR requirements NOPSEMA during this year have continued to respond to requests for meetings and phone calls to assist in the submission and acceptance of the EP.	NOGA has considered all of NOPSEMA's feedback during these meetings and used that to update each revision of the EP.
NOPTA	Administers offshore petroleum titles.	Flyer initially emailed: 16 June 2016. Follow up email sent: 29 June 2016. Email response: 29 June 2016.	An out-of-office reply was received in response to the initial email. NOGA re-issued the flyer to the Deputy General Manager as directed in the out-of-office reply. The Deputy General Manager acknowledged receipt of email, with no other feedback provided.	NOGA responded with thanks by email. No feedback from NOGA required, as the NOGA title information is up to date.
AMSA (nautical safety division)	Key regulator for marine safety, advisor on shipping lanes and traffic.	Flyer initially emailed: 16 June 2016. Email response: 17 & 20 June 2016. Follow up phone call: 13 July 2016.	The Nautical and Hydrographic Advisor responded by email, including a map of vessel traffic in the vicinity of the Asset for the 2015 calendar year.	NOGA responded with thanks by email. The up to date shipping traffic map is included in Section 3.3.14 of the EP.
MBC	Key agency for border protection - need to be aware of FPSO location and operations. The FPSO Radio Operator needs to be aware of MBC's vessels, maintain communications on Ch 16 with vessels.	Flyer initially emailed: 16 June 2016. Follow up email sent: 7 July 2016. Follow up phone call: 21 July 2016.	No response to initial and reminder emails. NOGA telephoned MBC, who explained that because of a recent departmental restructure, the Senior Customs Officer (Integrated Planning Support) that dealt with petroleum operators was no longer in that role. NOGA was provided with new contact details to forward the original correspondence to, which was done, and advised that MBC would provide feedback. No contact has since been made.	NOGA does not believe follow up with MBC is warranted, as all relevant maritime navigation protocols are adhered to.
AFMA	Key agency regarding the provision of advice on fisheries that operate around the Asset.	Flyer initially emailed: 16 June 2016. Follow up email sent: 7 July 2016. Follow up phone call: 21 July 2016.	No response to initial and reminder emails. NOGA telephoned AFMA, speaking with the Environment Manager. He said that there had been no response to the emails because there was little fishing activity in the area around the Asset and because it is an ongoing operation (rather than an exploration location). He said the only possible fisheries operating near the Asset are the Northern Prawn, North West Slope and possibly the Western Tuna and Southern Bluefin Tuna fisheries (though young tuna using the region for migration are not targeted by the fisheries). AFMA also confirmed that the Western Skipjack Fishery is not active. Based on this information, the Environment Manager stated that it's not worth contacting the AFMA fisheries managers for further comment.	NOGA thanked AFMA for the advice during the phone call, stating that research undertaken for the EP concurred with AFMA's statement of fisheries likely to be operating in the region. NOGA confirmed that individual AFMA Fisheries Managers would not be contacted for further comment.
DIIS	The Resources Division of the DIIS is one part of the Joint Authority for management of the JPDA, which adjoins the licence areas.	Flyer initially emailed: 16 June 2016. Follow up email sent: 7 July 2016. Follow up phone	No response to initial and reminder emails. NOGA telephoned the DIIS. After being directed to the unconventional onshore gas division, NOGA left a voicemail message. No contact has since been made.	As continued FPSO operation does not have any impacts on the management of the JPDA, NOGA does not believe follow up with the DIIS is warranted. It is not anticipated that feedback from the DIIS would have any bearing on

Stakeholder	Functions, interests and/or activities	Method and date of consultation	Concerns, impacts or claims raised by stakeholder	NOGA assessment of merit and feedback to stakeholder
		call: 21 July 2016.		the content of the EP.
AQIS/DAFF – Seaports Program	Key agency regarding quarantine clearance for vessels entering Australian waters from international waters.	Flyer initially emailed: 16 June 2016. Follow up email sent: 7 July 2016. Follow up phone call: 21 July 2016.	No response to initial and reminder emails. NOGA telephoned the DAFF, who stated that the original email would be searched for. DAFF obtained NOGA's contact details and said that someone would either respond via email or phone. No contact has since been made.	NOGA does not believe follow up with AQIS/DAFF is warranted, as all relevant Commonwealth quarantine protocols are adhered to.
DoD	Key agency regarding advice on offshore defence training.	Flyer initially emailed: 16 June 2016. Follow up email sent: 7 July 2016. Follow up phone call: 21 July 2016.	No response to initial and reminder emails. NOGA telephoned the Project Officer for the Infrastructure Division (Estate & Infrastructure Group), who advised that the DoD does not have any concerns given it is the continuing operations of an existing asset, as opposed to a new exploration location.	NOGA thanked the DoD for their advice during the phone call, stating that this was the expected response, and confirmed that the DoD email addresses used for petroleum activity correspondence remains current.
AHS	Agency that issues Notice to Mariners (NTM). They require 6 weeks prior warning for issuing NTM (e.g., if FPSO moves off location).	Flyer initially emailed: 16 June 2016. Email response: 17 June 2016. Flyer re-issued: 13 July 2016. Email response: 14 July 2016.	The AHS responded by email stating that the incorrect email address had been used, directing NOGA to use a new centralised email address. NOGA subsequently forwarded the flyer to the new email address several weeks later. The AHS Data Centre responded with thanks by email, acknowledging that the email has been received. No other feedback was provided.	NOGA responded with thanks by email and advised the AHS that its stakeholder database was updated with the revised details. No additional correspondence is required, as routine maritime notification requirements are included in the EP.
DoE (Parks Australia)	Responsible for management of Commonwealth Marine Reserves. Likely to have some involvement in the case of a large spill from the Asset if marine reserves are at risk.	Flyer initially emailed: 1 6 June 2016. Follow up phone call: 21 July 2016. Email response: 27 July 2016.	No response to initial email. NOGA telephoned the Community Information Unit, who advised that they could not find the emails. The original email was re-issued to the DoE (and received), and they stated it would be forwarded to the Marine Protected Areas division for actioning. Parks Australia advised that several CMRs occur in the vicinity of the FPSO, for which transitional arrangements apply until a management plan comes into effect. When future management plans are prepared and come into effect, they expect Titleholders to revise and amend EPs accordingly.	NOGA responded by email with thanks and advised that descriptions of the CMRs are included in the EP, and that once management plans for them come into effect, NOGA will review the EP to determine whether the operations meet the aims/strategies outlined in the plans.
		Telecon 5 August 2016 David Morris CMR Branch	Discussion on access to Cartier Island, approval requirements, UOX risks	Information incorporated into OPEP, NEBA, Operational Monitoring Plans and contact lists.
DFAT	Needs to be aware of activities that may have impacts on neighbouring countries (e.g., large hydrocarbon spill), such as Timor Leste & Indonesia.	Flyer initially emailed: 16 June 2016. Follow up phone call: 16 July 2016. Email response: 21 July 2016.	No response to initial email. NOGA telephoned the DFAT and was directed to the Executive Assistant of the Assistant Secretary, Indonesia Program Delivery and Timor Leste Branch. After NOGA left a voicemail message, the Assistant Secretary replied to the initial via email to say that NOGA has been consulting with the DFAT office in Dili.	There is no need for NOGA to engage further regarding the EP, as commercial discussions between DFAT and NOGA are taking place.
Each Department or agency of a State or the Northern Territory to which the activities to be carried out under the EP may be relevant				
WA DoF	Manages State fisheries in adjacent WA waters.	Flyer initially emailed: 16 June 2016. Email response: 28 June 2016. Email reply: 29 June 2016	The DoF responded by email to thank NOGA for the update, asking that they be kept informed if activities are planned in the future.	NOGA responded by email the next day with thanks, stating that it would keep the DoF informed of any future activities.

Stakeholder	Functions, interests and/or activities	Method and date of consultation	Concerns, impacts or claims raised by stakeholder	NOGA assessment of merit and feedback to stakeholder
NT NPIF	Manages State fisheries in adjacent NT waters.	Flyer initially emailed: 16 June 2016. Follow up phone call and email: 21 July 2016.	No response to initial email. NOGA telephoned the NPIF and spoke with the Aquatic Resource Management Officer. He stated that fisheries were most concerned with seismic survey proposed in the Bonaparte Basin. He said that for an operating facility so far away from NT waters, there shouldn't be any fisheries concerns. He hadn't seen the original email, so NOGA forwarded it through to the Aquatic Resource Management Officer directly. He replied same day by email saying he'd get back to NOGA if more information was required.	NOGA agrees with the NPIF that because the Asset has been operating for some time without any fisheries issues raised in the past, it was unlikely that new issues would arise now. NOGA also explained that oil spill modelling indicates that NT waters and fisheries areas were unlikely to be affected in the event of a worst-case spill.
The Department of the responsible State Minister, or the responsible Northern Territory Minister				
WA DMP	Manages petroleum activities in adjacent WA waters. The DMP is the other half of the Joint Authority responsible for administering the JPDA.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016. Email response: 7 July 2016.	No response to initial email. A DMP Environmental Officer responded by email, stating that the DMP has reviewed the flyer and does not have any comments or requirements for further information. They asked that DMP be kept informed of activities.	NOGA responded with thanks by email the same day, confirming that the DMP will be kept informed of future activities.
NT DME	Manages petroleum activities in adjacent WA waters.	Flyer initially emailed: 16 June 2016 Email response: 16 June 2016	The DME responded by email stating that the correspondence was noted, with no other feedback provided.	No need for a NOGA response based on the DME feedback.
A person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the EP				
Peak fisheries associations				
WAFIC	The peak industry body representing the commercial fishing, pearling and aquaculture industries. Project area is located outside of the AFZ, but a large oil spill may extend into members' fisheries operations, breeding or feeding grounds.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016. Email response: 7 July 2016. Follow up phone call: 13 July 2016.	No response to initial email. The Executive Officer, Resource Access, stated by email and phone that as the Asset is outside the 200 nm AFZ boundary, WAFIC and state-managed fisheries are not relevant stakeholders and do not require ongoing communications as they will not be potentially affected by the activity. WAFIC suggested accessing online Commonwealth and State fisheries references for further information.	NOGA responded with thanks via email, stating that the online fisheries resources suggested had already been accessed and were used to update the EP. NOGA had a follow-up phone discussion with WAFIC's Executive Officer Resource Access, who said that she didn't feel it was necessary to consult with Australian fisheries given that the asset is located outside of the AFZ. NOGA stated that it took into consideration the stakeholders that Woodside consulted with regarding the potential decommissioning of the asset (whom were likely to be interested that the asset is no longer being decommissioned) and the oil spill ZPI to determine stakeholders, but agreed in principle that limited consultation with fisheries was necessary.
NTSC	Peak representative body of the seafood industry in the NT, representing ~222 businesses. Project area is located outside of the AFZ, but a large oil spill may extend into members fishing grounds or feeding and breeding areas of target species.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016. Follow up phone call: 22 July 2016.	No response to initial and reminder emails. NOGA telephoned the NTSC and left a voicemail message with the Chief Executive Officer. No contact has since been made.	Based on the discussion with WAFIC, NOGA does not believe follow up with the NTSC is necessary.

Stakeholder	Functions, interests and/or activities	Method and date of consultation	Concerns, impacts or claims raised by stakeholder	NOGA assessment of merit and feedback to stakeholder
CFA	The peak body representing the collective rights, responsibilities and interests of a diverse commercial fishing industry in Commonwealth regulated fisheries. Project area is located outside of the AFZ, but a large oil spill may extend into Commonwealth, WA or NT fisheries operations, breeding or feeding grounds.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016. Follow up phone call: 22 July 2016.	No response to initial and reminder emails. NOGA telephoned the CFA and left a voicemail message with the Executive Officer. No contact has since been made.	Based on the discussion with WAFIC, NOGA does not believe follow up with the CFA is necessary.
Recreational fisheries associations				
AFANT	The peak body representing recreational fishing interests in the NT. Association members are unlikely to be operating around the Asset. A large oil spill is unlikely to extend into members' fishing grounds or breeding or feeding grounds for target species. Flyer sent as a courtesy.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016. Email response: 7 July 2016.	No response to initial email. The AFANT Executive Officer responded by email to the reminder email, stating that the fields are outside their area of interest due to their distance from the mainland.	NOGA responded with thanks by email and agrees that no further consultation is necessary based on the Asset's distance from the mainland (making access by recreational fishers impossible).
RecFish West	The peak body representing the interests of 740,000 recreational fishers in WA. RecFish West members are unlikely to be operating around the Asset. A large oil spill is unlikely to extend into members' fishing grounds or breeding or feeding grounds for target species. Flyer sent as a courtesy.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016.	No response to initial and reminder emails.	Based on the advice received from AFANT, NOGA elected not to follow up with a phone call to this stakeholder, as recreational fishers are unlikely to operate anywhere near the Asset.
Game Fishing Association Australia (WA)	Represent a small, specialised interest. Project area is located outside of the AFZ, but a large oil spill may extend into member's fishing grounds or into the breeding or feeding grounds of target species.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016.	No response to initial and reminder emails.	Based on the advice received from AFANT, NOGA elected not to follow up with a phone call to this stakeholder, as recreational fishers are unlikely to operate anywhere near the Asset.
Individual fisheries associations and representatives				
NTTOA	Members are unlikely to be operating in licence areas. Project area is located outside of the AFZ, but a large oil spill may extend into fisheries	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016.	No response to initial and reminder emails.	Based on the advice received from WAFIC and the NT DPIF, NOGA elected not to follow up with a phone call to this stakeholder.

Stakeholder	Functions, interests and/or activities	Method and date of consultation	Concerns, impacts or claims raised by stakeholder	NOGA assessment of merit and feedback to stakeholder
	operations or the breeding or feeding grounds of target species.			
Northern Prawn Fishery Trawl Association	Association members are unlikely to be operating around the Asset. The Asset is located outside of the AFZ, but a large oil spill may extend into member's fishing grounds or feeding and breeding areas of target species.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016.	No response to initial and reminder emails.	Based on the advice received from WAFIC and the NT DPIF, NOGA elected not to follow up with a phone call to this stakeholder.
Australian Council of Prawn Fisheries	Association members are unlikely to be operating around the Asset. The Asset is located outside of the AFZ, but a large oil spill may extend into member's fishing grounds or feeding and breeding areas of target species.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016.	No response to initial and reminder emails.	Based on the advice received from WAFIC and the NT DPIF, NOGA elected not to follow up with a phone call to this stakeholder.
Northern Fishing Companies Association	Association members are unlikely to be operating around the Asset. The Asset is located outside of the AFZ, but a large oil spill may extend into member's fishing grounds or feeding and breeding areas of target species.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016.	No response to initial and reminder emails.	Based on the advice received from WAFIC and the NT DPIF, NOGA elected not to follow up with a phone call to this stakeholder.
JAMACLAN	The Asset is located outside of the AFZ, but a large oil spill may extend into members fishing grounds or feeding and breeding areas of target species.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016.	No response to initial and reminder emails.	Based on the advice received from WAFIC and the NT DPIF, NOGA elected not to follow up with a phone call to this stakeholder.
Northern Prawn Fishery Industry Pty Ltd	The association is a collective of trawler operators, processors and marketers acting together as a single voice for the industry in the Northern Prawn Fishery, which spans the waters from Cape York to the Kimberley's. The Asset is located outside of the AFZ, but a large oil spill may extend into members fishing grounds or feeding and breeding areas of target species.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016.	No response to initial and reminder emails.	Based on the advice received from WAFIC and the NT DPIF, NOGA elected not to follow up with a phone call to this stakeholder.
Northern Prawn Fishery (Qld) Trawl	The Asset is located outside of the AFZ, but a large oil spill may extend into member's fishing grounds or	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July	No response to initial and reminder emails.	Based on the advice received from WAFIC and the NT DPIF, NOGA elected not to follow up with a phone call to this stakeholder.

Stakeholder	Functions, interests and/or activities	Method and date of consultation	Concerns, impacts or claims raised by stakeholder	NOGA assessment of merit and feedback to stakeholder
Assoc. Inc.	feeding and breeding areas of target species.	2016.		
WA Seafoods	Seafood export company, focusing on prawns (banana and tiger). The Asset is located outside of the AFZ, but a large oil spill may extend into the company's fishing grounds or feeding and breeding areas of target species.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016.	No response to initial and reminder emails.	Based on the advice received from WAFIC and the NT DPIF, NOGA elected not to follow up with a phone call to this stakeholder.
A. Raptis & Sons Pty Ltd	Raptis owns and operates 15 commercial fishing vessels that work out of the Northern Prawn Fishery, the Gulf of Carpentaria Developmental Finfish Trawl Fishery, the Gulf of Saint Vincent and the Great Australian Bight Trawl Fishery as well as participating in many international fishing operations. The Asset is located outside of the AFZ, but a large oil spill may extend into the company's fishing grounds or feeding and breeding areas of target species.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016.	No response to initial and reminder emails.	Based on the advice received from WAFIC and the NT DPIF, NOGA elected not to follow up with a phone call to this stakeholder.
Kimberley Professional Fishermen's Association	Association members are unlikely to be operating around the Asset. The Asset is located outside of the AFZ. A large oil spill is unlikely to extend into members' fishing grounds or breeding or feeding grounds for target species. Flyer sent as a courtesy.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016.	No response to initial and reminder emails.	Based on the advice received from WAFIC and the NT DPIF, NOGA elected not to follow up with a phone call to this stakeholder.
ASBTIA	This fishery is not currently active, and AFMA management arrangements are under review. No fishing takes place in the northern extent of this fishery. Flyer sent as a courtesy.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016.	No response to initial and reminder emails.	Based on the advice received from WAFIC and the NT DPIF, NOGA elected not to follow up with a phone call to this stakeholder.
PPA	Wild oysters are caught in waters 30 m or less, generally south of Lacapede Islands (near Broome), so the pearling industry shouldn't be impacted	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016.	No response to initial and reminder emails.	Based on previous discussions with the PPA regarding the location of its operations, NOGA elected not to follow up with a phone call to this stakeholder.

Stakeholder	Functions, interests and/or activities	Method and date of consultation	Concerns, impacts or claims raised by stakeholder	NOGA assessment of merit and feedback to stakeholder
	by the Asset. Flyer sent as a courtesy only.			
Oil spill preparedness and response agencies				
AMSA – Marine Environment Pollution	Oil spill response Combat Agency for vessels in Commonwealth waters (e.g., spill from support vessel transiting to/from the FPSO).	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016.	NOGA has maintained regular contact with AMSA in in accordance with their Advisory Note for the Offshore Petroleum Industry Consultation (see Table 9.2) stating that their preferred method of consultation with Titleholders to enter into an MoU.	NOGA has entered into an MoU with AMSA to provide support for oil spill preparedness and response.
		Telecon 1 August 2016 David Imhoff Senior Response Commander	Discussion on process for issuing Temporary Notice to Mariners and protocols	Information incorporated into OPEP and EP drafts
AMOSC	AMOSC and Industry Consultation under the OPGGS Act 2011 (August 2012)	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016.	AMOSC expects to review all EPs and OPEPs in which AMOSC is named as part of the support mechanisms.	NOGA has been working closely with AMOSC in the revision of the OPEP to ensure that spill response capabilities are readily available. See individual communications below
		Email 25 May 2016	Early OPEP Draft review.	Comments from AMOSC taken into account with updates
		Meeting 7 June 2016	AMOSC visit to NOGA offices to explain membership.	
		Email 8 June 2016	AMOSC provision of information on NEBA / SIMA.	Information incorporated into draft OPEP NEBA
		Email June 14 2016	AMOSC information regarding use of capping stack technology on production wells.	Information incorporated into draft EP
		Email 21 June 2016	AMOSC information on SFRT costs and conditions.	Information reviewed as part of source control analysis
		Email 23 June 2016	Containment and Recovery operational advice.	Information incorporated into OPEP and EP drafts
		Email 28 June 2016	Containment and Recovery operational advice.	Information incorporated into OPEP and EP drafts
		Email 7 July 2016	Waste Management operational advice.	Information incorporated into OPEP and EP drafts
		Email 21 July 2016	Advice on manning arrangements/backups.	Information incorporated into OPEP and EP drafts
		Email 27 July 2016	Advice on SFRT contracts.	Information incorporated into OPEP and EP drafts and source control procedures
		Email 27 July 2016	Advice on the use of subsea dispersants.	Information incorporated into OPEP and EP drafts and source control procedures
		Email 29 July 2016	Advice on aerial monitoring aircraft requirements.	Information incorporated into EP drafts Operational Monitoring procedures
		August 8 2016 Oil Spill Training Workshop	Draft OPEP and First Strike Plan provided to AMOSC for use in 4 days NOGTA workshop and exercise training.	Information and comments received in training workshop incorporated into OPEP and EP drafts
OSRL	International oil spill response company that would be requested to assist in combating a Tier 3 spill.	Email 8 July 2016 Email 12 July 2016 Email 18 July 2016 Email 20 July	NOGA has maintained regular contact with OSRL while revising the OPEP, seeking OSRL's expertise on the applicability of various oil spill response strategies for various spill scenarios. An integration workshop was held between NOGA and OSRL to align activation	The OPEP has been developed with input by OSRL.

Stakeholder	Functions, interests and/or activities	Method and date of consultation	Concerns, impacts or claims raised by stakeholder	NOGA assessment of merit and feedback to stakeholder
		2016 Email 21 July 2016 Email 25 July 2016 Email 1 August 2016 Email 10 August 2016	protocols for OSRL personnel, equipment and services on 28th July 2016. OSRL have provided details on the capacity of Containment and Recovery Skimmers Deflection Booms and protocols for deployment of this equipment and oil spill specialist response resources. OSRL have also provide details on the number of personnel available to be deployed for particular requirements and the level of competency.	
NT DoT – Marine Safety Branch	Key industry agency that will assist with oil spill response if a spill enters NT state waters (within 3 nm of mainland and islands).	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016. Follow up phone call: 20 July 2016. Email response: 20 July 2016.	No response to initial email. NOGA telephoned the DoT. The Principal Nautical Advisor of the Marine Safety Branch stated that considering the geographical location of the Asset, the issue is better dealt with at the Commonwealth level and the NT Marine Safety Branch has no comments.	NOGA responded by email with thanks the next day, confirming that it has arrangements in place with AMSA for responding to an oil spill.
WA DPW	Key industry agency that will assist with oil spill response if a spill enters WA state waters (within 3 nm of mainland and islands) and threatens protected areas or wildlife.	Flyer initially emailed: 16 June 2016. Initial flyer re-issued to different email address: 19 July 2016.	No response to initial or follow up emails.	NOGA OPEP and Oiled Wildlife Recovery Mobilisation Plan structured in accordance with WAOWRP requirements.
WA DoT – Oil spill response coordination	Key industry agency that will assist with oil spill response if a spill enters WA state waters (within 3 nm of mainland and islands).	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016. Follow up phone call: 20 July 2016. Email 29 July 2016 Email 2 August 2016	WA DoT has provided access to obtain Oil Spill Response Atlas (OSRA) mapping for areas within the ZPIs to assist with OPEP response planning.	Liaison with the DoT is ongoing.
Nearby petroleum Titleholders				
ENI Australia Ltd	Titleholder for exploration permit AC/P21, and operator of the Kitan Field, 20 km to the east of the Asset in the JPDA (the field ceased production in December 2015). Likely to be within the ZPI of the largest credible oil spill.	Flyer initially emailed: 16 June 2016. Follow up phone call and email: 22 June 2016. Flyer subsequently emailed: 23 June 2016.	Initial email bounced back. NOGA telephoned ENI to determine the most appropriate point of contact. The Environmental Advisor asked for the flyer to be issued to the Managing Director. This was done, and no response was received.	NOGA forwarded the flyer to the Managing Director by email as requested. As there are no ENI production facilities within the ZPI, no follow up is considered necessary.
PTTEP Australasia (Ashmore Cartier) Pty Ltd	In a joint venture with ENI in the Kitan Field, 20 km to the east of the Asset in the JPDA (the field ceased production in December 2015). Titleholder for several licences and retention leases in the Ashmore/Cartier Area.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016. Email response: 7 July 2016.	No response to initial email. A PTTEP Senior Environmental Advisor responded to the reminder email, stating that PTTEP has no comments.	NOGA responded with thanks by email. As there are no PTTEP production facilities within the ZPI, no follow up is considered necessary.
ConocoP	Operator of Bayu-	Flyer initially	No response to initial or reminder emails.	No further action required based

Stakeholder	Functions, interests and/or activities	Method and date of consultation	Concerns, impacts or claims raised by stakeholder	NOGA assessment of merit and feedback to stakeholder
hillips Australia Exploration Pty Ltd	Undan, 85 km SE of the Asset (JPDA 03-12 & 03-13). The Bayu-Undan facility is likely to be within the ZPI of the largest credible oil spill.	emailed: 16 June 2016. Follow up phone call: 20 July 2016. Flyer re-issued by email: 20 July 2016.	NOGA telephoned ConocoPhillips. The receptionist asked for the flyer to be re-issued to External Affairs so they could provide comments. No contact has since been made.	on stakeholder response.
Inpex Operations Australia Pty Ltd	Inpex is a joint venture participant in the nearby Bayu-Undan project (11.4%) and the Kitan project (35%). Bayu-Undan is within the ZPI of the largest credible oil spill.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016. Follow up phone call: 22 July 2016.	No response to initial or reminder emails. NOGA telephoned Inpex and left a voicemail message with a member of the external relations team. No contact has since been made.	No further action required based on stakeholder response.
Finder Exploration Pty Ltd	Titleholder of nearby exploration permits AC/P45, 52, 55, 56 and 61. These permits may be within the ZPI of the largest credible oil spill.	Phone call: 22 July 2016. Flyer initially emailed: 22 July 2016. Email response: 22 July 2016.	NOGA telephoned Finder Exploration to determine the most appropriate point of contact. The receptionist provided NOGA with the email address for the Offshore Australia Exploration Manager. The Offshore Australia Exploration Manager replied to the NOGA email stating that he had caught up with the NOGA CEO at the 2016 APPEA Conference and appreciated the follow up.	No further action required based on stakeholder response.
Shell Australia Pty Ltd	Titleholder of nearby exploration permits AC/P41, 52 and RL/9. These permits may be within the ZPI of the largest credible oil spill.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016. Follow up phone call: 22 July 2016.	No response to initial or reminder emails. NOGA telephoned the Shell switchboard in an attempt to find the most appropriate point of contact, who refused to connect with a representative from the Environmental Department. NOGA subsequently emailed the Environment Manager.	Given that consultation is in relation to the continued operation of the Asset, with no changes other than a new Titleholder, NOGA does not consider that a lack of correspondence with Shell is a hindrance to the content of the EP.
Woodside Energy Ltd	Former Asset owner. Operator of Sunrise and Troubadour gas and condensate field development in the adjoining JPDA. Operator of AC/RL8 (Vulcan Sub-basin), NT/RL2 & 4 (Bonaparte Basin), WA-28-R, -29, -30, -31 & -32 (Browse Basin). Any future development of the Sunrise and Troubadour gas and condensate field may be in the ZPI of largest credible oil spill.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016.	WEL not part of forward plan post new EP acceptance.	Consultation between NOGA and Woodside has been ongoing during the revision of the EP, so no follow up is considered necessary in response to the information flyer.
Murphy Oil Australia Pty Ltd	Titleholder of AC/P57, -58 & -59 in the Ashmore/Cartier Area. Will not be within ZPI of largest credible oil spill. Flyer sent as courtesy only.	Flyer initially emailed: 16 June 2016. Follow up phone call and email: 20 July 2016. Email response: 20 July 2016.	No response to initial email. NOGA telephone Murphy Oil. The Office Manager asked for the flyer to be re-issued to her directly, and she would forward to the Exploration Manager for comment. This was done. No contact has since been made.	As there are no Murphy Oil production facilities within the ZPI, no follow up is considered necessary.
MEO Australia Ltd (includin	Titleholder of AC/P50, AC/P51 and AC/P53. Will not be within ZPI	Flyer initially emailed: 16 June 2016.	No response to initial email. NOGA telephoned MEO. The Office Manager asked for the flyer to be re-issued	NOGA replied by email with thanks. No further action required.

Stakeholder	Functions, interests and/or activities	Method and date of consultation	Concerns, impacts or claims raised by stakeholder	NOGA assessment of merit and feedback to stakeholder
g Vulcan Exploration Pty Ltd as a wholly owned subsidiary)	of largest credible oil spill. Flyer sent as courtesy only.	Follow up phone call and email: 20 July 2016. Email response: 26 July 2016.	to her directly, and she would provide comments. MEO subsequently emailed to advise that they have no issues.	
Bounty Oil and Gas NL	Titleholder of AC/P32. Major growth project, with Azalea and East Swan prospects. Will not be within ZPI of largest credible spill. Flyer sent as courtesy only.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016. Follow up phone call: 20 July 2016.	No response to initial or reminder emails. NOGA telephoned Bounty Oil and Gas, but there was no response and no answering service.	As there are no Bounty Oil and Gas production facilities within the ZPI, no follow up is considered necessary.
Any other person or organisation that the titleholder considers relevant				
Marine conservation interests				
CWR	Project is located too far outside of Australian waters for this organisation to have any real interests. Flyer issued as a courtesy only.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016.	No response to initial or reminder emails.	Given that the Asset is located well outside of known whale BIAs, it is not considered essential to gain feedback from the CWR, as information from the Jenners (operators of the CWR) has been incorporated in to the EP.
AIMS	Project is located too far outside of Australian waters for this organisation to have any real interests. Flyer issued as a courtesy only.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016. Follow up phone call: 20 July 2016.	No response to initial or reminder emails. NOGA telephoned AIMS, who suggested the flyer be re-issued to the Personal Assistant of the WA Program Manager for review. NOGA did this. There has since been no response.	NOGA does not consider it essential to gain feedback from this stakeholder, as the EP contains a significant level of detail on marine ecology of the region that the AIMS is unlikely to be able to augment.
WAMSI	Project is located too far outside of Australian waters for this organisation to have any real interests. Flyer issued as a courtesy only.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016. Follow up phone call: 20 July 2016.	No response to initial or reminder emails. NOGA telephoned WAMSI. The General Manager asked to be sent the flyer again and would provide comment once she'd reviewed it. NOGA did this, and WAMSI provided thanks by email.	NOGA does not consider it essential to gain feedback from this stakeholder, as the EP contains a significant level of detail on marine ecology of the region that the WAMSI is unlikely to be able to augment.
AMCS	Project is located too far outside of Australian waters for this organisation to have any real interests. Flyer issued as a courtesy only.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016. Follow up phone calls: 20 & 21 July 2016. Phone response: 22 July 2016.	No response to initial or reminder emails. NOGA telephoned AMCS, and was advised that emails have gone overlooked during the build up to the federal election. An AMCS representative subsequently telephoned NOGA to say that it's unlikely that they'll follow up with a response.	NOGA does not consider it essential to gain feedback from this stakeholder, as the EP contains a significant level of detail on marine ecology of the region that the AMCS is unlikely to be able to augment.
ACF	Project is located too far outside of Australian waters for this organisation to have any real interests. Flyer issued as a courtesy only due to	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016. Follow up phone	No response to initial or reminder emails. NOGA telephoned the ACF Broome office, but there was no response and no answering service.	NOGA does not consider it essential to gain feedback from this stakeholder, as the EP contains a significant level of detail on marine ecology of the region that the ACF is unlikely to be able to augment.

Stakeholder	Functions, interests and/or activities	Method and date of consultation	Concerns, impacts or claims raised by stakeholder	NOGA assessment of merit and feedback to stakeholder
	previous consultation with Woodside.	call: 20 July 2016.		
IFAW	Project is located too far outside of Australian waters for this organisation to have any real interests. Flyer issued as a courtesy only due to previous consultation with Woodside.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016. Follow up phone call: 20 July 2016.	No response to initial or reminder emails. NOGA telephoned IFAW. Their Policy & Campaigns Manager stated that marine mammals are their main area of interest, and he wasn't aware of any marine mammal issues in the Timor Sea. As such, they have no comments on the ongoing operations of the Asset.	Given that the Asset is located well outside of known whale BIAs, and that relevant information regarding whale distribution and abundance has been incorporated in to the EP, NOGA is satisfied with IFAW's lack of concern for the Asset's ongoing operations.
The Wilderness Society	Project is located too far outside of Australian waters for this organisation to have any real interests. Flyer issued as a courtesy only due to previous consultation with Woodside.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016. Follow up phone call: 20 & 21 July 2016.	No response to initial or reminder emails. NOGA telephoned The Wilderness Society. Several messages were left between NOGA and The Wilderness Society, with The Wilderness Society not responding to the last phone call.	NOGA does not consider it essential to gain feedback from this stakeholder, as the EP contains a significant level of detail on marine ecology of the region that The Wilderness Society is unlikely to be able to augment.
WWF	Project is located too far outside of Australian waters for this organisation to have any real interests. Flyer issued as a courtesy only due to previous consultation with Woodside.	Flyer initially emailed: 16 June 2016. Reminder email issued: 7 July 2016. Follow up phone call: 20 July 2016.	No response to initial or reminder emails. NOGA telephoned WWF. The Species Conservation Manager asked to be sent the flyer again (because the original recipient is now based in an overseas WWF office) and would provide comment once she or others had reviewed it. NOGA did this. There has since been no response.	NOGA does not consider it essential to gain feedback from this stakeholder, as the EP contains a significant level of detail on marine ecology of the region that the WWF is unlikely to be able to augment.
Other interests				
APPEA	Industry representative. Flyer issues as a courtesy to inform them that consultation is underway regarding transition to a new Titleholder.	Flyer initially emailed: 16 June 2016.	No response to initial email.	No response to the NOGA emails is necessary from APPEA given that NOGA has been liaising with APPEA to sign on to the *MoU: Mutual Assistance Agreement* (to facilitate the transfer of a drill rig between operators in the event of an offshore emergency), with the APPEA Board accepting NOGA's application for MoU membership at its sitting on 28 July 2016.

5 ENVIRONMENTAL RISK MANAGEMENT METHODOLOGY

This section of the EP describes the methodology used to identify, analyse and evaluate the risks and potential environmental impacts associated with operation of the NE FPSO as required by Regulation 13(5) of the Environment Regulations.

Effective risk management is vital to delivering on our objectives, our success and our continued growth. NOGA is committed to managing all risk in a proactive and effective manner. NOGA's risk management process is detailed in its Hazard Identification and Risk Management Procedure (00-HSE-PC01) and adopts a risk management methodology consistent with the *AS/ISO 31000-2009 Risk Management Principles*.

The risk management methodology provides a framework to demonstrate:

- The identified risks and impacts are reduced to ALARP, which meets the requirements of Regulation 10A(b) of the Environment Regulations; and
- The acceptability of risks and impacts, which meets the requirements of Regulation 10A(c) of the Environment Regulations.

The key steps of the NE risk management framework are shown in Figure 5-1. A description of each step and how it is applied to operation of the NE FPSO is provided in Sections 5.1 to 5.4.

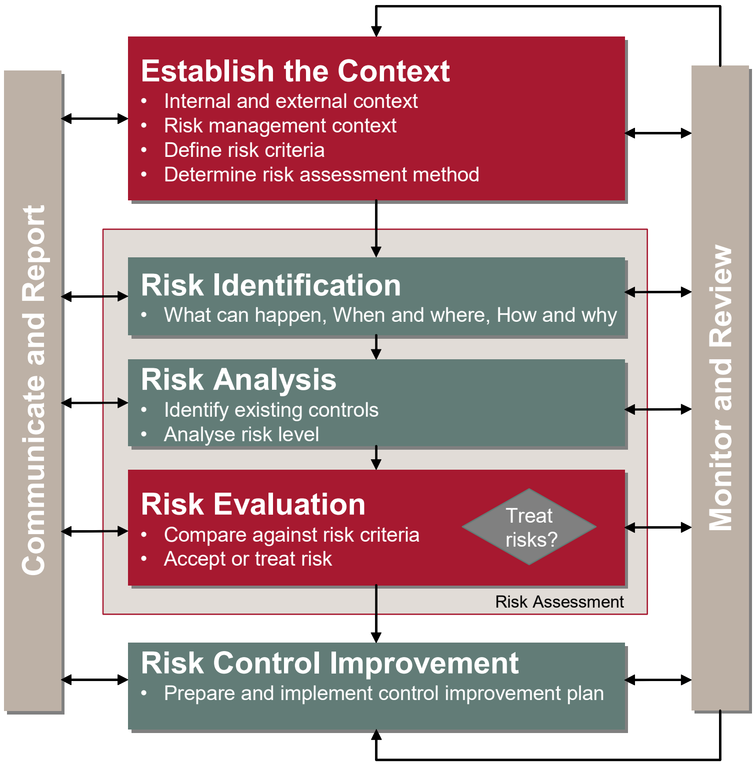

Figure 5-1. Key Steps in the risk management framework

Implementation of the NOGA risk management procedure found no additional risks beyond those identified in the previous version of the EP. Some controls have been added to reflect change in technology or best practice operations and are described in the sections below.

5.1 Establish the Context

The objective of a risk assessment is to assess identified risks and apply appropriate control measures to eliminate, control or mitigate the risk to ALARP and to determine if the risk is acceptable.

An environmental risk assessment for the NE FPSO was conducted by NOGA in June 2016 to revise the and update risk register to reflect the NOGA Risk Matrix, and in order to continually improve processes and practices.

The risk assessment workshops for the NE FPSO was undertaken by multidisciplinary teams made up of relevant personnel with sufficient breadth of knowledge, training and experience to reasonably assure that risks and associated impacts were identified and assessed. This included experienced engineering, operations, maintenance and environmental personnel.

The output of the environmental risk assessment is documented in NE FPSO Environmental Risk Register (01-HSE-RG01). This is summarised in Table 6-1 and further described in the environmental impact assessment.

5.2 Risk Identification

The risk assessment workshop for the NE FPSO undertaken in June 2016 was used to identify risks with the potential to harm the environment. Risks were identified for both planned (routine and non-routine) and unplanned (accidents/incidents) activities. Potential environmental impacts were then determined based on the stressor type.

5.3 Risk Analysis

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

The following key steps were undertaken for each identified risk during the NE FPSO risk assessment:

- Identification of decision type in accordance with the Decision Support Framework ;
- Identification of appropriate preventative and mitigation control measures
- Calculation of the residual risk rankings; and
- Classification and analysis of Major Environment Events (MEE) .

5.3.1 Identification of Control Measures

NOGA applies a hierarchy of control measures when considering Good Practice and Professional Judgement. The hierarchy of control is applied in order of importance as follows:

- *Elimination* – It is preferable to 'design out' the risk altogether;
- *Substitution* – Remove or substitute the risk for a lower risk;
- *Engineering control measures*, to include:
  - Prevent the hazard - incorporate measures to prevent a potential hazard from being realised;
  - Detect the hazard - install systems to identify potentially hazardous deviations (such as leak detection);
  - Control the severity of the potential consequences / impacts – for example alarms and automatic shut-down of the activity to prevent escalation.
- *Administrative control measures* – Such as site rules, procedures, etc.; and
- *Mitigation of the consequences/impacts* – Measures to mitigate or offset any unavoidable or residual impacts.

5.3.2 Risk Rating Process

The risk rating process is undertaken to assign a level of risk to each impact measured in terms of consequence and likelihood. The assigned risk level is the residual risk (i.e. risk with controls in place) and is therefore undertaken following the identification of the Decision Type and appropriate control measures.

The risk rating process considers the environmental impacts and where applicable, the social/cultural impacts of the risk. The residual risk rating is then determined by multiplying the selected consequence and likelihood levels: Residual Risk Level = Highest Selected Consequence Level x Selected Likelihood Level.

Environmental Risk Register

The purpose of the Environmental Risk Register is to record the risk identification process, categories and controls in a consolidated format. The environmental risk register (01-HSE-RG01) is the record of the environmental risk workshop that was held to update and review the register in June 2016.

5.4 Risk Evaluation

Environmental risks, as opposed to safety risks, cover a wider range of issues, multiple species, persistence, reversibility, resilience, cumulative effects and variability in severity. The degree of environmental risk and the corresponding threshold for acceptability (Figure 5-4) has been adapted to include principles of ecological sustainability (an objective in the OPGGS(E) and defined in the EPBC Act), the Precautionary Principle and the corresponding environmental risk threshold decision-making principles used to determine acceptability.

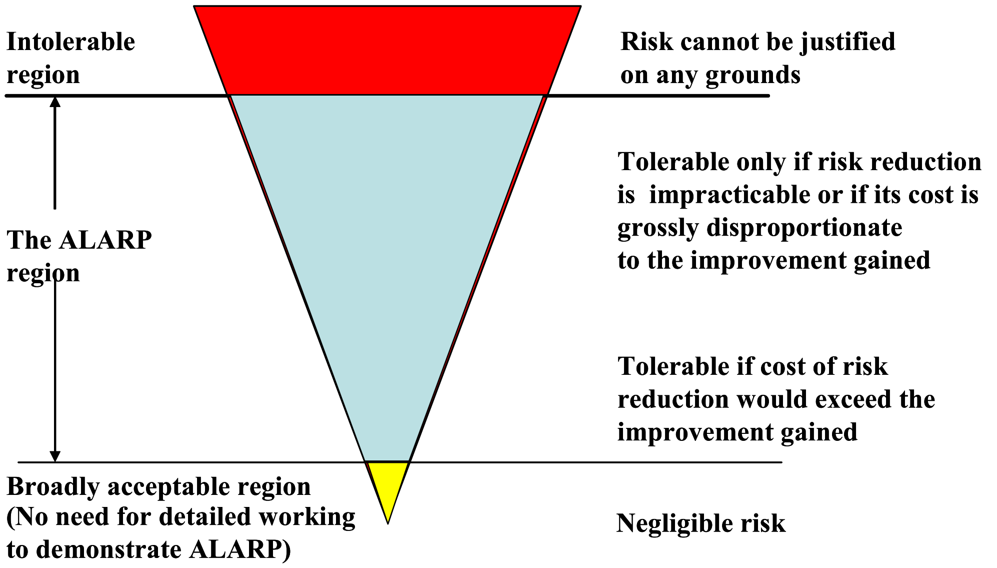

Figure 5-1. Environmental risk threshold, ALARP Triangle

5.4.1 Demonstration of ALARP

Regulation 10A(b) of the OPGGS(E) require a demonstration that environmental impacts are reduced to ALARP. The ALARP principle states that it must be possible to demonstrate that the cost involved in reducing the risk further would be grossly disproportionate to the benefit gained. The ALARP principal arises from the fact that infinite time, effort and money could be spent attempting to reduce a risk or impact to zero. This concept is also shown diagrammatically in Figure 4-4.

An iterative risk evaluation process is employed until such time as any further reduction in the residual risk ranking is not reasonably practicable to implement. At this point, the impact or risk is reduced to ALARP. For planned activity impacts, residual impact ratings of 'negligible' or 'minor' are considered by NOGA to be ALARP.

For unplanned activities, a residual risk ranking of 'low' in the risk matrix is considered by NOGA to be ALARP. 'Significant' residual rankings may be considered to be ALARP if further risk reduction measures are shown not to be practicable.

For The EP, the process involved a review of the identified risks, consideration of industry experience and evidence from other similar activities, identifying accepted industry practices and developing a list of potential treatment options.

When formulating risk treatments or impact controls for each activity, the 'Hierarchy of Controls' philosophy was applied. The 'Hierarchy of Controls' is a system used in industry to minimise or eliminate exposure to hazards. The hierarchy of controls are, in order of effectiveness:

- Eliminate;
- Substitute;
- Engineer;
- Isolate;
- Administration; and
- Protection.

Although commonly used in the evaluation of occupational health and safety (OHS) hazard control, the Hierarchy of Controls philosophy is also a useful framework to evaluate potential environmental controls to ensure reasonable and practicable solutions have not been overlooked.

Those treatments that were considered by the teams to be reasonably practicable have been implemented, while those considered to be not reasonably practicable have not been implemented.

5.4.2 Demonstration of Acceptability

Regulation 10A(c) of the OPGGS(E) require a demonstration that environmental impacts are of an acceptable level. NOGA considers a range of factors when evaluating the acceptability of environmental impacts associated with its activities. This evaluation works at several levels, as outlined in Table 5-1. The criteria for demonstrating acceptability were developed based on NOGA's interpretation of NOPSEMA's Guidance Note for EP Content Requirements (N04750-GN1344, Rev 0, February 2014).

Table 5-1. Acceptability test

Test	Question	Acceptability demonstrated
Policy compliance	Is the proposed management of the risk or impact aligned with the NOGA HSE Policy?	The risk or impact must be compliant with the objectives of the company policies.
Management System Compliance	Is the proposed management of the risk or impact aligned with the NOGA HSE Policy and or HSE MS procedures?	Where specific NOGA procedures, guidelines, expectations are in place for management of the risk or impact in question, acceptance is demonstrated.
Social acceptability	Have stakeholders raised any concerns about activity impacts or risks, and if so, are measures in place to manage those concerns?	Stakeholder concerns must have been adequately responded to and closed out.
Laws and standards	Is the risk or impact being managed in accordance with existing Australian or international laws or standards such as MARPOL, AMSA Marine Orders, API standards, etc.?	Compliance with specific laws or standards is demonstrated.
Industry practice	Is the impact or risk being managed in line with industry practice, such as OSPAR OCNS, APPEA Code of Environmental Practice, etc.?	Management of the impact or risk complies with relevant industry practices.
Environmental context	Is the impact or risk being managed pursuant to the nature of the receiving environment (e.g., sensitive or unique environmental features generally require more management measures to protect them than environments widely represented in a region)?	The proposed risk or impact controls, environmental performance objectives and standards must be consistent with the nature of the receiving environment.
Environmentally Sustainable Development (ESD) Principles	Does the proposed risk or impact comply with the APPEA Principles of Conduct (APPEA 2003), which includes that ESD principles be integrated into company decision-making.	The activities and impacts are consistent with the APPEA Principles of Conduct.
ALARP	Are there any further reasonable and practicable controls that can be implemented to further reduce the risk or impact?	There is a consensus among the risk assessment team that risks or impacts are at ALARP.

6 ENVIRONMENTAL RISK ANALYSIS AND EVALUATION

This section of the EP describes the results of the risk analysis and evaluation for the NE FPSO using the methodology described in Section 5. As required by Regulation 13(5) and 13(6) of the Environment Regulations, this evaluation demonstrates that the risks and impacts associated with operation of the NE FPSO will be reduced to ALARP and will be of an acceptable level.

The risks identified during the NE FPSO environmental risk assessment (ENVID) workshop (described in Section 5.2) have been divided into two broad categories: Planned (routine and non-routine); and Unplanned (accidents/incidents) activities. Both of these categories have then been further divided into impact assessment groupings based on stressor type e.g. light, noise etc.

6.1 RISK ANALYSIS AND EVALUATION SUMMARY FOR NE FPSO

The risk analysis and evaluation for the NE FPSO indicates that the environmental risks and impacts associated with operation of the NE FPSO will be reduced to ALARP and are of an acceptable level.

The environmental risk assessment identified 29 sources of environmental risk, of these:

- Three are considered Major Environment Events. A further level of classification and analysis is undertaken for the MEEs. This extra level of rigour is applied to ensure sufficient controls are in place for moderate consequence risks.
- Five are considered Minor Events and have had associated Oil Spill Modelling done to confirm they are not of significant impact. This extra level of rigour is applied to ensure sufficient controls are in place to mitigate risks.

The MEEs identified for the NE FPSO are:

- MEE-01 – Hydrocarbon release caused by a well loss of containment;
- MEE-04 – Hydrocarbon release caused by an offloading equipment loss of containment;
- MEE-05 – Hydrocarbon release caused by a cargo tank loss of containment;

Minor Events (MEs) are those that were previously considered MEEs but with controls in place are now not considered to meet the MEE criteria, they include;

- ME-02 – Hydrocarbon release caused by a subsea loss of containment;
- ME-03 – Hydrocarbon release caused by a topsides loss of containment;
- ME-06 – Hydrocarbon release caused by a loss of structural integrity;
- ME-07 – Supply Vessel Diesel tank loss of containment; and
- ME-08 – Hydrocarbon release caused by loss of control of suspended load.

The summary details of all risks is provided in table 6-1.

The Detailed Summary of all impacts and controls in place for the identified risks is presented in Appendix A.

Table 6-1. Summary Environmental Impact and Risk Analysis for the NE FPSO

EP Ref	Source of Risk	Key Potential Environmental Impacts (Refer to relevant section for details)	Residual Risk Rating			Category of Risk	Major Environment Event Classification (*i.e. consequence 3+)*	
			Consequence	Likelihood	Residual Risk		MEE– Yes/No	MEE Ref No.
6.1.1	Light emissions from platform and OSVs	• Disturbance to marine fauna, particularly seabird's marine turtles and fish.	1	1	Low	Negligible Risk	No	N/A
6.1.2	Noise emissions during routine operations	• Disturbance to marine fauna, particularly whales, marine turtles and fish, potentially as direct physical damage or as a behavioural effect.	1	1	Low	Negligible Risk	No	N/A
6.1.3	Physical presence of the facility and OSVs	• Exclusion of other users including shipping and fishing; • Collision with marine fauna resulting in injury or fatality; and • Provision of artificial habitat.	2	1	Low	Negligible Risk	No	N/A
6.1.4	Physical footprint	• Seabed disturbance including localised mortality/disturbance of benthos.	1	1	Low	Negligible Risk	No	N/A
6.2.1	Gas flaring during operations	• Temporary reduction in air quality beyond localised area; • Contribution to global greenhouse gas emissions; and • Visual impact from flare flame and possibly dark smoke.	1	2	Low	Negligible Risk	No	N/A
6.2.2	Emissions from fuel combustion	• Contribution to global greenhouse gas emissions; and; • Consumption of non-renewable natural resources.	1	1	Low	Negligible Risk	No	N/A
6.2.3	Fugitive emissions	• Contribution to global greenhouse gas emissions; and; • Loss of non-renewable natural resources.	1	1	Low	Negligible Risk	No	N/A
6.3.1	Discharge of hydrocarbons and chemicals during subsea operations and activities	• Localised water column pollution; and • Localised adverse effect to marine biota.	1	1	Low	Negligible Risk	No	N/A
6.3.2	Discharge of PFW (PFW)	• Acute and chronic toxicity to marine biota; • Accumulation of toxicants in sediments affecting biota; and • Bioaccumulation of organic toxicants.	1	4	Med	Tolerable (as ALARP is demonstrated)	No	N/A
6.3.3	Discharge of sewage and putrescible wastes	• Eutrophication of localised water column.	1	1	Low	Negligible Risk	No	N/A
6.3.4	Discharge of cooling water	• Alteration of physiological processes; • Toxic effect to biota.	1	2	Low	Negligible Risk	No	N/A
0	Discharge of brine water	• Alteration of physiological processes of marine biota	1	1	Low	Negligible Risk	No	N/A

EP Ref	Source of Risk	Key Potential Environmental Impacts (Refer to relevant section for details)	Residual Risk Rating			Category of Risk	Major Environment Event Classification (*i.e. consequence 3+*)	
			Consequence	Likelihood	Residual Risk		MEE– Yes/No	MEE Ref No.
0	Discharge of drainage water	• Localised water column pollution.	1	2	Low	Negligible Risk	No	N/A
6.4.1	Hazardous and non-hazardous waste handling and disposal	• Pollution and contamination of the environment; and • Secondary impacts on marine fauna (e.g. entanglement).	1	1	Low	Negligible Risk	No	N/A
6.4.2	Release of Naturally Occurring Radioactive Materials (NORMs)	• Pollution of the ocean and potentially chronic and acute toxicity impacts on marine flora and fauna; and • Pollution of the terrestrial environment and potentially chronic and acute toxicity impacts on terrestrial flora and fauna.	2	1	Low	Negligible Risk	No	N/A
6.4.3	Chemical selection and use	• Localised water column pollution; and • Localised adverse effect to marine life	1	2	Low	Negligible Risk	No	N/A
6.5.1	Introduction of invasive marine species	• Introduction of invasive marine species, possibly resulting in alteration of the natural ecosystem.	1	1	Low	Negligible Risk	Yes	N/A
6.6.1	Venting of hydrocarbon gases	• Contribution to global greenhouse gas emissions.	1	2	Low	Negligible Risk	No	N/A
6.6.2	Release of Synthetic Greenhouse Gases and Ozone-Depleting Substances	• Ozone depletion and contribution to atmosphere of gases with high global warming potential and atmospheric lifetime.	1	4	Med	Tolerable (as ALARP is demonstrated)	No	N/A
6.7.1	Chemical spill from platform and OSVs	• Pollution of the ocean; and • Adverse effects on marine life (seafloor & open water)	1	3	Low	Negligible Risk	No	N/A
6.7.2	Hydrocarbon release during bunkering operations	• Localised water column pollution; and • Localised adverse effect to marine biota.	1	3	Low	Negligible Risk	No	N/A
6.7.3	Hydrocarbon release caused by a well loss of containment MEE-01	• Biological and ecological impacts to megafauna, plankton, deep water benthic communities, offshore fish species, fisheries, coral reefs, mangroves, subtidal flats and sandy beaches and seagrass communities.	4	2	Med	Tolerable (as ALARP is demonstrated)	Yes	MEE-01
6.7.4	Hydrocarbon release caused by offloading equipment loss of containment MEE-04	• Biological and ecological impacts to megafauna, plankton, deep water benthic communities, offshore fish species, fisheries, coral reefs, mangroves, subtidal flats and sandy beaches and seagrass communities.	3	2	Med	Tolerable (as ALARP is demonstrated)	Yes	MEE-04

EP Ref	Source of Risk	Key Potential Environmental Impacts (Refer to relevant section for details)	Residual Risk Rating			Category of Risk	Major Environment Event Classification (*i.e. consequence 3+*)	
			Consequence	Likelihood	Residual Risk		MEE– Yes/No	MEE Ref No.
6.7.5	Hydrocarbon release caused by cargo tank loss of containment MEE-05	• Biological and ecological impacts to megafauna, plankton, deep water benthic communities, offshore fish species, fisheries, coral reefs, mangroves, subtidal flats and sandy beaches and seagrass communities.	4	2	Med	Tolerable (as ALARP is demonstrated)	Yes	MEE-05
6.7.6	Hydrocarbon release caused by a subsea loss of containment ME-02	• Biological and ecological impacts to megafauna, plankton, deep water benthic communities, offshore fish species, fisheries, coral reefs, mangroves, subtidal flats and sandy beaches and seagrass communities.	2	3	low	Negligible Risk	No	N/A
6.7.7	Hydrocarbon release caused by a topsides loss of containment ME-03	• Biological and ecological impacts to megafauna, plankton, deep water benthic communities, offshore fish species, fisheries, coral reefs, mangroves, subtidal flats and sandy beaches and seagrass communities.	2	2	Low	Negligible Risk	No	N/A
6.7.7	Hydrocarbon release caused by a loss of structural integrity ME-06	• Biological and ecological impacts to megafauna, plankton, deep water benthic communities, offshore fish species, fisheries, coral reefs, mangroves, subtidal flats and sandy beaches and seagrass communities.	2	2	Low	Negligible Risk	No	N/A
6.7.8	Supply Vessel Diesel tank loss of containment ME-07	• Biological and ecological impacts to megafauna, plankton, deep water benthic communities, offshore fish species, fisheries, coral reefs, mangroves, subtidal flats and sandy beaches and seagrass communities.	2	2	Low	Negligible Risk	No	N/A
6.7.7	Hydrocarbon release caused by loss of control of a suspended load. ME-08	• Biological and ecological impacts to megafauna, plankton, deep water benthic communities, offshore fish species, fisheries, coral reefs, mangroves, subtidal flats and sandy beaches and seagrass communities.	2	2	Low	Negligible Risk	No	N/A

7 OIL POLLUTION EMERGENCY PLAN (OPEP)

7.1 OPEP Structure

In the event of a hydrocarbon spill, the NE Emergency Response Plan [26/HSEQ/ENV/PL04] and NE Oil Pollution First Strike Plan [01-HSE-PL01] [26/HSEQ/ENV/PL04] will be activated. The NOGA OPEP [01-HSE-PL02], which demonstrates NOGA's ability to respond to an oil spill event, supports these documents.

NOGA utilises the Australasian Inter-Service Incident Management System (AIIMS) system of incident management for all emergencies including hydrocarbon spills. AIIMS provides the basis for running incident management teams for incidents involving multiple hazards or impacts. AIIMS is utilised by the AMSA and WA DoT, as detailed in the NatPlan and WestPlan SEMP for MOP. The structure of NOGA's Oil Spill Response Document Hierarchy is shown below in **Figure 7-1**.

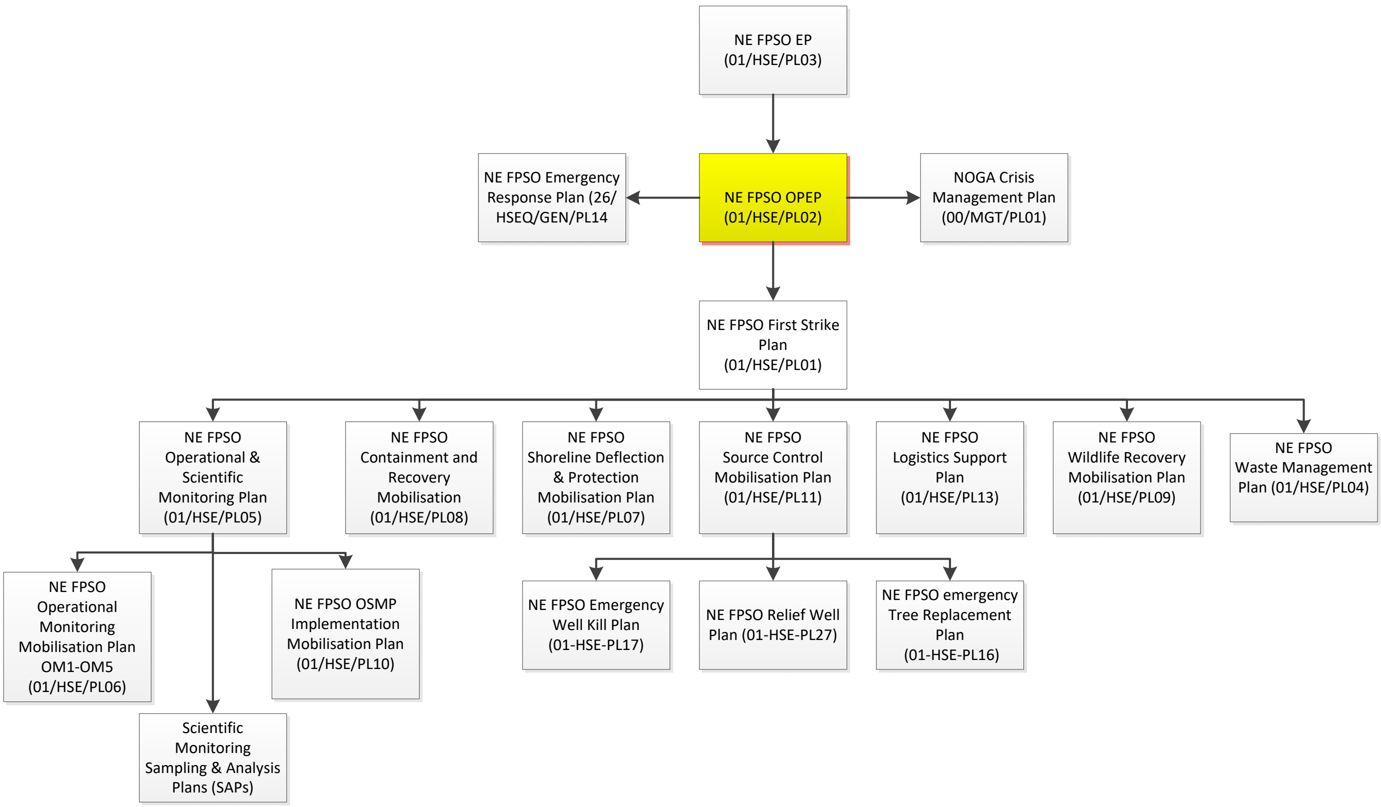

Figure 7-1. Oil spill response support plans hierarchy

The NOGA Oil Spill Response Organisational structure is set out below in Table 6-2.

Table 7-1 OPEP Organisational Structure

Team	Membership	Responsibilities
UPS Facility Tactical Response Team (TRT)	TRT Leader And Facility Tactical Response Teams	• Manage immediate response by triggering First Strike Plan (FSP) • Manage security and protection of health, safety and well-being of people • Protection of the environment • Restrict damage to assets
On-site Teams	On Scene Commander (OSC) and support personnel	• Implement Control Strategies as per OPEP • Conducts and coordinates response tasks on site • Establishes staging areas and field command posts • Communicates site conditions and resource needs to IMT.

Team	Membership	Responsibilities
IMT	IMT Leader Operations Officer Planning Officer Logistics Officer Administration and Finance Officer	• Operate in accordance with the OPEP and provide tactical and operational support to the OSC. • Provide structured command and control system that interfaces with all internal and external agencies. • Sets up and implements Incident Action Plans (IAPs) for the OPEP Response Strategies. • Manage Source Control strategies. • Manages Operational and Scientific Monitoring Plan (OSMP).
CMT	CMT Leader Media Legal HSE Regulatory Technical Advisor Admin/HR Finanace	• Activated for large hydrocarbon spill (Level 2/3) that could seriously threaten people, environment, assets, reputation, livelihood or essential services, or any combination of these elements. • Operates in accordance with the NOGA Crisis Management Plan (CMP). • Provide strategic level support to the IMT to enhance emergency response effectiveness and ultimately assist recovery to normal operations. • Provides business continuity management for Level 3 incidents. • Manage media, regulator and broader stakeholder issues.

NOGA's hydrocarbon spill response is based on a graduated 'level' response classification aligned to the National Plan. The three levels – Level 1, 2 and 3, are defined based on characteristics associated with the resources mobilised, organisational arrangements and on the nature and scale of impacts that could occur for the hydrocarbon spill. This 'level'-based response system provides a structured approach to both establishing hydrocarbon spill preparedness and undertaking a response.

For a Level 3 response, the escalated response structure is shown in Figures 7-2 and 7-3.

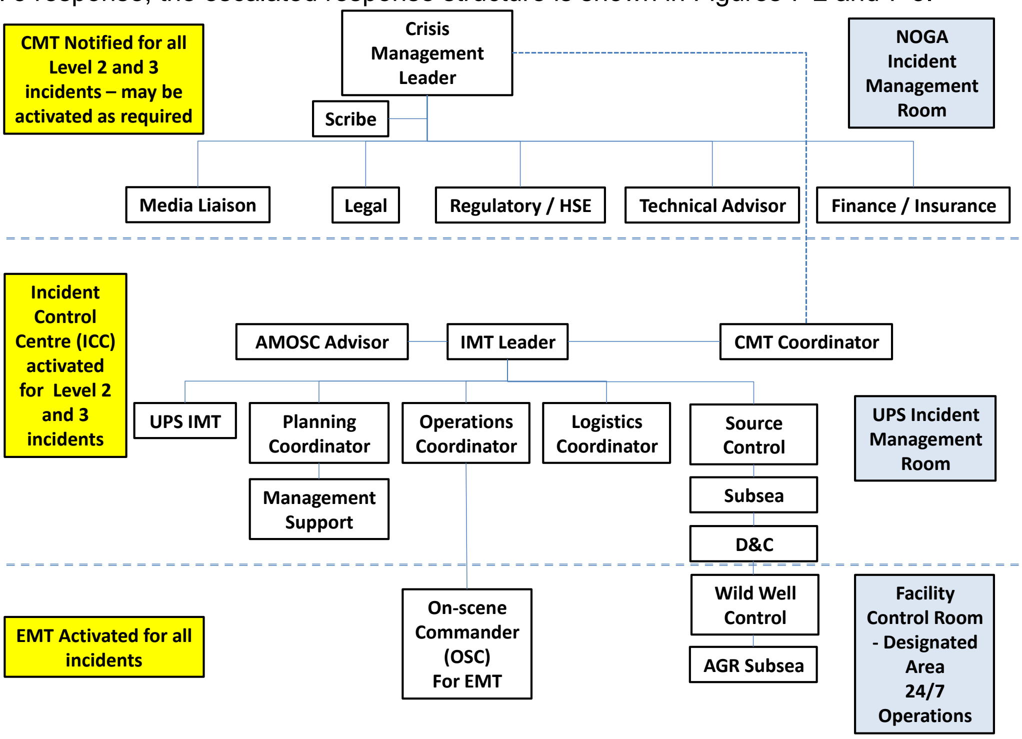

Figure 7-2 NOGA Incident Management Structure

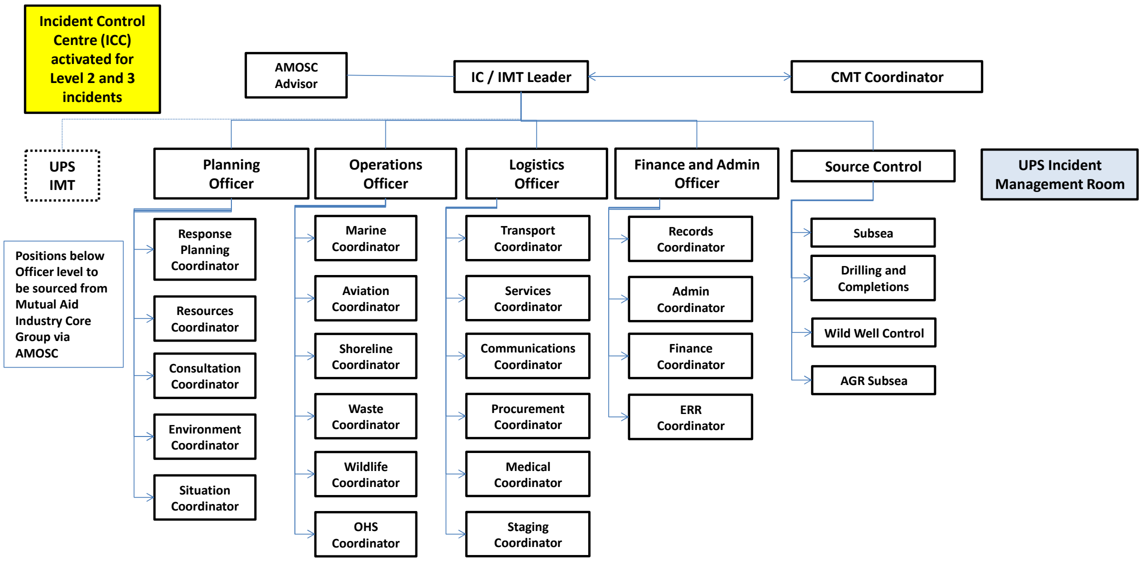

Figure 7-3 NOGA Expanded Incident Management Structure for Level 3 Events

7.2 OPEP Activation

In the event where effective management of an oil spill response is considered to be beyond the capability of the immediate FPSO resources (i.e. > Level 1), the response may be escalated immediately to the next level. Specific details for level escalation are detailed below and depicted schematically in Figure 7-4.

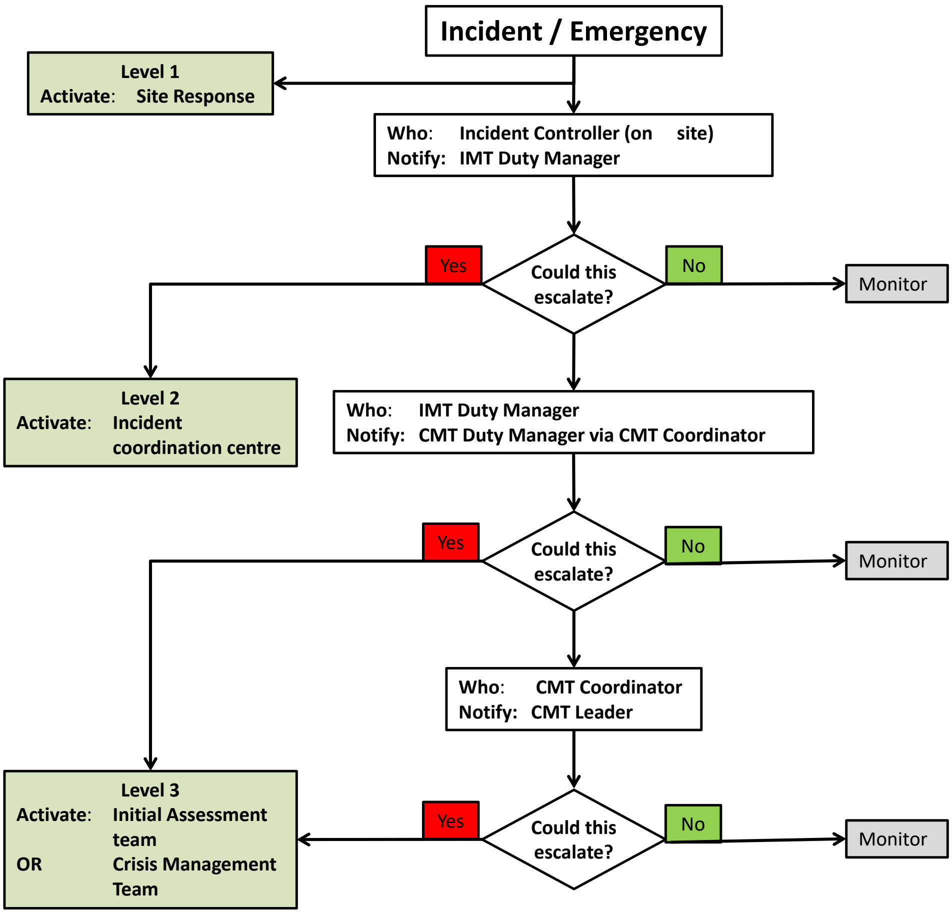

Figure 6-4-Indicative Response Escalation Process

Level 1 Resources and Organisation

Resources - a Level 1 response will be site/facility-based and does not require external assistance. Resources will be drawn from NOGA's own stockpiles for a Level 1 response. For the NE FPSO, these may include shore-based equipment and personnel and also the resources held for other operations (e.g. exploration, drilling and completions) and trained personnel based in NOGA's Perth headquarters. A Level 1 response will not typically include any scientific monitoring given the small scale and significance of this type of spill.

The objectives of the response relate to the security and protection of health, safety and well-being of people, restricting damage to assets and protection of the environment.

Organisation – a Level 1 response can be controlled and resolved with the operational resources normally available at the site/facility.

The OSC coordinates a Level 1 response and will determine additional roles and teams required to support the hydrocarbon spill response. The OSC will be the person in charge (i.e. Vessel Master if the spill originates on a vessel). The UPS IMT Leader Duty Manager retains the authority to replace an OSC.

Level 2 Resources and Organisation

Resources - a Level 2 response assumes the existing activation of Level 1 response arrangements. Level 2 resources are based primarily on utilising AMOSC existing stockpiles, which will be sought from Fremantle, Geelong or at their stockpiles around Australia, or via OSRL from their Singapore base, and if required, industry support. Regional (Port and State/Territory) equipment and human resources may also be mobilised through the relevant Port Authority or State/Territory Control Agency.

Organisation - a Level 2 hydrocarbon spill response requires coordination support that is provided to the site via the activation of part or all of the NOGA IMT. For Level 2 hydrocarbon spills, the IMT Duty Manager transitions to become the IC due to the evolving complexity of the spill response. The objectives are similar to Level 1 incident response and involve providing additional resources to support the site and notify stakeholders.

The UPS IMT Duty Manager informs the NOGA CMT Duty Manager by providing an initial incident notification report of the Level 2 event and the potential for the spill response to escalate. The CMT Duty Manager then:

- Activates the required resources to provide operational management support to the site;
- Reviews the possibility of escalation and the need for additional resources with the CMT Leader; and
- Assumes the role of IC for the spill event, given the OSC need to focus on the asset and safety of personnel.

In the event of a requirement to escalate the response to Level 3, the NOGA IC will liaise directly with AMOSC and OSRL and, where required and appropriate to the spill trajectory, the WA and NT DoT in order to source additional support and equipment. Level 2 responses may result in some operational and scientific monitoring being triggered.

Level 3 Resources and Organisation

Resources - a Level 3 response assumes the existing activation of Level 1 and 2 response arrangements. Such a response is likely to utilise industry response arrangements comprising the mobilisation of AMOSC's Level 3 stockpiles in Geelong and/or Fremantle and potentially other AMOSC or AMSA stockpiles depending on the spill trajectory.

In addition, NOGA can activate OSRL's Singapore-based services and resources via its existing contract arrangement. Level 3 responses are likely to result in many of the operational and scientific monitoring plans being triggered.

Organisation - Level 3 responses require corporate strategic direction due to the impact on reputation, liabilities, business continuity and stakeholders via activation of part, or all, of the CMT. For a Level 3 Response, the CMT Duty Manager (after discussion with the CMT Leader) is responsible for:

- Activating the required resources to manage the strategic element of the incident;
- Fulfilling the role of CMT Team Leader until that person is available;
- On arrival of the Team Leader, assumes the role of facilitator.

The CMT Leader:

- Informs the CEO of the event;
- Discusses actions taken and the possible activation of the full CMT.

NOGA may request assistance from supporting agencies such as AMOSC, AMSA or OSRL.

7.3 Oil Spill Response Strategies

The application of the mitigation controls varies according to the event, the hydrocarbons released and receptors that may be impacted, including sensitivities such as fisheries, migratory species and presence/absence of species. A pre-operational Net Environmental Benefit Analysis (NEBA) has been undertaken to broadly evaluate each potential mitigation control and decide whether implementation is of potential net environmental benefit, as well as considering its feasibility. Mitigation controls that are not beneficial are rejected at this stage and not assessed further.

The NEBA is based on key identified sensitive receptors and evaluates the delivery of the selected mitigation controls, including environmental risks and impacts to ALARP. In the event of an actual hydrocarbon release an operational NEBA will be conducted using the same pre-operational NEBA format but updated with information from Operational Monitoring Plans to confirm the most appropriate control strategies and inform ongoing relevant scientific monitoring studies.

A summary of the strategies selected through the NEBA process are shown in Table 6-1 below.

Table 7-2 Summary of Oil Spill Response Strategies

Oil spill response technique	Description
Source control	In the scenario where there is a loss of well control and the Laminaria and Corallina tree valves fail to shut in or there is a failure of other primary or secondary barriers between the reservoir and the tree valves, NOGA has prepared three source control response strategies. The primary source control strategy is the implementation of an Emergency Well Kill Plan control strategy is required. The emergency well kill procedure consists of pumping treated seawater into the well tree via a dedicated well kill tie-in point on the FPSO (referred to as bullheading). Seawater has a specific gravity of 1.02, which is higher than that of the normal production well fluid (SG approx. 0.7). If sufficient seawater in injected into the well production tubing, the well will be unable to generate sufficient pressure to flow. The secondary source control strategy is Emergency Tree Replacement. This response involves deployment of a dedicated emergency standby tree stored in Darwin, removing the damaged tree and replacing with the emergency standby tree. The tertiary source control method is to drill a relief well to kill the flowing well. A relief well requires the mobilisation of a Mobile Offshore Drilling Unit (MODU) to the location adjacent to the failed well and the drilling of an interception well through which the failed well can be killed and made safe.
Evaporation and natural dispersion	Due to the ultra-light nature of the Laminaria / Corallina crude, a key mitigation control strategy is to allow natural evaporation, dispersion and degradation to take place concurrently with operational and scientific monitoring that will inform other potential strategies. The main drivers for this response are: • The ultra-light nature of the Laminaria crude and its high rate of evaporation; • The low floating oil areal coverage; • The low probability of any shoreline contact; • The distance of any shorelines where contact is potentially made and the relatively low level of weathered crude accumulation; and • The high level of Volatile Organic Compounds (VOCs) following a major spill restricts the selection of offshore responses that can be safely carried out for the first 72 hours.
Operational Monitoring	Operational monitoring related to Level 2 or 3 hydrocarbon spills requires long-range support from dedicated air and marine services. Monitoring involves several concurrent activities, listed below, over a wide geographical area: • Oil Spill Trajectory Modelling (OSTM) – The OSTM will assist in determining which direction oil slicks are travelling in, what sensitivities are at risk and therefore what on-ground responses should be undertaken.

<table>
<tr><th>Oil spill response technique</th><th>Description</th></tr>
<tr><td></td><td>Deployment of satellite-tracking buoys – NOGA has a satellite-tracking buoy available on the FPSO. In the event of a Level 2 or 3 spill, the tracking buoy will be deployed into the ocean and drift with the currents. Its signal will be satellite-monitored and tracked via computer to provide real-time information on oil slick movement.
Vessel- and aerial-based observations – Offshore Support Vessels (OSVs), vessels of opportunity, NOGA-chartered aircraft and aircraft of opportunity will be used to transport trained oil spill observers to undertake visual estimation of the oil slick (distribution, colour and consistency) and determine weathering characteristics to inform oil spill response options. Given the FPSO's distance from the coast and the need for extended period in the air to monitor a spill, it is likely that large fixed wing airplanes will be used to conduct surveillance rather than rotary air (helicopter) services.</td></tr>
<tr><td>Scientific Monitoring Plan (SMP)</td><td>The SMP is informed by the Operational Monitoring Program (OMP) but differs from the OMP in being a long-term program independent of and not directing the operational oil spill response. The SMP comprises nine targeted environmental monitoring programs to address condition assessment of a range of physical-chemical (water and sediment) and biological (species and habitats) receptors including EPBC Act-listed species, environmental values associated with protected areas and socio-economic values such as fisheries. The nine SMPs are:
SM01 - Desk-top review and assessment of hydrocarbons in marine waters.
SM02 - Assessment of the presence, quantity and character of hydrocarbons in marine sediments.
SM03 - Assessment of impacts and recovery of subtidal and intertidal benthos.
SM04 - Assessment of impacts and recovery of seabird and shorebird populations.
SM05 - Assessment of impacts and recovery of nesting marine turtle populations.
SM06 - Desktop assessment of impacts to other non-avian marine megafauna.
SM07 - Assessment of impacts and recovery of marine fish.
SM08 - Assessment of physiological impacts to commercially important fish and shellfish species (fish health and seafood quality/safety) and recovery.
SM09 – Hindcast modelling.
Key objectives of the NOGA oil SMP are:
Assess the extent, severity and persistence of the environmental impacts from the spill event; and
Monitor subsequent recovery of impacted key species, habitats and ecosystems.</td></tr>
<tr><td>Containment and Recovery</td><td>Containment and recovery operations involves concentrating of the remaining floating surface oil after the initial evaporation phase and recovering on to vessels. It involves deployment of:
An On-scene Command and Monitoring Vessel;
Recovery unit vessels (one vessel deploying a 600 m containment J-boom and a second vessel conducting skimmer recovery); and
A waste storage vessel.</td></tr>
<tr><td>Shoreline Deflection and Protection</td><td>Shorelines deflection and protection involves the deployment of offshore booms to protect Ashmore Reef from contact from any remaining weathered oil after the initial evaporation phase. Shoreline protection booms will be deployed using small, shallow-draft vessels capable of towing boom from the beach along with larger vessels capable of carrying small vessels, shoreline equipment, and waste and supporting responders offshore.</td></tr>
<tr><td>Oiled Wildlife Response</td><td>An oiled wildlife response (OWR) would be undertaken in accordance with NOGA's policy, values, and recognition of societal expectations. It would form part of both the open ocean response and the shoreline response, and resources and may be required in both locations.

OWR involves the following three-tiered approach:
Primary response:
Undertaking surveillance to determine the location and extent of wildlife injuries or death.
Deflecting oil away from areas of high sensitivity where practicable.
Secondary response:
Hazing (scaring animals from impacted or potentially impacted areas).
Pre-emptive capture and exclusion activities.</td></tr>
</table>

Oil spill response technique	Description
	• Tertiary response: o Capture and stabilisation of oiled wildlife (on vessels or the beach). o Transport to treatment facilities. o Treatment of affected animals. o Rehabilitation and release of affected animals.
Waste Management	Waste generated and collected during an oil spill response requiring management and disposal may consist of: • Liquids (recovered oil/water mixture), recovered from containment and recovery or shoreline protection operations; • Semi-solids/solids (oily solids), collected during shoreline protection and deflection operations; and • Debris (e.g. seaweed, sand, woods, plastics), collected during shoreline protection operations. Expected waste volumes during an event will vary depending on volume released, mitigation controls employed and how fresh / weathered oil is. Waste management, handling and capacity should be scalable to ensure continuous response operations can be maintained. The objectives of NOGA's waste management response, derived from the respective mitigation controls described above, are: • Mobilise waste storage and transport resources to support containment and recovery and shoreline protection responses; and • Arrange for sufficient waste storage, handling, transport and disposal capability to support continuous response operation.

7.4 Response Capability

NOGA maintains a response capability by having contracted resources in place for equipment access, specialist personnel and conducting regular oil spill response exercises with both its offshore and onshore support teams. NOGA Oil Spill Response resources include:

- Membership with AMOSC and OSRL for access to equipment, resources and specialist personnel;
- MoUs with APPEA, AMSA and Wild Well Control;
- Vessel and aerial response contracts;
- Oil Spill Trajectory Modeling contracts;
- Satellite monitoring capability with OSRL;
- Satellite Drifter buoys;
- MoUs in place with Operational and Scientific Monitoring resources;
- Source control plans in place.

Level 1 readiness and competency of the NE facility to respond to incidents and emergencies is maintained and tested by conducting periodic emergency exercises. The exercises have the objective of developing and testing procedures, skills and teamwork of the Emergency Response and Command Teams to respond to Major Environment Events (MEE).

The Annual Level 3 crisis exercise involves activation of the NOGA & UPS Crisis Management Teams (CMT) for significant, complex incidents that have potential corporate level impact (including significant or extreme environmental impact). Level 3 exercises focus on critical risks to the business, including oil spills, and are conducted annually with the theme (i.e. oil spill, cyber-attack etc.) determined by the CEO.

The objective of these exercises is to test NOGA's oil spill response arrangements and the oil pollution first strike plans incorporating the use of operational plans and tactical response plans. Testing the response arrangements will include:

- Immediate notifications;
- Consideration of appropriate response strategies and associated resources;
- Development of Incident Action Plans beyond the initial first strike period;
- Initiation of appropriate response strategies;
- Field deployment exercise;

- Ability of third parties listed as part of the response strategies to respond in the timeframes and manner outlined in the oil spill support plans including the availability and mobilisation times of personnel and equipment.

8 MONITORING OF ENVIRONMENTAL PERFORMANCE

This section summarises the key systems, practices and procedures implemented by the NE FPSO to ensure the environmental risks and impacts are reduced to ALARP and to an acceptable level, and that the performance outcomes and standards outlined in The EP are met.

8.1 Inductions

A comprehensive induction process is in place for personnel working on or visiting the NE facilities. The induction process is designed to equip personnel with the health, safety and environmental awareness and skills necessary for them to manage their own safety and environmental performance and contribute to others working around them.

The induction process includes:

- NE Onboarding Induction – All personnel visiting the facility are required to complete this on-line induction. The induction provides and overview of the facility, information about travelling to the NE, rules and services when one arrives offshore and key environmental risks and awareness.
- NE Facility Orientation – All employees and contractors that have not accessed the NE facility within 6 months are required to undertake this induction on arrival at the facility. This induction covers the HS&E and emergency response issues specific to each facility. For environment this induction covers the Facility EP, prevention of spills, waste management, fauna interactions, hazard identification and risk assessment and incident reporting.

8.2 Training

Three core training programs operate to support implementation of the EP:

1. All NE offshore personnel complete internal environmental awareness training.
2. Key offshore managers and supervisors also complete internal environmental leadership training, to provide them with detailed knowledge required to fulfil their EP-defined accountabilities and responsibilities - and to develop the environmental capability of other facility personnel.
3. System-specific competency training for offshore personnel with influence over the technical integrity of the facility. This includes personnel with responsibility for implementation of pollution/emergency response procedures or SCE procedures, and personnel implementing facility system procedures for which The EP requires records to be kept that verify operator competency.

Emergency and Oil Spill Response Training

The NE OIM is responsible for ensuring that personnel fulfilling emergency response roles are competent in crisis and emergency procedures related to the protection of health, safety, environment and integrity. The level of training and associated competency demonstration is dependent on their role in a crisis or emergency situation.

All personnel involved in crisis and emergency management are required to undertake ongoing training, process improvement and participation in emergency and crisis response (both real and simulated), including emergency drills specific to potential incidents at the NE facility. Training includes task specific training and role based training. Oil spill task specific training (IMO 2 and 3 or PMAMIR320 and PMAMIR418B)) is typically undertaken by either the Australian Marine Oil Spill Centre (AMOSC) or OSRL, whereas role-based training includes a combination of courses (i.e., Command and Control) and 'on the job' experience (i.e., participation in crisis or emergency management exercises).

The NOGA Production Operations Manager is responsible for identifying and developing approved competency and non-competency based courses, identifying relevant personnel required to undertake training and ensuring training records are maintained.

Environmental Awareness Refreshers

Ongoing environmental awareness refresher training is undertaken to ensure personnel working on the NE facility are aware of their EP related responsibilities and to ensure environmental risks and impacts are continually being reduced to ALARP, and performance outcomes and standards outlined in the EP are achieved. This is undertaken through deployment of the:

- Offshore Environmental Awareness Competency (2 yearly); and
- Regular environment toolbox topics (e.g. waste management, EP, spill response, incident reporting, hazardous chemicals, temporary bunding, etc.).

Environment toolbox topics are scheduled in the Integrated Activity Plan and the training material (which generally comprises posters, toolbox presentations and palm cards) is deployed through the Offshore Installation Manager and UPS HSE Coordinator to all offshore personnel during crew HSE meetings. Records of training and environmental toolbox deployment dates are maintained by the HSE Coordinator.

8.3 Monitoring, Auditing, Management of Non-conformance and Review

This section summarises the measures undertaken by NOGA and UPS to regularly monitor the management of environmental risks and impacts of the NE facility against the performance outcomes, standards and measurement criteria, with a view to continuous improvement of environmental performance.

Environmental performance of the NE facility is monitored and reviewed in a number of ways including monitoring of emissions and discharges from the facility and through use of various tools and systems to report on environmental performance as described below.

Monitoring and Reporting Environmental Performance

The NE Operations Manager and NE OIM are fundamental to providing immediate feedback on performance to personnel in the field and onshore:

- Internal daily reporting – The NE FPSO Daily Production Report is issued to key support personnel by the OIM. This report provides performance information on HSE, technical integrity, production, together with equipment information, current and planned work activities. Daily meetings are used to transfer information, agree plans for forward activities and develop plans and accountabilities for issue resolution.
- On a monthly basis the environmental checklist is used as directed by the HSEC Manager on board the FPSO to undertake a routine check of the key environmental processes and systems.
- NE Operating Performance Report – This report is prepared monthly and compiles information regarding environmental, operating, assurance and IMR performance for review by the leadership team and senior operator/contractor management.

8.4 Routine Reporting

A suite of internal and external annual reporting is undertaken for the facility, as briefly described here.

Internal Reporting

- Annual NE Facility Environment Audit Report – Each year, as part of the NE Assurance Plan, the NOGA Production Operations Manager or delegate undertakes a site- and office-based environment audit of performance against the EP performance outcomes, standards and measurement criteria at the NE facility. A report is prepared including findings and recommendations, which is provided to the NOGA leadership team and senior operator management, then submitted to the UPS NE Operations Manager and OIM for implementation.
- NE Operating Performance Report – The collation of the monthly NE Operating Performance Report over a twelve-month period creates an annual performance report for the NE facility and activities. This information, combined with the Annual NE Facility Environment Inspection Report and learnings from other internal and external reports, enable the NOGA leadership team and senior operator/contractor management to review environmental performance and progress against the NE Annual Operating Plan and Facility Scorecard, and then manage future performance via the update of the NE Annual Operating Plan.

External Reporting

The routine external reporting requirements for the NE FPSO are detailed in Table 7-1.

Table 7-1. Routine external reporting requirements for the NE FPSO

Report	Recipient	Frequency	Content
Monthly Recordable Incident Report	NOPSEMA (National Environment Regulator)	Monthly by 15th of the month following the reporting period.	As required by Regulation 26B a written report of recordable incidents that have occurred on the NE FPSO will be submitted to NOPSEMA on a monthly basis (if applicable). See Section **Error! Reference source not found.** for more detail.
Annual Environmental Compliance and Performance Report	NOPSEMA	Annually by 30 April of the year following the reporting period	As required by Regulation 14(2) a written report is submitted to NOPSEMA to assess and report on compliance with the accepted environmental performance outcomes and standards outlined in the EP. The report also contains a summary of environmental performance including for example, a summary of incidents for the year, emissions and discharges results, stakeholder consultation undertaken, results of monitoring programs or environmental studies, emergency response exercises and opportunities for future improvements. The reporting period is 1 January to 31 December each year.
Annual National Pollutant Inventory (NPI) Report	WA Department of Environmental Regulation (DER)	Annually by 30 September of the year following the reporting period.	Summary of the emissions to land, air and water from the NE FPSO, submitted via State environmental regulatory agencies for inclusion in the Commonwealth Government's NPI Database. The reporting period is 1 July to 30 June each year.
Annual National Greenhouse and Energy Reporting (NGERS)	Clean Energy Regulator	Annually by 31 October of the year following the reporting period.	Summary of energy use and greenhouse gas emissions from the NE FPSO. The reporting period is 1 July to 30 June each year.

8.5 Incident Reporting

All NOGA and UPS employees and contractors are required to report environmental incidents and non-conformances with The EP. Incidents are reported using an Incident and Hazard Report Form which includes details of the event, immediate action taken to control the situation, and corrective actions to prevent reoccurrence.

It is the responsibility of the NE FPSO OIM to ensure environmental incidents are reported in accordance with regulatory reporting requirements as detailed in the UPS Hazard and Incident Reporting Procedure [00/HSEQ/GEN/PC23] and this section of the EP.

A **reportable incident** as defined under OPGGS(E) Regulation 4(1) as:

> '*an incident relating to the activity that has caused, or has the potential to cause, moderate to significant environmental damage'*.

A reportable incident from the NE FPSO is therefore:

- An incident that has caused environmental damage with a Consequence Severity Level of 3+ (as defined under the Operational Risk Matrix); or
- An incident that has the potential to cause environmental damage with a Consequence Severity Level of 3+ (as defined under the Operational Risk Matrix).

A review of the environmental risk assessment (Table 6-1) for the NE FPSO identifies those risks with a potential consequence level of 3+ for environment, which are restricted to events causing a loss of hydrocarbon containment to the ocean (i.e., MEE-01, 4 and 5), and are therefore reportable incidents.

Agencies other than NOPSEMA also have regulatory requirements for reporting incidents that affect their functions or interests, and these are outlined in Table 6-2 (note that phone numbers and email addresses have been removed, but are available in the EP and OPEP). Notifications for all reportable incidents will be undertaken according to the requirements of Regulation 26, 26A and 26AA (Part 3) of the OPGGS(E). The NOGA HSE Manager is responsible for making these notifications and providing relevant reports.

Table 8-1. External reportable incident Requirements for the NE FPSO

Requirements	Timing
Oil spill (Commonwealth waters)	
In addition to reporting to NOPSEMA, the following reporting requirements are in place. AMSA Any unplanned hydrocarbon spills from the FPSO or OSVs must be reported to AMSA. A Pollution Report (POLREP) form can be completed and submitted online at: https://amsa-forms.nogginoca.com/public/	As soon as possible. POLREP within 2 hours.
DoEE Any oil spills that threaten a MNES must be reported by phone and email.	As soon as possible.
Oil spill (if approaching WA state waters)	
Any unplanned hydrocarbon spills from the FPSO or OSVs that may approach WA state waters must be reported as soon as possible to the: WA DMP	As soon as possible, but within 2 hours of the incident. Phone notification to be followed by written notification as soon as practicable.
WA DoT • By phone. • Complete a POLREP report once verbal notification has been provided (http://www.transport.wa.gov.au/imarine/report-marine-oil-pollution.asp). • Prepare a Situation Report (SITREP) if requested (http://www.transport.wa.gov.au/imarine/report-marine-oil-pollution.asp).	As soon as possible. As soon as possible. Within 24 hours.
The WA DoT, as the Maritime Environmental Emergency Response (MEER) Unit of WA, is responsible for reporting to the DER and DPaW.	As soon as possible.
Cetacean interactions	
DoEE Report injury to cetaceans from OSV strike to the National Ship Strike Database. Report injury to or death of a cetacean by phone and email. Report injury to or death of any other EPBC Act-listed species by phone or email.	As soon as possible, but no later than 72 hours of the incident occurring. As soon as possible. Within 7 days of becoming aware of incident.

A **recordable** incident as defined under OPGGS(E) Regulation 4(1) as:

> *'a breach of an environmental performance outcome or environmental performance standard, in the environment plan that applies to the activity, that is not a reportable incident'.*

Examples of recordable incidents for the NE FPSO include:

- An incident that breaches a performance outcome of The EP.
- Discharge of PFW into the sea above 30 mg/L OIW concentration over any period of 24 hours.
- For performance outcomes and standards that relate to the prevention of hydrocarbon or chemical loss of containment events, a reporting threshold has been set. This is based on the likelihood that spills below this threshold will not result in any measurable impact to the ocean surrounding the NE FPSO. This reporting threshold also accounts for the complexity of estimating spill volumes of a lower threshold.
- Breach of the CMS (e.g. failure to raise a performance standard non-conformance for critical equipment or systems that do not meet the requirements of the relevant SCE Performance Standard.
- An uncontrolled release of a synthetic greenhouse gas of 40 kg or more (for non-ozone depleting substances) or 10 kg or more (for ozone depleting substances).

NOPSEMA will be notified of all **recordable incidents**, according to the requirements of Regulation 26B, as soon as practicable but not later than 15 days after the end of the calendar month.

8.6 Monitoring and Measurement of Emissions and Discharges

Emissions and discharges to the environment from the NE facility are monitored to assess the environmental performance of the facility on an ongoing basis. A summary of emissions and discharges monitoring for the NE facility is provided in Table 6-3 overpage.

Table 6-3. Emissions and discharges monitoring for the NE Facility

Category	Parameter to be Monitored / Reported	Monitoring Frequency	Monitoring Equipment / Methodology	Relevant Monitoring Procedures	Records
Planned emissions and discharges					
Gas flaring	Volumes of gas flared to atmosphere.	Ongoing	• HP Flare Flow. • LP Flare Flow.	NE Operations Performance Standard - P31 Environmental Emissions and Discharges Monitoring and Controls [26/OP/INT/PS50]	• Production Daily Report – HP and LP Gas Flared.
Emissions from fuel combustion	Fuel gas and crude oil consumption	Ongoing	• Lift Gas Compressor Turbines Fuel Gas Flow. • Power Generation Turbines Fuel Gas Flow.	NE Operations Performance Standard - P31 Environmental Emissions and Discharges Monitoring and Controls [26/OP/INT/PS50]	• Daily Report – tonnes of fuel gas consumed.
Emissions from fuel combustion	Diesel consumption	Ongoing	• Diesel tank level gauges' system.		• Daily Report – tonnes of diesel consumed.
Discharge of subsea control fluids during well actuations	Subsea control fluid consumption.	Ongoing	• Pressure alarms for gross leaks / ruptures.	Not applicable	• Subsea control fluid consumption records in daily report.
Discharge of hydrocarbons and chemicals during subsea IMR activities	Volumes of hydrocarbons and chemicals released subsea.	As required (activity specific)	• Estimates based on known volumes of vented voids, known volumes pumped and ROV observation.	Not applicable	• IMR activity daily reports .
Discharge of PFW	Volume of PFW discharged.	Ongoing	• Online OIW analyser. • Overboard Flow Meter.	NE Operations Performance Standard - P31 Environmental Emissions and Discharges Monitoring and Controls [26/OP/INT/PS50]	• Daily Report. • Monthly OIW Report.
	OIW concentration of discharged PFW.	During overboard discharge	• Online OIW analyser. • Overboard Flow Meter. • Online OIW Analyser located on slops tank outlet. • Overboard Flow Meter.	NE Operations Performance Standard - P31 Environmental Emissions and Discharges Monitoring and Controls [26/OP/INT/PS50] CMMS Record: AU060842-1: 1M P31 INSP & CAL OF SIGRIST OIW ANALYSER Determination of TPH in Aqueous Samples,	• Daily Report. • Monthly OIW Report.

Category	Parameter to be Monitored / Reported	Monitoring Frequency	Monitoring Equipment / Methodology	Relevant Monitoring Procedures	Records
			• Horiba manual OIW samples.	Process Solvents and Soil Samples (NE Laboratory Procedures Manual [26/OP/LT/MN01])	
	Effects of PFW on existing environment assessed by: • OIW concentration of discharged PFW; • Chemical characterisation of PFW; • Ecotoxicity assessment of PFW; and • Predictive dispersion and risk assessment modelling of PFW.	Various	• Continuous monitoring of OIW concentration in PFW. • Annual PFW chemical characterisation. • Three-yearly PFW chemical characterisation and ecotoxicity testing.		• PFW Ecotoxicity, Chemistry and Discharge Assessment – Woodside Production Facilities (SKM, 2011).
Waste recycling and disposal	Quantities of solid and liquid wastes disposed, recycled and incinerated.	Quarterly	• Quarterly Waste Report from waste contractor. • NE FPSO Waste Manifest [26/HSEQ/ENV/RG100].	NE Offshore Waste Management Plan [01-HSE-PL14]	• Waste contractor database and reports - quantities of waste landfilled, recycled and incinerated onshore. • OSV Garbage Book and Oil Record Book.
Unplanned emissions and discharges					
Unplanned release of Synthetic GHG and Ozone-Depleting Substances	Refrigerant type, serial number, weight and inspections.	As required	• Quarterly leak testing of refrigerant containers. • Testing conducted by a licenced technician. • Maintenance of equipment, including leak detectors, vacuum pumps and recovery units.	NE Offshore Refrigerant Management Plan [26/HSEQ/ENV/PL07]	• NE FPSO Refrigerant Register [26/HSEQ/ENV/RG100]. • Incident reports in *MyOSH* incident reporting database. • Monthly Operating Performance Report - summary of environmental

Category	Parameter to be Monitored / Reported	Monitoring Frequency	Monitoring Equipment / Methodology	Relevant Monitoring Procedures	Records
					incidents. • Reportable incident report to NOPSEMA.
Unplanned hydrocarbon or chemical spills	• Type, volume and concentrations. • Incidents reported in accordance with NOGA and regulatory requirements.	As required	• Monthly incident analysis. • Regulatory reporting as required. • Oil spill trajectory modelling; and • Where metering is unavailable, volumes will be determined based on best technical data and evaluations (e.g. known well flow rates, reservoir characteristics and known inventory volumes).	Hazard and Incident Reporting Procedure [00/HSEQ/GEN/PC23]	• Incident reports in *MyOSH* incident reporting database. • Monthly Operating Performance Report - summary of environmental incidents. • Oil spill modelling report. • Reportable incident report to NOPSEMA.

8.7 Auditing and Assurance

Assurance is the process used to provide confidence to NOGA's internal and external stakeholders that NE operations are meeting their objectives and delivering on agreed targets. This involves demonstrating that the process and performance risks are being effectively managed.

The outputs of the assurance process are the corrective actions that feed the improvement process. Therefore, assurance is a key driver of continuous improvement.

Audit and Assurance Plan

NOGA maintains an NE Audit and Assurance Schedule to provide confidence that all NE petroleum activities are meeting or exceeding the requirements of the NOGA policies, performance standards, criteria and targets (including regulatory requirements). The Audit and Assurance Schedule is managed on a rolling three-yearly cycle and details the assurance activities implemented by NOGA, UPS and Contractors.

Audits, inspections, monitoring and other assurance measures generate corrective actions that support continuous improvement of NOGA's environmental processes and performance. Corrective actions generated from audits are assigned and tracked in the Action Tracking System to ensure they are completed in a timely manner.

The NE Audit and Assurance Plan includes;

- Annual Environmental Inspection – At a minimum, an annual site-based environment inspection at the NE facility is undertaken by the titleholder NOGA representative (the Production Operations Manager, HSEC Manager or delegate). This includes a review of the performance against the EP performance outcomes, standards and measurement criteria and a review of the effectiveness of the Implementation Strategy outlined in The EP (i.e., inspection against all environmental performance outcomes, standards and measurement criteria This audit will be FPSO- and office-based.

- Monthly Environment Inspections – Managers, Supervisors and Team Leads at the NE facility are involved in monthly environment inspections in order to demonstrate that they are complying with the performance standards outlined in the EP. Monthly Inspections are guided by an Environmental Inspection Checklist which is schedule via a CMMS routine order, from which a report is generated and recorded, with actions raised and tracked until closed.

- Quarterly Procedure Compliance Reviews – Procedure reviews are completed as outlined in the assurance schedule but at a minimum of one key procedure a quarter. These reviews may be undertaken either on board the FPSO or as a desktop compliance review onshore. These reviews include compliance audits of certain key procedures such as chemical use, storage and handling, flaring and venting, oil spill response and PFW management.
- Contractor Audits: Key Environmental Contractors and suppliers that have been identified as high risk may also be subject to ongoing compliance audits. Initial audits are undertaken upon contractor engagement and then as determined by a risk basis for review after that as outlined in the assurance schedule.

All performance standards and SCE's identified as part of the MEE process are also included in the NE Audit and Assurance Schedule and will undergo routine compliance audits as outlined in the assurance schedule.

If the results from implementing the NE Audit and Assurance Schedule require that the EP is updated to reflect new or changed levels of risk, the EP will be reviewed and revised as required.

Marine Operations Assurance

The NOGA Marine Assurance (Tankers, Ships and Vessels) Procedure [01-OPS-PC01] requires all chartered vessels to undergo a marine vessel operator inspection on a two-yearly basis. This inspection includes a search of Offshore Vessel Inspection Database (OVID) for all relevant certifications and maintenance records related to marine regulations (e.g., MARPOL). The ship inspection process is managed by the Operations Manager, and all inspections are planned and tracked in the actions tracking database. Applicable legislative and project-specific commitments relating to marine quarantine are also implemented via this procedure.

Environmental requirements specific to facility OSV contactors are communicated via the NE Marine Operations Procedures for Support Vessels [26/OP/GO/MN/AG010]. This document provides the Master of a vessel on hire with a clearly defined set of requirements and procedures for operating the vessel in the vicinity of the operating facility. This includes the management of environmental risks and impacts from the NE facility.

8.8 Management of Non-conformance and Corrective Action

Identified Performance Standard non-conformance, unavailability of SCE or SCA are managed under the UPS Performance Standard Non-Conformance Procedure [26/OP/INT/PC03].

Other than environmental incidents, non-conformances with EP performance standards and corrective actions may come to light through:

- Inspection findings;
- Audit findings;
- Incident Investigations;
- Legislative changes;
- Drills and Exercises;
- HSE Meetings
- Changes to organisation structure; and
- Changes to industry practices.

Non-conformances (and/or corrective actions) are entered into *MyOSH* (onboard the FPSO) or any member of the NOGA or UPS management team in Perth. Personnel are assigned the task to complete the corrective action or close out the non-conformance, with *MyOSH* generating email alerts until the task is closed out. All personnel on the FPSO and in the NOGA and UPS NE FPSO teams have read/write access to *MyOSH*.

The status of performance standards non-conformances is reviewed and discussed in weekly operations meetings. The status of open corrective actions is tracked and reported as part of the monthly operations report. The numbers of outstanding corrective actions and performance standard non-conformance are reported monthly as a key performance measure.

9 EMERGENCY PREPAREDNESS AND RESPONSE

Several plans are in place to deal with emergency response management, as listed below:

- The NOGA Crisis Management Plan [00-MGT-001] – describes the strategic support to the asset in order to provide business continuity and support to the facility.

- The UPS Crisis Management Plan [00/HSEQ/GEN/PC18] – describes the crisis management arrangements that UPS has in place to manage foreseeable and unexpected events that could affect the viability or reputation of the organisation or its businesses.

- The NE Emergency Response Plan [26/HSEQ/GEN/PL03] – covers health, safety, asset and environmental risks (including fire, structural integrity, sabotage etc.) to ensure the range of occupational, asset and environmental risk exposures from incidents have been considered and plans are in place for their management.

- The NE Emergency Management Plan [26/HSEQ/GEN/PL04] – details the UPS Incident Management team and support to be provided to the facility to respond to the event.

- The NOGA Oil Pollution Emergency Plan (OPEP) [01-HSE-PL02], supported by the NOGA Oil Pollution First Strike Plan [01-HSE-PL01] – cover spill preparedness and response for the NE facility. These have been prepared in consultation with a range of regulatory authorities with expertise in oil spill planning and response.

NOGA utilises the Australasian Inter-Service Incident Management System (AIIMS) system of incident management for all emergencies including hydrocarbon spills. This allows NOGA to respond in a scalable structure both for time and location, that takes maximum advantage of its contractual arrangements with the NE FPSO Operator (Upstream Petroleum Services) as well as its contract oil spill response agencies.

The readiness and competency of the NE facility to respond to incidents and emergencies is maintained and tested by conducting periodic emergency exercises. The exercises have the objective of developing and testing procedures, skills and teamwork of the Emergency Response and Command Teams to respond to Major Environment Events (MEE). After each exercise the NE team holds a debrief session during which the exercise is reviewed, and lessons learnt and areas for improvement are identified for incorporation into emergency procedures where appropriate.

All Response arrangements are tested when they are introduced of when they are significantly amended as required by the OPGGS(E) Regulation 14(8C).

10 CONTACT DETAILS

The nominated liaison person for this Summary EP is:

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APPENDIX A ENVIRONMENTAL RISK ANALYSIS AND EVALUATION DETAILS

PLANNED (ROUTINE AND NON-ROUTINE) ACTIVITIES

Physical Presence - Light Emissions

Residual Risk	Low	Category of Risk	Negligible risk	MEE Code *(if applicable)*	N/A

Description and Cause of Risk

The environmental risk is light emitted from the FPSO and OSVs causing disturbance to protected marine fauna. The marine species with greatest sensitivity to light are seabirds and turtles.

The NE FPSO and OSVs have adequate lighting to allow safe working conditions during 24 hour operations. Unless required to support over the side activities (such as lifting operations, IMR activities) or for navigational purposes, lighting on the FPSO and OSVs is directed to the work area, which aids in limiting light spill to the ocean. During IMR activities, underwater lighting is generated over short periods of time while ROVs are in use. Flaring can also contribute to light being emitted from the FPSO.

Potential Environmental Impacts

Seabirds and Migratory Birds

Weise *et al* (2001) presented a literature review regarding the effect of light from platforms in the North West Atlantic on seabirds. They noted that seabirds are highly visually orientated and that large attractions of birds, and in some cases mortality, have often been documented by lighthouses, communication towers, buildings and oil platforms. Injuries occur through direct collisions and the rate of collision is (as inferred from literature) related to weather conditions, the cross-sectional area of the obstacle, amount of light and number of birds travelling through an area. Where bird collision incidents have been reported, low visibility weather conditions (cloudy, overcast and foggy nights) are usually implicated as the major contributing factor, in contrast there are seldom collision incidents on clear nights (Avery, 1976; Elkins, 1988; Weise *et al*, 2001). Conditions in the region are not conducive to fog formation and most rainfall is seasonal associated with summer monsoon and cyclones in November to March (Section 4). This is outside the period of bird migration (southward migration is from July to December, and northward migration from March to April).

Black (2005) reported on two cases of mass seabird mortalities from striking ships in the Southern Ocean (the *Aurara Australis* and the *Dorade)*. In both cases, mortality incidents occurred when the vessels were at anchor near seabird colonies and conducting night deck operations, during periods of reduced visibility due to foggy weather conditions.

Newly fledged juvenile birds leaving the breeding colony for the first time are the most prone to disorientation by nearby lighting (Commonwealth of Australia, 2012b). No roosting or nesting habitat exists within the NE FPSO Operational Area. The offshore islands of Cartier Island, Adele Island and Browse Island provide nesting and foraging habitats for some seabirds and waders. There are also areas of critical habitat for seabirds and waders in the broader region including the Ramsar Convention protected sites at Ashmore Reef and Cobourg Peninsula. However, the NE FPSO is located over 300 km or more from the closest of these locations.

The potential for seabirds colliding with the NE FPSO due to disorientation by lighting is therefore considered to be insignificant given the minimal light being directed outwards from the facility, the distance from nesting habitats and seabird colonies, and the prevalent clear visibility conditions.

In a study of offshore oil platforms in the North Sea, Poot *et al* (2008) demonstrated that large flocks of migrating seabirds can be attracted to the lights and flares of offshore oil platforms, particularly on cloudy nights and between the hours of midnight and dawn. They hypothesised that when such offshore platforms are located on long-distance bird migration routes, the impact of this attraction could be considered highly significant, as many birds cross the ocean with twelve hours of fat reserves (for instance, for a ten-hour flight). Any delay (e.g. resting on a platform or circling around them) could significantly reduce the bird's resilience and potential survival. Migratory shorebirds travelling the East Asian-Australasian Flyway may transit through the NE FPSO Operational Area en route to staging areas, before moving onto the mainland in the South in the spring or Indonesia in the North in the autumn. It is possible that many of the birds on migration may also take advantage of ships and offshore facilities in the area to rest. However, the possibility of this occurring in the NE FPSO Operational Area is considered to be extremely low as migrating birds in the region are at or near the end of their migration (or staging area) and if any are attracted to the FPSO, they will not be facing long-distance journeys upon leaving the facility. The environmental impact associated with seabirds potentially attracted to the light, and hence diverted from their migratory pathway is considered to be insignificant.

Since production commenced, there have been no recorded incidents of birds colliding with the NE FPSO.

Marine Turtles

The attraction of marine turtles to light has been well documented (for example, Salmon *et. al,* 1992 and Witherington and Martin, 2000). Disturbance can occur to adults during nesting or to newly emerged hatchlings. Disturbance to nesting adults is limited to light on or in very close proximity to the nesting beach and not discussed further. If hatchlings emerge from the nest at night, they use light cues to find their way to the ocean. Once in the water the exact methods of navigation are not fully understood, but it is known that hatchlings in the water are attracted to strong light sources.

The potential for turtle hatchlings to be attracted to the NE Operational Area is mitigated by its distance from the nearest shoreline and offshore islands where turtle nesting may occur (more than 150 km to the Timor coast and more than 300 km to Ashmore Reef, which means that light generated from the FPSO is insignificant from ground level at the closest coasta turtle nesting location. The potential effect is also mitigated by minimal light being directed outwards from the facility and (in the case of OSVs) the movement of the vessel. Similarly, light generated by flaring would not be visible at the nearest coastal location and the potential for disorientation or disruption of natural turtle behaviour at these locations would not occur. Waters around the NE Operational Area are not critical habitat for turtles and are distant from interesting areas. The environmental impact associated with turtles being attracted by NE operational activities is considered to be insignificant.

Fish

Lighting from activities in the NE Operational Area may result in the localised aggregation of fish below the source of light. These aggregations of fish would be confined to a small area. Any long term changes to fish species composition or abundance in the NE Operational Area resulting from light spill from the FPSO and OSV activities is highly unlikely.

For the oil spill response activities where the use of a vessel is required to conduct the activity, the predicted impacts do not significantly differ from the analysis presented above.

Preventative Controls

- Lights are not normally directed outwards away from work areas except when necessary for safe operations outboard, such as lifting operations, and deployment / retrieval of equipment from IMR activities. Activities requiring ROVs will be intermittent and of short duration.
- A review of light spill is conducted on the NE FPSO during the environmental inspections, which includes verification that lighting is limited to that required for safe navigation and working conditions.

Noise Emissions During Routine Operations

Residual Risk	Low	Category of Risk	Negligible	MEE Code *(if applicable)*	N/A

Description and Cause of Risk

The environmental risk is noise emitted from the NE FPSO causing disturbance to marine fauna. The facility, associated infrastructure and OSVs will emit noise from machinery, production process equipment and subsea activities. The FPSO, OSVs and helicopters will also create noise from engines and propellers.

Potential Environmental Impacts

The species with greatest sensitivity to underwater noise are whales, turtles and fish. Two pathways of effect are considered - direct physical damage and behavioural effect.

Physical damage

Whales: The potential for physical damage to whales from noise, such as hearing loss, is limited to circumstances when individuals are in close proximity to an intense sound from high energy sources. For baleen whales, the threshold for physical injury (defined as the onset of permanent threshold shift) from pulse and non-pulse sources has been estimated by Southall *et al* (2007) as occurring at the received sound exposure levels (SEL) of 198 and 215 dB re 1μPa^2.s, respectively. The approach of Southall *et al* (2007) recognises that even if the initial received levels are not great enough to cause injury, harmful effects can result from lower level sounds that last for a longer duration.

The EPBC Seismic Interaction Guidelines DEWHA (2008) use the lower standard of 160 dB re 1μPa^2.s from a single pulse at 1 km, on the assumption that the whale would receive the multiple pulses for a 30-minute period (leading to a cumulative SEL of 183 dB re 1μPa^2.s, the threshold for temporary threshold shift). Given the average broadband source levels for the NE FPSO is expected to be approximately 181 dB re 1 μPa at 1 m, physical impacts to baleen whales passing the NE FPSO are extremely unlikely. Comparison to the thresholds for physiological damage indicate that if a whale were to approach to within 10 m of a OSV while the vessel was holding station it may receive cumulative SEL sufficient to experience temporary threshold shift, but would not receive cumulative SEL sufficient to cause permanent physiological damage. There are no activities that are predicted to result in sound intensity exceeding the threshold peak impulse sound pressure and hence there is no potential for direct physical trauma of cetaceans in the NE Operational Area.

Turtles: Marine turtles do not have an external hearing organ but can detect sound through bone conducted vibration in their skull and by using their shell as a receiving surface (Lenhardt *et al*, 1983). Electro-physical studies have indicated that the best hearing range for marine turtles is in the 100 to 700 Hz range. For turtles, the only known data addressing threshold shift is a study conducted by Eckert *et al* (2006) on leatherback turtles. This study demonstrated that turtles will suffer temporary threshold shift and eventually permanent threshold shift from seismic impulses with sound exposure level greater than 185 dB re 1 μPa^2. s. A turtle swimming past a OSV holding station would need to pass within 1 m to receive cumulative SEL sufficient to cause physiological damage.

Fish: There is a wide range of susceptibility to noise pulses among fish species. The primary factor likely to influence susceptibility to noise is the presence or absence of a swim bladder. Generally, fishes with a swim bladder will be more susceptible than those without. Many large fishes, including the elasmobranchs (sharks, rays and sawfish) do not possess a swim bladder and so are not susceptible to swim bladder-induced trauma. Using a similar approach to the DEWHA Policy Statement (DEWHA, 2008) and the derived relationship of Hastings and Popper (2005), threshold criteria for physiological harm to fish with a swim bladder has been calculated to be (assuming one pulse every 8 seconds resulting in a total of 75 pulses over a ten-minute period):

- For a 0.1 kg fish: single exposure of 199 dB re 1 μPa^2.s; and
- For a 1 kg fish: single exposure of 200 dB re 1 μPa^2. s.

It is unlikely that fish would receive cumulative SEL from the NE FPSO Operational Area activities that is sufficient to cause physiological damage.

Behavioural Effects

Whales: Southall *et al* (2007) conducted a comprehensive review of published data describing behaviour of marine mammals in response to sound. They defined the threshold for behaviour response as being, "moderate changes in locomotion speed direction and/or dive profile but no avoidance of the sound source, brief minor shift in group distribution and moderate cessation or modification of vocal behaviour". The review indicated no (or very limited) response to noise from cetaceans at received levels below 120 dB re 1 μPa, and an increasing probability of avoidance and other behavioural effects in the 120 to 160 dB re 1 μPa range. Contextual variables (such as proximity of source, novelty and operational features) in addition to received level may also affect response type and magnitude. Initial reactions by cetaceans to noise may (in some conditions) diminish with repeated exposure and individual experience. it can be inferred that whales may exhibit avoidance behaviour within approximately 5 km of a OSV holding station at the NE FPSO and within approximately 2 km of the FPSO under normal operating conditions (or for typically short-lived intermittent periods, to approximately 5 km if its main engine is in use for positioning under certain weather conditions). Whales are unlikely to exhibit avoidance of the wellheads as result of underwater noise effects.

The presence of Humpback Whales in the NE FPSO operational area is unlikely given the facility is located further offshore and more eastward than the general migration area and main breeding and calving area off the Kimberley coast

Pygmy Blue Whales are only expected infrequently in the vicinity of the NE FPSO. It is likely any pygmy blue whales passing in the vicinity of the NE FPSO will limited to few or isolated individuals, representing a very small proportion of migrating whales, as they migrate through the broader region on North and South bound migration to the Banda and Molucca Seas. The potential for a behavioural response if approaching whilst a DP vessel is holding station is therefore likely to be infrequent and limited to few individuals. Based on McCauley (2003) noise generated from a DP OSV at the facility is not expected to result in a behavioural response in most migrating Pygmy Blue Whales that are passing through the broader region.

Turtles: Marine turtles have been recorded as demonstrating a startle response to sudden noises (Lenhardt *et al*, 1983). Captive experiments with green and loggerhead turtles showed behavioural responses (increased swimming activity) to an approaching single airgun (bolt 600B, 20 cui) at received sound levels of approximately 166 dB re 1 μPa (rms), and erratic behaviour (presumed leading to avoidance) at around 175 dB re 1μPa (rms) (McCauley *et al*, 2003). McCauley *et al* (2000) found behavioural avoidance at 155 to 164 dB re 1 μPa^2. s. Above a received airgun level of approximately 155 dB re 1 μPa^2-s, the turtles began to noticeably increase their swimming speed. Above a received airgun level of approximately 164 dB re 1 μPa^2 -s the turtles began to show a more erratic swimming pattern, possibly indicative of a distressed state. However, there is no impulsive noise sources similar to seismic noise associated with the NE FPSO operations, and such a response is less likely to occur with continuous noise sources such as vessel noise. By reference to Error! Reference source not found. it can be inferred that turtles may exhibit avoidance behaviour within approximately 50 m of a OSV holding station, but are unlikely to exhibit avoidance of the NE FPSO or wellheads as result of underwater noise effects.

Fish: Bony fish vary widely in their vocalisations and hearing abilities, but generally hear best at low frequencies below 1 kHz (Ladich, 2000). Behavioural effects of noise on fish may include changes to schooling behaviour and avoidance of the noise source (Simmonds and MacLennan, 2005). Available evidence suggests that behavioural change for some fish species may be no more than a nuisance factor. These behavioural changes are localised and temporary, with displacement of pelagic or migratory fish populations having insignificant repercussions at a population level (McCauley, 1994).

Whale Sharks were not identified during the Protected Matters Search within a 20km buffer zone of the NE FPSO and are therefore considered absent from the NE Operational Area.

Noise from helicopters is highly transient and within the bounds of ambient noise conditions. Therefore, it is not considered to pose any risk of physiological hazard or behavioural effects to either whales or turtles unless they hover above the animal for an extended period of time.

The amount of behavioural effect that may arise is not considered likely to cause significant effect at the population level, as defined by the EPBC Act Matters of National Environmental Significance: *Significance Guidelines 1.1* (Deepak, 2009).

Preventative Controls

The environmental requirements for marine vessels and helicopters shall be consistent with EPBC Regulations 2000 – Part 8 Division 8.1 (Regulation 8.05) - Interacting with Cetaceans:

- OSVs will not travel greater than 6 knots within 300 m of a cetacean (caution zone) and minimise noise;
- OSVs will not approach closer to the cetacean than 50 m for a dolphin and/or 100 m for a whale (with the exception of bow riding); and
- If the cetacean shows signs of being disturbed, OSVs will immediately withdraw from the caution zone at a constant speed of less than 6 knots.
- Helicopters shall not operate lower than 1,650 feet or within the horizontal radius of 500 m of a cetacean known to be present in the area, except for take-off and landing.

Routine preventive maintenance, as well as inspections and reactive maintenance/repairs that reduce noise and vibration from FPSO utility and process systems. These inspections and maintenance/repair activities are scheduled and tracked to completion via the NE Computerised Maintenance Management System (CMMS).

Physical Presence of the NE FPSO and OSV's

Residual Risk	Low	Category of Risk	Negligible	MEE Code (*if applicable)*	N/A

Description and Cause of Risk

The NE FPSO, subsea infrastructure and associated OSVs have a physical presence. There are four main areas of environmental risk associated with their physical presence, these being:

- Exclusion of other users from the area;
- Potential for vessels to collide with the FPSO or other vessels supporting the facility, or to snag equipment on subsea infrastructure
- Potential collision between OSVs and marine fauna during transit; and
- Subsea Facilities provide artificial habitat for colonisation by marine organisms.

Potential Environmental Impacts

The presence of infrastructure has the potential to disrupt commercial users of the NE Operational Area, including shipping and fishing.

Potential impacts to commercial activities include:

- Navigational hazards associated with infrastructure, construction and OSV movements;
- Exclusion of commercial fishing operators from the immediate area surrounding the offshore infrastructure; and
- Disruption of commercial fishing operations due to vessel transits and pipeline presence, if required (i.e. disruption of trawling operations).

Shipping: The NE FPSO is not located within any major shipping lanes. The nearest fairways are located on the NWS, which are approximately 475 nm to the southwest of the NE FPSO. The actual impact of the physical presence of the NE FPSO to shipping is the requirement for slight modifications of shipping routes to avoid the Operational Area, though because the NE FPSO is listed on nautical charts, such shipping movements are factored into commercial shipping transits. Since production commenced in 1999, there have been no recorded near-misses with regards to third-party vessels breaching the Operational Area's exclusion zone. Potential impacts associated with risk of collisions by vessels are discussed separately.

Fishing: The NE FPSO is located outside the limit of the AFZ and therefore does not overlap any Commonwealth or State managed fisheries. Australian commercial fishing is therefore not expected to be affected by the presence of the NE FPSO and associated infrastructure. Since production commenced in 1999, there have been no recorded incidents with regards to fishing vessel interactions with the NE FPSO or subsea infrastructure, and no complaints received from fisheries operators regarding a reduction in fishing area.

As the FPSO has been on location for the last 16 years, the likelihood of impacts to traditional fishers is remote. The FPSO poses only a minor obstacle for their ocean voyages, especially as there are no reefs or shoals (targeted by traditional fishers) in the immediate vicinity of the FPSO.

<u>Collisions with Marine Fauna</u>

The NE FPSO receives regular visits by OSVs, approximately every 21 days to supply stores, water and diesel as required. The vessels supporting the facility may vary depending on vessel schedules and availability.

All large air-breathing marine fauna species are vulnerable to vessel collision (Hazel *et al*, 2007; Silber *et al*, 2010) due to their extended surface times. Vessel collisions have been known to contribute to the mortality of marine fauna, and specifically turtles (Hazel and Gyuris, 2006; Hazel *et al*, 2007) and whales (Laist *et al*, 2001; Jensen and Silber, 2003).

For both whales and turtles, the risk of lethal collision is a function of abundance of animals in the area of operations, the probability of a collision actually occurring and the probability of that collision being fatal.

Whales: The most recent satellite tagging confirmed pygmy blue whale general distribution, including in the Timor Sea was offshore in water depths over 200 m and commonly over 1,000 m (Double *et al*, 2012b). Humpback whales complete their seasonal migration at the Camden Sound area of the West Kimberley (Jenner *et al*, 2001). OSVs travelling to and from the mainland (supply base at Darwin) may therefore traverse the migration route and potentially encountering a low number of Pygmy Blue Whales but are not expected to encounter migrating Humpback Whales. Other whale species known to frequent the area are expected in low numbers only.

Turtles: There is no available data on factors affecting the likelihood of a vessel-turtle collision being lethal. It is reasonable to assume that the higher the speed of collision the greater the risk of mortality. Studies have shown that turtles are less likely to flee from a fast moving vessel, presumably because of poor hearing and visual senses, than from a slow moving vessel (Hazel *et al*, 2007).

In the event of a whale or turtle mortality the effect is not likely to be significant (as defined by the EPBC Act Matters of National Environmental Significance: *Significance Guidelines 1.1*, SEWPAC 2009) at the population level.

The presence of subsea structures including the NE FPSO hull, mooring lines, turret and exposed subsea flowlines has the potential to provide artificial habitats through the following mechanisms:

- Subsea infrastructure provides a hard substrate for the settlement of marine organisms that would otherwise be unsuccessful in colonising the area;
- Subsea infrastructure provides artificial habitat for marine organisms, particularly fish; and
- Exposed surface structures can be used for resting by birds.

Further colonisation of the structures over time by other species leads to the development of a fouling community, similar to that which is found on subsea shipwrecks. The presence of the structures, and the fouling community, also provides for predator or prey refuges and visual clues for aggregation (Galloway *et al*, 1981).

The environmental impacts associated with the provision of artificial habitat are locally increased biological productivity and diversity. The provision of artificial habitat on the seabed is likely to influence the composition of the benthic community in the immediate vicinity due to altered predator-grazing pressures (Hixon and Beets, 1993)

The provision of artificial habitat will have either no adverse environmental impact or a low level of positive environmental impact (with increased species diversity, richness and populations in the area).

Preventative Controls

Interactions between OSVs and cetaceans will be managed as outlined below:

- Implementation of *EPBC Regulations 2000* – Part 8 Division 8.1 (Regulation 8.05) Interacting with cetaceans (modified to include turtles):
    - OSVs will not travel greater than 6 knots within 300 m of a cetacean or turtle (caution zone) and minimise noise.
    - OSVs will not approach closer to the cetacean than 50 m for a dolphin or turtle and/or 100 m for a whale (with the exception of bow riding).
    - If the cetacean or turtle shows signs of being disturbed, OSVs will immediately withdraw from the caution zone at a constant speed of less than 6 knots.
- Permanent infrastructure has been marked by the Australian Hydrographic Service on marine charts.
- The NE FPSO is equipped with navigational aids, radar and automatic radar plotting aid (ARPA) to allow detection of vessels approaching or passing nearby. Lighting and sound signals are also provided. OSVs are also equipped with navigational aids as required by Maritime Regulations.
- A 500 m safety exclusion zone is maintained around the NE FPSO at all times.
- NE Operations Performance Standard - P34 Collision Prevention Systems [26/OP/INT/PS45].
    - Systems and equipment will detect and alert facility personnel of a potential collision with the facility and respond to a potential collision with the facility.
- Simultaneous Operations (SIMOPS) is considered as part of the risk assessment for IMR activities. For all of contracted OSVs, a project-specific SIMOPS risk assessment will be created. If required, a specific SIMPOS Matrix will be developed. The SIMOPS matrix provides the guidelines for

determining when two or more major activities at one location are or are not acceptable, and are a key tool for coordinating and interfacing with facility and subsea activities.

- A Stakeholder Fact Sheet for the NE FPSO was distributed to relevant stakeholders as part of The EP revision.

Physical Footprint

Residual Risk	Low	Category of Risk	Negligible	MEE Code *(if applicable)*	N/A

Description and cause of Risk

The environmental risk is disturbance to the seabed, resulting in the displacement of benthic biota. During routine FPSO operations, there will be little seabed disturbance. Some minor disturbance may result from subsea IMR activities, the possibility of vessel anchoring and accidental disturbance (e.g. dropped objects).

Potential Environmental Impacts

Activities that disturb the seabed can cause localised impacts including disturbance or mortality to benthos. The NE FPSO Operational Area is located in deep open ocean waters away from sensitive benthic habitats and there is only a small area of direct seabed disturbance from the mooring, subsea infrastructure and subsea IMR activities. The impact of this disturbance is considered to be insignificant due to the very small area of disturbance to soft sediment seabed, whether considered in total or as proportion of similar habitat available and the widespread distribution of potentially affected benthic species.

Preventative Controls

- Anchoring in the NE FPSO exclusion zone for third-party vessels is prohibited except in emergency situations or under issuing of a specific permit by the FPSO. Furthermore, the majority of OSVs have the capability to hold station using engine propulsion/dynamic positioning.
- NE Operations Performance Standard - P20 Lifting Equipment [26/OP/INT/PS38]:
  - Lifting and lifted equipment will be in a safe and serviceable condition to prevent dropped objects.
- NE Operations Performance Standard – P15 Crane Operations [26/OP/INT/PS37]:
  - Lifting operations will be safely performed to minimise potential for dropped objects.
- UPS Lifting Operations and Lifting Equipment Procedure [00/HSEQ/GEN/PC41], specifically:
  - A lift plan, specific to the operation, will be developed by a trained and competent person; and
  - Operators of powered lifting equipment will be trained and competent for that specific equipment and location.

Routine Atmospheric Emissions

Gas Flaring During Operations

Residual Risk	Low	Category of Risk	Negligible	MEE Code *(if applicable)*	N/A

Description and Cause of Risk

Flaring volumes will vary as a result of production rates, non-routine activities, process upsets and shut-downs. The forecast annual atmospheric emissions from flaring have been estimated using the E&P Forum (1994) Tier 3 (tonnes of throughput) technique. This method is considered sufficient because any inaccuracies inherent in the method are minor in comparison to variability in forecasts of production over a five-year period.

Potential Environmental Impacts

Gas flaring increases the volumes of greenhouse gases (GHG) emitted to the atmosphere. Flaring also consumes natural gas, a non-renewable resource. Incomplete combustion under certain scenarios may also generate other air pollutants and dark smoke.

Atmospheric emissions from flaring will result in a minor localised, temporary reduction in air quality and contribute to GHG emissions. The impact of atmospheric emissions from flaring from NE FPSO on the surrounding ocean of the region is negligible.

Visual Impact

Given the NE FPSO is located in a remote offshore location, more than 500 km from the nearest Australian mainland residences at Darwin, flare flame and smoke emissions would not be visible from these distances. As a result, the visual impact of operation of the NE FPSO is assessed as negligible.

Preventative Controls

- NE Operations Performance Standard - P31 Environmental Emissions and Discharges Monitoring and Controls [26/OP/INT/PS50]:
  - Flare system will be maintained to ensure gas is combusted in an efficient manner; and
  - Gas flared will be monitored at all times.
- The flare system is to be operated by competent personnel in accordance with NE Flare System operating procedures to ensure efficient operation of the system in line with design specifications.
- Flaring will be managed at the NE facility in line with annual limits.
- Performance against the annual limit is regularly monitored.
- Where a change from this annual limit cannot be reasonably avoided, a business case shall be prepared and approved by Production Operations Manager.

Emissions From Fuel Combustion

Residual Risk	Low	Category of Risk	Negligible	MEE Code *(if applicable)*	N/A

Description and Cause of Risk

The combustion of fuel (gas, crude oil and diesel) to power the NE FPSO topsides and utility equipment result in air emissions being released to the atmosphere, including NO_x, SO_x, CO_2, CO and particulates. OSVs will emit similar air pollutants from engine stacks as a result of diesel consumption.

Potential Environmental Impacts

Inefficient operation of fuel combustion equipment has the potential to increase the volumes of greenhouse gases emitted to the atmosphere and consumption of a non-renewable natural resource. However, both OSVs and the NE FPSO represent small sources of emissions. When coupled with a large and relatively clear air shed and significant distance to sensitive receptors, the impact of emissions from fuel combustion on sensitive receptors (i.e. human populations) and the local air shed is negligible.

Preventative Controls

- Fuel gas is the preferred fuel source for the FPSO (instead of diesel or oil).
- Fuel system is to be operated by competent personnel in accordance with NE Power Generation operating procedures to ensure efficient operation of the system in line with design specifications.
- Maintenance and repairs of combustion equipment are undertaken in accordance with the CMMS.
- NE Operations Performance Standard - P31 Environmental Emissions and Discharges Monitoring and Controls [26/OP/INT/PS50]:
  - Fuel gas, fuel oil and diesel consumption will be monitored at all times.
  - Low-sulphur diesel will be used.
- For OSVs and the FPSO, compliance with MARPOL 73/78 Annex VI (Prevention of Air Pollution from Ships) requirements as defined in the Marine Order 97 (Marine Pollution Prevention, Air Pollution) (pursuant to the Commonwealth *Navigation Act 2012*):
  - A valid International Air Pollution Prevention (IAPP) Certificate;

- o Implementation of a preventative maintenance system to confirm diesel powered equipment is maintained for efficient operation; and
- o Use of low sulphur diesel.

Fugitive Emissions

Residual Risk	Low	Category of Risk	Negligible	MEE Code *(if applicable)*	N/A

Description and Cause of Risk

Fugitive emissions are non-intentional releases of hydrocarbon and refrigerant gases, and being GHG and/or ozone-depleting substances (ODS), they pose a risk to the environment by contributing to the GHG effect.

Fugitive emissions arise from unintentional equipment leaks from valves, flanges, pump seals, compressor seals, relief valves, sampling connections, process drains, open-ended lines, casings, tanks and other leakage sources from pressurised equipment.

Potential Environmental Impacts

Fugitive atmospheric emissions have the potential to increase the volumes of GHG and ozone depleting substances within the atmosphere and result in the loss of non-renewable natural resources. The residual risk of fugitive emissions on air quality is considered low.

Preventative Controls

NE operational requirements to minimise fugitive emissions include:

- Leakage testing prior to commissioning and re-commissioning;
- Inert gas blankets pumped through hydrocarbon cargo tanks as required
- Routine monitoring of the process plant for leaks;
- Maintenance and inspection in accordance with operating procedure and design specifications; and
- Facility is operated and maintained by trained and competent personnel.

Routine Discharges

Discharge of Hydrocarbons and Chemicals During Subsea Operations and Activities

Residual Risk	Low	Category of Risk	Negligible	MEE Code *(if applicable)*	N/A

Description and Cause of Risk

Hydrocarbons and chemicals may be discharged intermittently and for short durations as a result of routine (e.g. discharge of subsea control fluid) and non-routine (e.g. acid cleaning) operations and activities, and may include:

- Discharge of subsea control fluids - subsea control fluid is used to control well-head valves remotely from the facility. It is an open-loop system, with small amounts of control fluid discharged from the well-head valves on the seabed when they are operated;
- Discharge of residual hydrocarbons remaining in subsea lines and equipment as a result of subsea intervention works; and
- Discharge of chemicals remaining in subsea lines and equipment or the use of chemicals for subsea IMR activities.

Potential Environmental Impacts

There is potential for localised water column pollution and adverse effects to marine biota as a result of planned hydrocarbon and chemical discharges. However, the volume of these planned discharges are low and are minimised as far as practicable via flushing of the lines back to the facility. Chemical use and discharge is minimised as far as practicable for required work.

Planned Routine Discharges

Subsea control fluid is the main planned routine chemical discharge subsea which occurs when a valve is actuated and occurs for short periods of time and in small volumes (5 L per valve actuation). Upon discharge, the fluid is rapidly diluted in the high energy oceanic conditions.

The control fluid used on the NE FPSO is a Group D (non-CHARM)-ranked product under the OCNS, and is therefore considered an acceptable product for use and discharge under the FPSO's chemical selection and management procedure.

Planned Non Routine Discharges

The release of minor quantities of hydrocarbons to the subsea environment during planned non-routine IMR activities may result in a localised reduction in water quality, but due to rapid dilution and dispersion in the water column, these releases are unlikely to have acute or chronic toxicity impacts to marine fauna or plankton through ingestion or absorption through the skin. Due to the water depth, hydrocarbons will usually not bubble to the surface but will disperse into the water column, which may result in a slight increase in biological oxygen demand (BOD). Due to rapid dilution, the concentration of hydrocarbons (and associated BOD) is expected to be below that which will affect marine organisms within a short distance of the release.

Subsea IMR activities may also require the planned non-routine use and discharge of chemicals to ensure the integrity of the equipment. Typical chemicals used for subsea activities are listed in Section 3.6.6. and managed in accordance with the chemical selection and approval procedures. Chemicals discharged into the ocean may result in a localised reduction in water quality, but due to rapid dilution and dispersion in the water column, acute or chronic toxicity impacts to marine fauna or plankton through ingestion or absorption through the skin are unlikely.

Preventative Controls

- All valves were subject to factory acceptance testing prior to deployment, and operate according to design.
- Valves are operated by trained and competent personnel.
- NE Chemical Selection and Management Procedure [01-HSE-PC01] is used to screen operations and subsea IMR chemicals:
  - Where chemicals are rated Gold or Silver (CHARM) or E or D (non-CHARM) under the OCNS with no substitution warnings, they may be approved for use, providing they are used as detailed in the relevant procedure.
  - Chemicals with OCNS rating other than Gold or Silver (CHARM) or E or D (non-CHARM) or those that have a substitution or product warning require an ALARP demonstration before they can be used.

Discharge of PFW

Residual Risk	Medium	Category of Risk	Tolerable (as ALARP is demonstrated)	MEE Code *(if applicable)*	N/A

Description and Cause of Impact

When hydrocarbons are recovered from the reservoir, water is also produced. This water is referred to as PFW and is separated out from the oil and gas in the crude oil separation process. Separation of oil from water is not 100% effective and the PFW often contains small amounts of naturally occurring contaminants including dispersed oil, dissolved organic compounds (aliphatic and aromatic hydrocarbons, organic acids and phenols), inorganic compounds and residual process chemicals.

PFW is treated by the FPSO Produced Water System, which cools, degasses and removes residual oil prior to it being discharged overboard. Produced water is discharged to the ocean directly from the process via an overboard caisson, which discharges at a minimum of 3 m below the water-line (the exact depth varies with ballast/loading levels).

The PFW System is designed, operated and maintained under controlled procedures, so that under normal operating conditions, the daily discharge rate does not exceed 13,500 m^3/day, and the concentration of petroleum in any PFW discharged into the sea as a result of the operation of NE FPSO will not exceed an average of 30 mg/L over any daily (24 hour) period. To adhere to the above operating limits, flow-meters and OIW analysers are monitored. Procedures are in place to inspect/maintain the above equipment.

Alarms are used to trigger an operational response if the instantaneous OIW concentration at the pre-outfall OIW analyser exceeds 30 mg/L.

Potential Environmental Impacts

The discharge of PFW to the marine waters surrounding the FPSO creates the potential for the localised decline in marine water and benthic sediment quality, the contamination of benthic sediments, and for biota in those environments to be exposed to the contaminants at concentrations that may cause acute or chronic toxicity effects. The potential for those effects varies according to multiple factors, including PFW composition, plume dilution/dispersion, bioavailability, duration of exposure and marine species physiology and behaviour.
Regular monitoring of PFW discharges and its effect continues to show that there are no effects on the bethic sediments to date.

To determine the 'safe' concentration, a range of tropical Australian marine test species were selected for the direct toxicity assessment based on their ecological relevance and the availability of standard tests with known reproducibility. Test species that exhibited the most sensitive response to previous PFW testing were also included to permit comparison of results with these previous studies.

The results of all acute and chronic test results were combined using 'species sensitivity distributions' following the ANZECC/ARMCANZ (2000) approach to obtain estimates of 'safe' concentrations (with 50% confidence) for protection of 95% of species and for protection of 99% of species.

These "safe" concentrations are estimates of the PFW concentration below which the PFW would pose minimum environmental risk in "slightly - moderately disturbed" environments and in 'pristine environments', respectively. For the offshore ocean surrounding the NE facility, the 99% species protection level is applied beyond the mixing zone for assessment of potential impacts.
The calculated dilutions to meet 'safe' concentrations of NE PFW were determined by CSIRO Centre for Environmental Contaminants Research (Binet and Spadaro, 2011 and Adams et al 2014). These calculations were based on the respective acute EC50 data (after application of an Acute to Chronic Ratio (ACR) of 10), together with the chronic EC10 data shown below.

Given the deep open ocean location (360 m depth) with potential for impact limited to <1% of the water column, and the large separation distance of the discharge from sensitive environments (Section **3**) (>10 km to the nearest shoal), the PFW discharge is not predicted to result in any significant toxicity effect to protected species. It is probable that PFW discharge may affect the community structure of biofouling associated with the NE facility but this will be of very minor/negligible nature. It is very unlikely that there will be any toxic effect beyond a localised mixing zone.

Accumulation of PFW chemical constituents in marine sediments depends primarily on the volume/concentration of particulates in PFW discharges or constituents that sorb onto seawater particulates, the area over which those particulates could settle onto the seabed (dominated by current speeds and water depths) and re-suspension, bioturbation and microbial decay of those particulates in the water column and on the seabed.

Review of the 2015 Annual study report indicates that the field data supports the conclusions made in the previously accepted EP regarding the potential impacts and risks of PFW discharges being minimal and managed to ALARP.

The potential environmental impact associated with bioaccumulation of PFW constituents in the water column and in the sediments is considered to be very low and limited to a potential localised effect on a small number of non-threatened species in waters immediately surrounding the facility. The potential health risk is further reduced to ALARP as a result of negligible exposure given the operational exclusion zone that prohibits fishing from or near the FPSO, and the absence of commercial fisheries in the waters surrounding the NE FPSO (Section **3**).

Preventative Controls

- The concentration of petroleum in any PFW discharged to sea as a result of the operation of the NE FPSO will not exceed an average of 30 mg/L over the defined 24-hour period.
- NE Operations Performance Standard - P31 Environmental Emissions and Discharges Monitoring and Controls [26/OP/INT/PS50]:

  - PFW discharge volume and OIW concentration will be monitored and controlled; and
  - Discharge of PFW with high OIW concentrations will be prevented.
- PFW discharge system is operated by competent personnel in accordance with the design specifications and relevant operations procedures.
- NOEC is to be achieved 95% of the time within a mixing zone extending 1,000 m from the NE FPSO (i.e. defined as the ‘accepted mixing zone’), or an alternative mixing zone as established in consultation with the Regulator.
- Routine PFW monitoring (i.e. OIW and discharge rate) will be undertaken continuously to confirm the Performance Outcome is being achieved.
- Routine PFW chemical composition study will be completed every year or more frequently if risks (such as significant changes to OIW volumes) are identified.
- Routine PFW ecotoxicity (and plume dilution) verification will be undertaken every 3 years or more frequently if risks (such as significant changes to chemical composition) are identified.
- NE benthic sediment quality will be routinely studied every six years concurrent with the routine Chemical Characterisation and Ecotoxicity/plume dilution study.
- Additional non-routine/verification monitoring or assessment will be undertaken should there be potential for a change to discharge characteristics.
- PFW analysers are calibrated and maintained.

Discharge of Sewage and Putrescible Wastes

Residual Risk	< Low	Category of Risk	Negligible	MEE Code *(if applicable)*	N/A

Description and Cause of Risk

Black water (from toilets) and grey water (water from showers, wash basins, galley and laundry facilities) generated on the FPSO and OSVs is treated in sewage treatment plants (STPs) that meets IMO Resolution and Marine Protection Environment Committee 2 (VI) criteria prior to disposal overboard via the hull discharge line below the waterline.

Sewage can contain hazardous pathogens (including faecal coliform bacteria), intestinal parasites, viral agents and nutrients that, if released untreated to the ocean, may cause contamination to the food chain. Nutrients in sewage, such as phosphorus and nitrogen may contribute to eutrophication of receiving waters. However, this is only likely in still, calm, inland waters, where it can cause algal blooms, which in turn degrade aquatic habitats by reducing light levels and producing certain toxins, some of which are harmful to marine life and humans. Grey water can contain a wide variety of pollutant substances at different strengths, including oil and some organic compounds, hydrocarbons, detergents and grease, metals, suspended solids, chemical nutrients, food waste, coliform bacteria and some medical waste. Discharges of sewage and grey water will be rapidly diluted in the surface layers of the water column and dispersed by currents.

The overboard discharge of macerated putrescible (food) wastes creates a localised and temporary increase in the nutrient load of the surface waters. This may in turn act as a food source for scavenging marine fauna and seabirds, whose numbers may temporarily increase as a result.

Potential Environmental Impacts

Although the Timor Sea is characterised as a low nutrient environment (Brewer *et al*, 2007) seasonal upwelling can result in localised and sporadic high phytoplankton productivity along the Sahul Shelf including immediately offshore of the shelf. The estimated daily loading from sewage, grey water and putrescible waste (1.42 to 1.77 kg/day of TN and 0.22 to 0.25 kg/day of TP) is inconsequential in comparison to the daily turnover of nutrients in the area.

The BOD of the treated sewage and grey water effluent is unlikely to lead to oxygen depletion of the receiving waters (Black *et al*., 1994), as it will be treated prior to release. On release, surface currents will assist with oxygenation of the discharge. The rapid consumption of macerated putrescible waste by scavenging fauna, combined with physical and microbial breakdown, ensures that the impacts of putrescible waste discharges are short-lived and insignificant. There are no nearby sensitive environments or biological communities that are at risk from temporary increases in nutrient levels or increased numbers of scavenging fauna. The volume of these discharges is small relative to daily nutrient turnover in a given area of ocean and the assimilative capacity of the receiving offshore environment. Therefore, the environmental impact associated with the discharge of sewage, grey water and putrescible waste is considered to be low.

Preventative Controls

For the NE FPSO and OSVs, compliance with:

- MARPOL 73/78 Annex IV: *Sewage* (as implemented in Commonwealth waters by the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*); Marine Orders - Part 96: *Marine Pollution Prevention – Sewage*:
  - Use of STPs certified under MARPOL MEPC.2 (IV) or MEPC.159 (55);
  - Possession of valid International Sewage Pollution Prevention (ISPP) certificates;
  - Discharge of sewage that is not comminuted or disinfected will only occur at a distance of more than 12 nm from the nearest land (for the FPSO, this is only done during equipment breakdowns);
  - Discharge of sewage that is comminuted or disinfected using a certified approved STP will only occur at a distance of more than 3 nm from the nearest land; and
  - For the OSVs, discharge of sewage will occur at a moderate rate while vessel is proceeding (greater than 4 knots), with no visible floating solids or discolouration of the surrounding water.

- MARPOL 73/78 Annex V: G*arbage* (as implemented in Commonwealth waters by the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*); Marine Orders - Part 95: *Marine Pollution Prevention – garbage*:
  - Putrescible waste is macerated to <25 mm particle size prior to discharge.

The STP is operated by competent personnel in accordance with the Sewage System operating procedures to ensure operation of the system in line with design specifications.

Discharge of Cooling Water

Residual Risk	Low	Category of Risk	Negligible	MEE Code (*if applicable)*	N/A

Description and Cause of Risk

The environmental risks are:

- The discharge of cooling water to the ocean, causing localised elevation in ambient seawater temperature, leading to adverse physiological effects to biota in the water column;
- The release of residual hypochlorite or other biocide (used in the Marine Growth Protection System) in cooling water, causing toxic effect to biota in the water column.

Potential Environmental Impacts

Elevated seawater temperatures are known to cause alteration of the physiological processes (especially enzyme-mediated processes) of exposed biota (Wolanski, 1994). These alterations may cause a variety of effects, ranging from behavioural response (including attraction and avoidance behaviour), minor stress and potential mortality for prolonged exposure.

Upon discharge to sea, the cooling water is initially subject to turbulent mixing and transfer of heat to the surrounding waters. The plume then rises to the sea surface where further dilution and loss of heat would occur as the plume is dispersed in the prevailing currents.

The total residual chlorine level in the NE FPSO cooling water system is measured on a weekly basis. Most chlorine injected into the system will react and be neutralised by the cooling water system, with discharged concentrations in the order of 200 µg/L. Chlorine is a strong oxidant and following discharge and dilution, the residual hypochlorous acid will quickly react with inorganic constituents such as sodium, iron (II), nitrite and sulphide to produce chlorides (such as NaCl).

The discharge of residual hypochlorous acid will not cause significant or unacceptable environmental impact due to the low concentration of discharge, rapid rate of reaction to non-harmful products and localised area of effect. Hence the environmental impact is considered to be low.

Preventative Controls

- Chemical dosage of the cooling water system is undertaken in a controlled manner to minimise dosage to the minimum required to achieve treatment efficiency.
- Surface water temperature increase is to be less than 3°C above ambient 95% of the time at 200 m from the offshore discharge source (i.e. defined as the ‘approved mixing zone’).
  - Additional verification assessment or monitoring will be undertaken should there be potential for a change to discharge characteristics, which may alter existing compliance with the Performance Outcome.
- NE Operations Performance Standard - P31 Environmental Emissions and Discharges Monitoring and Controls [26/OP/INT/PS50]:
  - Monitor Seawater Overboard OIW Concentration.

Electro-chlorination as a means of controlling biofouling is a widely used technique. It is used by marine vessels, drilling rigs and production facilities around the world as it provides a cost effective treatment system that does not require the use of large volumes of chemicals.

Discharge of Brine Water

Residual Risk	Low	Category of Risk	Negligible	MEE Code *(if applicable)*	N/A

Description and Cause of Risk

The environmental risk is the discharge of reject water (brine) from the NE FPSO Reverse Osmosis (RO) plants, which has a slightly elevated salinity (~15% higher) than seawater. This can cause physiological effect to marine biota exposed to this plume of water.

Brine (saline wastewater from potable water production) is discharged as a rate of about 60 m^3 per day and is predicted to have a concentration of approximately 40 to 45 ppt (compared to seawater, which has a salinity of about 35 ppt). Water is supplied from the chlorinated seawater supply system prior to passing through a series of filters and RO membranes. The process also includes dosing of anti-scalants as well as cleaning chemicals as part of the filtration process.

Potential Environmental Impacts

The potential impacts of RO brine have been subject to a considerable amount of study due to the large number of high-volume desalination plants being constructed. As a result, the potential impacts are well known.

The potential impacts relate to effects caused by salinity. Other constituents, such as anti-scaling additives and anti-fouling additives, are not discharged during normal operations at levels that are likely to cause toxicity on marine biota (HydroBiology, 2006), as they are usually 'consumed' in the process, with little or no residual levels remaining upon consumption or discharge.

Marine organisms exist in osmotic balance with their ocean and exposure to a rapid change in salinity has the potential to result in the dehydration of cells, decreasing turgidity with potentially lethal consequences. However, most marine species are able to tolerate short-term fluctuations in salinity of 20 to 30% (Walker and McComb, 1990). It is expected that most pelagic species passing through a denser saline plume would not suffer adverse impacts. Other than plankton, pelagic species are mobile and would be subject to elevated salinity levels for a very short time as they swim through the plume.

A review of 'safe dilution' values obtained for RO brine from recent projects has been compiled. It can be inferred from these values that the 'safe dilution' of NE RO brine would be in the order of 10 to 15:1 for PC95(50) and 15 to 20:1 for PC99(50).

On discharge, the higher density RO brine plume will tend to sink in the water column and will be subject to rapid dilution and dispersion in the prevailing currents. Owing to the low discharge rate of 60 m^3 per day and given the understanding of dilutions achieved by marine discharges (Section 0), it is likely that a 'safe dilution' would be rapidly achieved within a few metres of the discharge point and the potential for impact will be insignificant.

Preventative Controls

- Chemical dosage of the RO system is undertaken in a controlled manner to minimise dosage to the minimum required to achieve treatment efficiency.

Discharge of Deck Drainage and Bilge Water

Residual Risk	Low	Category of Risk	Negligible	MEE Code *(if applicable)*	N/A

Description and Cause of the Risk

The drainage system on the NE FPSO facility consists of:

- Non-hazardous open drains, which collect rainwater, wash down water and the spillage of liquids from decks located in non-hazardous areas of the facility. The water collects in the non-hazardous open drain header then flows to the slops tank.

- Hazardous open drains, which collect oily water from hazardous areas on the FPSO, including wash down water and spillage of liquids on decks, equipment drip trays or bunded areas. The hazardous open drains are directed to the slops tank; and
- Hazardous closed drains system, which drains volatile hydrocarbon liquids from all process equipment and routes them to the LP flare knock-out/closed drains drum, with recovered liquids recycled back to the process via the flare drum knock-out pumps or to the cargo tanks.

Drainage water from the open drains system is contained in the slops tank prior to discharge to the ocean. In the slops tank, the water is treated by gravity separation prior to discharge. The OIW concentration of the water in the slops tank is monitored by an t OIW analyser prior to discharge, which is manually calibrated. Water is only discharged to the ocean if it has an OIW concentration less than 30 mg/L.

Liquid hydrocarbons separated in the slops tank are drained by gravity flow to the LP flare/closed drains drum via drain headers. Under normal operations the liquids in the closed drains drum are pumped back under level control to the process upstream of the oil heaters, or sent to the cargo tanks and mixed with crude oil for offtake.

If there is a chemical or hydrocarbon spill on board the FPSO, the drainage water is contained in the hazardous slops tank, with the possibility for transfer to a tote tank and disposal onshore in accordance with the NE Offshore Waste Management Plan [01-HSE-PL14].

The flow through the closed drains system is directed to the closed drains break drum. The liquids are returned to the oily water drains separator where the water and hydrocarbons are separated by gravity. The hydrocarbons are directed back to the process from this separator and the water is directed to the slops tank. The gases from the closed drains system are directed to the LP flare.

The environmental risk is the discharge of drainage water from the hazardous open drains to the ocean, causing a reduction in water quality and acute or chronic toxicity to marine biota through ingestion and absorption.

Potential Environmental Impacts

The OIW concentration of discharge from the slops tank is monitored prior to release, and only water with an OIW concentration of <30 mg/L is released.

Chemicals discharged to the ocean have the potential to temporarily reduce water quality and cause physiological damage to marine fauna that may ingest or absorb the chemicals. The greatest risk within the NE FPSO Operational Area is to plankton and pelagic fish, given the absence of sensitive habitat types in the area. With appropriate controls in place, only trace quantities of contaminants would be expected in deck drainage and bilge water discharge, and these would be rapidly diluted and dispersed.

Given the very small volumes of such chemicals or hydrocarbons (oil, grease) that may be washed overboard with routine deck cleaning or accidentally discharged overboard in the event of a spill to an un-bunded area and the high rates of dilution and dispersion in the open ocean environment, it is not expected that marine fauna or plankton will be exposed to chemicals or hydrocarbons in quantities that would induce acute or chronic toxicity impacts.

Preventative Controls

During operations, the key controls in place for management of drainage water include the following:

- NE SCE Performance Standard – F22 Open Hazardous Drains [26/OP/INT/PS25]:
  - F22.1 - Open hazardous drains will contain leaks and spills of hazardous liquids.
  - Inspection and maintenance of drain boxes, gratings, pipework (blockages), tundishes, gutters, bunds, drip pans and trays, liquid seals, seal pots, deck coaming, level transmitter alarm for seal pots.
- NE Operations Performance Standard - P31 Environmental Emissions and Discharges Monitoring and Controls [26/OP/INT/PS50]
  - P31.3- Monitor slop water volume and OIW concentration.
  - Discharge of water with a concentration of 30mg/l or less to be discharged.
- Spills on deck cleaned up rapidly in accordance with the Chemical Storage and handling procedures.

- Spill skits available and maintained.
- Personnel trained in spill response.
- Scupper plugs available.

Waste Management and Chemical Use

Hazardous and Non-hazardous Waste Handling and Disposal

Residual Risk	Low	Category of Risk	Negligible	MEE Code (*if applicable)*	N/A

Description and Cause of Risk

Normal operations on the NE FPSO and OSVs result in the generation of a variety of hazardous and non-hazardous wastes. These materials could potentially lead to ocean pollution if incorrectly disposed or discharged in significant quantities.

Non-hazardous wastes include domestic and industrial wastes, such as aluminium cans, bottles, paper and cardboard and scrap steel. Hazardous wastes include recovered solvents, excess or spent chemicals, oil contaminated materials (e.g. sorbents, filters and rags), batteries and used lubricating oils. Sand and sludge's may also be generated during well clean-up operations and vessel maintenance. All waste generated on the NE FPSO (other than liquid waste streams previously discussed) is transported to shore for disposal or recycling by a licensed waste contractor.

Potential Environmental Impacts

Hazardous wastes are defined as a substance or object that exhibits hazardous characteristics, is no longer fit for its intended use and requires disposal. Some of these hazardous characteristics (as outlined in Annex III to the Basel Convention) include being toxic, flammable, explosive and poisonous.

Improper management of hazardous or non-hazardous wastes may result in pollution and contamination of the environment. There is also the potential for secondary impacts on marine fauna that may interact with wastes, such as packaging and binding, should these enter the ocean. Marine fauna can become entangled in waste plastics and waste plastics can be ingested when mistaken as prey (Ryan *et al*, 1988). Hazardous wastes released to the sea cause pollution and contamination, with either direct or indirect effects on marine organisms. For example, chemical spills can impact on marine life from plankton to pelagic fish communities, causing physiological damage through ingestion or absorption through the skin. Plastic debris acts as a concentrator of persistent organic pollutants (POPs) that occur universally in seawater at very low concentrations and gets picked up by meso/microplastics via partitioning. The hydrophobicity of POPs facilitate concentration in the meso/microplastic litter at a level that is several orders of magnitude higher than that in seawater. When ingested by marine species, contaminated plastics present a credible route by which the POPs can enter the marine food web.

The environmental impact of routine waste disposal is a minor incremental increase in total waste received at the onshore recycling/disposal facilities and is considered to have a low environmental impact.

Preventative Controls

The following operational waste management procedures apply:

- NE Offshore Waste Management Plan [01-HSE-PL14]:
  - Waste will be stored and segregated, and handling equipment kept in good working order, to prevent accidental loss to the environment;
  - Records of waste transport, treatment, recycling or disposal will be maintained;
  - Wastes will be transported and disposed of in a safe and environmentally responsible manner that prevents accidental loss to the environment;
  - Training will be provided to relevant operational personnel to educate on the correct waste management requirements i.e. storage, handling, segregation and disposal; and
  - Waste contractors will be audited to ensure they have the facilities and systems to be able to dispose of the waste in an environmentally responsible manner.

- For the FPSO and OSVs, compliance with MARPOL 73/78 Annex III: Packaged Harmful Substances (as implemented in Commonwealth waters by the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*), *Marine Orders - Part 94: Marine Pollution Prevention – Packaged Harmful Substances*:
  - All solid, liquid and hazardous wastes (other than sewage, grey water and putrescible wastes) will be sent ashore for recycling, disposal or treatment.
- For the FPSO and OSVs, compliance with MARPOL 73/78 Annex V: Garbage (as implemented in Commonwealth waters by the *Protection of the Sea (Prevention of Pollution from Ships) Act* 1983), *Marine Orders* - Part 95: *Marine Pollution Prevention – Garbage*:
  - No disposal of domestic wastes or maintenance wastes overboard from vessels; and
  - All wastes (other than sewage, bilge water and putrescible waste) sent ashore for recycling, disposal or treatment.
- Audits of waste management practices are regularly conducted on the NE FPSO to ensure that the correct systems and processes are being followed and to identify opportunities for improvement.
- Recyclable hazardous wastes are stored separately from non-recyclable materials. All hazardous waste materials are stored in hazardous waste skips and drums (or tote tanks for liquid wastes) for transport to shore.

Naturally Occurring Radioactive Materials Handling and Disposal

Residual Risk	Low	Category of Risk	Negligible	MEE Code *(if applicable)*	N/A

Description and Cause of Risk

NORMs are comprised of radioactive elements such as uranium, radium and radon, and are often present in very low concentrations during normal reactions between water and rock. The environmental risk is incorrect disposal of waste (generally sand produced from the wells) containing NORMs, leading to pollution of the ocean and potentially chronic and acute toxicity impacts on marine flora and fauna. Inappropriate storage, handling or disposal may also impact on human health (depending on the composition of the NORMs) if people are exposed to the material.

Potential Environmental Impacts

NORMs are sometimes present in components of petroleum and natural gas production facilities. NORMs can be associated with the presence of crude oil, PFW and natural gas. Where petroleum industry NORM is observed, it is primarily found in scale, sludge and sand. In some instances, NORM is required to be removed as waste and managed appropriately.

The NORM nuclides of primary concern in oil production are Radium-226 and Radium-228. These decay into various radioactive progeny, before becoming stable. Radium-226 and Radium-228 belong to the two principal radioactive decay series associated with NORMs in the oil and gas industry (Uranium-238 and Thorium-228 respectively) (APPEA, 2002 and IOGP, 2008).

The deposition of radionuclides into waste streams requiring removal is most strongly correlated with the presence of formation water and associated salts, which permit the formation of precipitates and subsequently deposit throughout the process system as solid wastes, such as scales and sludge's. Sand production also has the potential to carry and accumulate small quantities of residual radioactive particles that then accumulate in the production system low points, separators and filters.

The activity concentrations involved in these materials cover a very wide range: at the low end Radium-226 concentrations can be 0.1 to 10 Bq/g, while at the high end concentrations can exceed 10,000 Bq/g. To be classified as Radioactive Material, the applicable Threshold Activity Concentration Limits must be exceeded (see Laws and Standards in the 'Demonstration of Acceptability' section).

The NE FPSO production system is designed for routine on-line sand removal and disposal, and has design features to minimise sand production. The NE FPSO basis of design assumed there is a low probability of sand production. To date there have been minor quantities of sand removed from production vessels, and tests found the material not to be classified as NORM. To avoid build-up of calcium and bicarbonates, scale inhibitor is injected into the process on a continual basis during production, such that the amount of scale produced throughout the lifetime of the facility is considered negligible. Should NORM nuclide levels increase or be found to be above safe levels, proposed management will be in line with legislation and industry guidelines.

It is possible, through design and management, for operators to prevent dilute NORMs being artificially accumulated and concentrated through the production process thereby keeping the waste below the threshold activity concentration limit for disposal. The direct discharge and dispersion of NORM at low levels (i.e. before artificial accumulation and concentration) into the sea is a common practice in offshore oil and gas exploration facilities around the world. This approach requires design and operation to minimise the concentration of NORMs.

NE FPSO production system and subsea facilities have been designed to manage small amounts of sand production (up to 1.3 kg/1,000 bbls). This is considered sufficient to manage the small quantity of sand which may be produced during the initial well clean up and following shut-in activities. The NE FPSO is equipped with jet washing capability to remove any accumulated sand if required

Preventative Controls

Jet washing of the process vessels may be performed with the oil processing facilities in service. If sand and slurry is produced on the NE FPSO it will be collected, sampled, handled and disposed of in accordance with the NE Offshore Waste Management Plan [01-HSE-PL14]. For any sand removed from the process vessels, samples will be taken and analysed for radioactive materials including Radium-226, Radium-228 and Thorium-228.

A testing regime is in place for determining the presence of NORMs in produced sand and sludge. This includes undertaking radiation surveys and taking laboratory samples from the vessels and shutdown materials as required.

- Hazardous waste including NORMS will be handled, stored and disposed of to prevent pollution or contamination of soil and water; and
- Waste contractors will be audited to ensure they have the facilities and systems to be able to dispose of the waste in an environmentally responsible manner.

NE Offshore Waste Management Plan [01-HSE-PL14]:

- NORMs will be stored in a designated labelled radioactive storage bin and transported by a licensed carrier to an appropriate onshore disposal facility; and
- Should it become necessary to dispose of waste containing NORMs, a specific risk assessment will be undertaken addressing disposal methods and fate in accordance with regulatory guidelines and best practice.

Chemical Selection and Use

Residual Risk	Low	Category of Risk	Negligible	MEE Code (*if applicable*)	N/A

Description Cause of Risk

Chemical usage is required for various routine and non-routine process or maintenance applications on the NE FPSO and as such chemicals may be present in waste water streams which are discharged to the ocean. There is also the potential for discharge of chemicals to the ocean via accidental or non-routine discharges (e.g. periodic maintenance requirements). A Master List of Approved Chemicals is kept and maintained annually by NOGA. In addition, the FPSO will contain small or very small quantities of other chemicals from time to time for various operational and/or maintenance purposes.

Potential Environmental Impacts

Bulk chemicals used on the NE FPSO generally have a low impact on the ocean as a result of using chemicals with low ecotoxicity.

Most chemicals selected for use in the process or on the facility are water-soluble. As such, emphasis is placed on minimising volumes stored and used wherever practicable, and ensuring storage integrity is high and providing containment in the event of a spill. Once spills of non-hydrocarbon chemicals enter the water, they are effectively impossible to recover. If spilled in large volumes, chemicals may cause acute or chronic toxicity to exposed marine fauna through ingestion or absorption. In general, however, given the dilutive and dispersive effects of the ocean, such impacts are likely to be minimal.

All other chemicals used on the facility and OSVs could present an array of consequences for specific biota if released to the environment depending on the nature and degree of exposure received by a particular individual. However, all non-process chemicals present on the facility are either of very minor quantity (usually less than 50 litres) or likely to have little to no effect in the ocean, particularly at the facility location (given the distance to sensitive shallow water habitat, depth of water at the facility and high rates of mixing).

Preventative and Mitigation Controls

- Chemicals have been selected for inclusion within the process based on safety, technical, environmental and commercial performance.
- Other controls in place that protect against the loss of chemicals to the ocean are similar to those required to manage hydrocarbons, including for example, the chemical injection skids with self-contained drip trays, the open and closed drains systems, segregation of process and hazardous wastes, bunding of chemical storage areas, and corrosion resistant material used in the process system.
- Facility operational (dischargeable) and maintenance chemicals undergo a selection process as described in NE Chemical Selection and Management Procedure [01-HSE-PC01].
  - For operational chemicals (dischargeable):
    - Where chemicals are rated Gold or Silver (CHARM), E or D (non-CHARM) on OCNS with no substitution warnings, they may be approved for use, providing they are used as detailed in the relevant procedure.
    - Chemicals with OCNS rating other than Gold or Silver (CHARM), E or D (non-CHARM) or those that have a substitution or product warning require an ALARP demonstration before use. The ALARP demonstration will include:
      - Details of the chemical application (volumes, concentration, location).
      - Ecotoxicity data.
      - Fate of the chemical.
      - Alternatives available to the Global and Australian market.
    - Maintain the NE Approved Chemical Master Register.
  - For facility maintenance chemicals:
    - Select, manage and handle chemicals in line with relevant Contractor Management Systems, Policies and Procedures,

UNPLANNED ACTIVITIES (ACCIDENTS / INCIDENTS)

Invasive Marine Species

Introduction of Invasive Marine and Terrestrial Species

Residual Risk	Low	Category of Risk	Negligible	MEE Code (*if applicable*)	N/A

Description Cause of Risk

The NE FPSO relies on a number of OSVs to service routine needs and, less frequently, to provide specialist services (subsea IMR activities, etc.). The OSVs may be sourced from the local area (e.g. Port of Darwin), depending on the type of vessel required and availability. In addition, the FPSO will require infrequent importation of materials (e.g. spares) from international suppliers.

All vessels are subject to some level of marine fouling. Organisms attach to the vessel hull, particularly in areas where organisms can find a suitable surface to adhere to (e.g. seams, strainers and unpainted surfaces) or where turbulence is lowest (e.g. niches, sea chests, etc.). Organisms can also be drawn into ballast tanks during on-boarding of ballast water as cargo is loaded or to balance vessels under load.

Potential Environmental Impacts

The environmental risk of introducing IMS are their survival, colonisation and spread, where in the absence of natural predators, they may outcompete native species for resources such as habitat, food and light, thereby reducing native species diversity and abundance.

Invasive marine species have also proven economically-damaging to areas where they have been introduced and established. Such impacts include direct damage to assets (fouling of vessel hulls and infrastructure) and depletion of commercially-harvested marine life (e.g. shellfish stocks). Introduced marine species have proven particularly difficult to eradicate from areas once established. If the introduction is noted early, eradication may be effective but is likely to be expensive, disruptive and, depending on the method of eradication, harmful to other local marine life.

Controls

- Ballast water discharges from the FPSO and OSVs will comply with Chapter 4 (Managing biosecurity risks: conveyances) and Chapter 5 (Ballast water and sediment) of the *Biosecurity Act 2015* (Cth) and Chapter 4 (Ballast water and sediment) of the Biosecurity Regulation 2016 (Cth) through the following means:
  - Adhering to the Australian Ballast Water Management Requirements (DAWR, 2016, Version 6);
    - Develop and implement a Ballast Management Plan.
    - Maintain an up to date Ballast Record Book. Obtaining clearance from the DAWR when vessels arrive from international destinations prior to commencing work (allowing unrestricted interaction with other, local, work vessels) or quarantine items will be clearly identified and managed to avoid inadvertent transfer to a local vessel or to shore.
  - Sediment from ballast water tanks must be disposed of at an appropriate land-based reception facility.
  - OSVs are exempt from the Biosecurity Act 2015 if ballast water on the vessel was taken up during a journey that commenced and ended in Australian seas.
- Biofouling on the OSVs will be managed in accordance with the National biofouling management guidance for the petroleum production and exploration industry (Australian Government, 2009):
  - Undertake 5-yearly hull inspections.
  - Maintain valid anti-fouling system certification in accordance with AMSA Marine Order Part 98 (Anti-fouling systems).
- Biofouling on the FPSO will be managed in accordance with the National biofouling management guidance for the petroleum production and exploration industry (Australian Government, 2009):
  - No removal of marine growth from the FPSO hull will take place, except that required for 3-yearly Class inspections, will be conducted.
  - 3 yearly In-water inspections of the FPSO hull to assess marine fouling growth thickness are conducted in accordance with Class requirements.

Because the FPSO is not a propelled vessel and remains on location at all times (fix moored), anti-fouling treatment of the hull is not deemed necessary from a biofouling perspective because fouling organisms will comprise species already occurring in the region and therefore do not pose a IMS risk

Non-Routine Atmospheric Emissions

Gas Venting

Residual Risk	Low	Category of Risk	Negligible	MEE Code *(if applicable)*	N/A

Description and Cause of the Risk

Displaced hydrocarbon vapours are discharged from the FPSO cargo and diesel tanks, and other low pressure hydrocarbon containing sources (e.g. drains caissons, open drains sources) to atmosphere. Other sources of venting may include vessel maintenance activities (i.e. purging/draining when flare route is unavailable).

The NE FPSO has an inert gas cargo tank vapour management system. Very low volumes of Volatile Organic Carbon (VOC) emissions are released by this system, with an estimate of 127 t released in 2015. Emissions from the system will decline with production rates over the life of the field.

Potential Environmental Impacts

Venting will release unburnt hydrocarbons into the atmosphere, including minor quantities of VOC and other constituents. The venting of hydrocarbons has a higher GHG intensity than if the same gas was flared. Venting from the NE FPSO represents only a minor source of atmospheric emissions, and in addition to the distance from shore, will not result in major effects on either local or global GHG concentrations.

Preventative Controls

- The key operational controls to prevent and mitigate impacts of gas venting align with those for the management of operational flaring. This is achieved by adherence to the NE Operations Performance Standard - P31 Environmental Emissions and Discharges Monitoring and Controls [26/OP/INT/PS50] and NE Operations Performance Standard - P25 Purge Gas and Blanketing Systems [26/OP/INT/PS42] to ensure the system is operated within the design specifications.
- The NE FPSO flare system is designed to prevent the need for cold venting.
- Process controls, alarms and safety shutdown devices are also in place.

Release of Synthetic Greenhouse Gases and Ozone Depleting Substances

Residual Risk	Medium	Category of Risk	Tolerable (based on ALARP demonstration)	MEE Code *(if applicable)*	N/A

Description and Cause of Risk

HVAC and refrigeration systems on the NE FPSO use various refrigerant gasses including R134a, R410a, R404a and R22. All these refrigerants have no ozone depleting potential, with the exception of R22, which has a low ozone depleting potential. R410a, R134a, and R22 are considered to have moderate Global Warming Potentials (GWP) (2,050 1,300, and 1,500 respectively) while R404a is considered to have a higher GWP (3,922). The facility may vary stocks of refrigerants as required in the future and has a refrigerant register where accurate records of refrigerants held are maintained.

The risk rating for HVAC gas releases was increased in 2016 recognising the corrosion-induced releases and fugitive leaks that were recorded in 2015 and 2016.

Additional controls have been put in place with increased visual inspections. Since 2015, a handheld gas detector is being used by the operators to enhance the routine visual HVAC inspections to enable operators to detect leaks. This enables leaks to be repaired prior to routine HVAC maintenance activities.

Refrigerants and firefighting system gases used on the NE FPSO have low or no ozone depleting potential and are only released in the event of a real fire or as per certification testing.

Potential Environmental Impacts

Ozone Depleting Substances attack the ozone layer, a thin veil of ozone (O_3) in the upper atmosphere that acts to block ultra-violet (UV) rays from reaching the surface of the earth. Depletion of ozone in the atmosphere plays a role in climate change (contributing to a southward shift of the storm track and rainfall decreases in southern Australia), and increases the risk of people being over-exposed to UV radiation (especially in countries with outdoor lifestyles), which can result in high levels of skin cancer.

Preventative and Mitigation Controls

- NE Offshore Refrigerant Management Plan [26/HSEQ/ENV/PL07], specifically:
  - Specialised HVAC contractor will hold a valid Refrigerant Trading Authorisation;
  - Refrigerant systems will be maintained by qualified licensed technicians;
  - Records of refrigerant inventories and equipment maintenance will be documented.
- Hand-held R22 refrigerant gas detector is used to monitor for leaks along with daily visual checks.

Accidental Hydrocarbon or Chemical Spills

Chemical Spills from Facility and OSVs

Residual Risk	Low	Category of Risk	Negligible	MEE Code *(if applicable)*	N/A

Description and Cause of Risk

The environmental risk is the accidental release of chemicals to the ocean from storage, use or during loading or back loading of chemicals to the NE FPSO.

Operational process chemicals on the NE FPSO that are kept in larger quantities are stored in dedicated vessels (usually tote tanks) that have similar controls of those related to mitigating hydrocarbon spills (e.g. permanent bunding, permanent piping to the process, isolatable by valves, etc.). Methanol is stored in a purpose-built vessel and is the chemical with the largest storage volume on the facility (25 m^3). Methanol is of low toxicity to the environment (PLONAR Substance), with an OCNS Rating of E.

OSVs used for IMR activities will require storage of small quantities of lubricating oils and hydraulic fluid, which have the potential to spill if not appropriately managed. Hydraulic fluid may also potentially be spilled from a leak in hoses or lines on hydraulic equipment such as cranes or winches.

The subsea equipment contains relatively small volumes of hydraulic fluid and there is a potential for hoses, shuttle valves and seals to fail during subsea operations resulting in a loss of hydraulic fluid to the ocean. Subsea hydraulic fluid is water and Ethylene Glycol mixture with an OCNS 'D' rating.

Potential Environmental Impacts

All chemicals used on the NE FPSO or OSVs may present an array of consequences for specific biota if released to the environment, depending on the nature and degree of exposure received by a particular individual.

However, all operational non-process chemicals and maintenance chemicals present on the NE FPSO and OSVs are either held in low quantities (usually less than 50 L) or likely to have little other than a localised and transient reduction in water quality if spilled, given the absence of known sensitive water column biota within the NE FPSO Operational Area and rapid dilution and dispersion of spills due to ocean currents.

Preventative and Mitigation Controls

FPSO

- Chemicals have been selected for inclusion within the process based on safety, technical, environmental and commercial performance.
- Chemical injection skids with self-contained drip trays,
- The open and closed drains systems.
- Bunding of chemical storage areas, and corrosion resistant material used in the process system.
- Facility chemicals undergo a selection process as described in NE Chemical Selection and Management Procedure [01-HSE-PC01].
    - Where chemicals are rated Gold or Silver (CHARM) or E or D (non-CHARM) under the OCNS with no substitution warnings, they may be approved for use, providing they are used as detailed in the relevant procedure.
    - Chemicals with an OCNS ranking other than Gold, Silver (CHARM) or E or D (non-CHARM) or those which have a substitution or product warning require an ALARP demonstration before use. The ALARP demonstration will include:
        - Details of the chemical application (volumes, concentration, location).
        - Ecotoxicity data.
        - Fate of the chemical.
        - Alternatives available to the Global and Australian market.
- Maintain the NE Approved Chemicals Register [01-HSE-RG02].
- Minor spills to deck will be contained if possible and the source of the leak identified and rectified if safe to do so. Spilt material will be either recovered or cleaned up immediately.

- Spill kits located around the FPSO are regularly inspected, and restocked as required.

OSVs

- During IMR activities, chemical and bulk material storage, handling and disposal procedures will be followed by vessel crew. This includes requirements for bunding, spill response, hazardous chemical management procedures and maintenance of an SDS register, but may differ from vessel to vessel.
- Any chemical storage above deck must be designed and maintained to have at least one barrier (i.e. form of bunding) to contain and prevent deck spills entering the ocean. This can include containment lips on deck (primary bunding) and/or secondary containment measures (bunding, containment pallet, transport packs, absorbent pad barriers) in place.
- Equipment located in areas of the deck utilising hydrocarbons (e.g. cranes, winches or other hydraulic equipment) will be maintained to reduce risk of loss of hydrocarbon containment to the ocean.
- Spill response bins/kits are maintained and located in close proximity to hydrocarbon storage areas and deck equipment / bunkering areas for use to contain and recover deck spills.

Equipment for IMR activities

- Subsea equipment utilising or transporting hydrocarbons will be maintained to reduce the risk of loss of hydrocarbon containment to the ocean.
- In-ocean equipment (subsea equipment and towed equipment) utilising hydrocarbons will be inspected to ensure equipment is not leaking and critical hydraulic hoses are in good working order prior to deployment.

Hydrocarbon Release During Bunkering Operations

Residual Risk	Medium	Category of Risk	Tolerable (as ALARP is demonstrated)	MEE Code *(if applicable)*	N/A

Description and Cause of Risk

Bunkering has the potential to result in an accidental spill of diesel to the ocean. Key sources of risk include damage to or failure of bunkering hoses, dry break couplings, tanks or connections. This may result from poor inspection and maintenance, loss of control on the supply boat (loss of vessel separation), inclement weather and/or operator error.

Although large volumes of diesel are involved in bunkering operations, a spill is most likely to be less than 200 L as a result of pin-hole leaks in hoses and decoupling spills. However, the worst case credible spill scenario could result in up to 8 m^3 of diesel being discharged to the ocean. This scenario represents a complete failure of the transfer hose combined with a failure to follow procedures during bunkering activities, which require continual monitoring. The 8 m^3 spill scenario represents a rupture of the hose and pumping being continued for five minutes until the failure is identified and the supply shut-off, as the process is monitored continually throughout the process by the offtake tanker, the operations personnel and control room personnel.

Potential Environmental Impacts

Spill modelling undertaken for a 105 m^3 diesel spill resulting from rupture of a supply vessel diesel tank indicated there would be potential for floating oil to occur up to 75 km from the release location at a concentration above the 10 g/m^2 threshold value, most likely extending towards the southwest or northeast. The modelling results indicate no potential contact with shorelines above 10 g/m^2 and there are no emergent features or shoreline receptors located in the ZPI but the spill would have the potential to drift over submerged shoals of the Sahul Shelf. Therefore, given the significantly lower volumes that may result from a bunkering spill, there is no potential for contact with sensitive shorelines or to extend beyond a localised area around the FPSO.

The volume of hydrocarbon released due to bunkering operations is expected to be less than what would result from a Loss of Marine Vessel Separation.

A spill due to bunkering operations is therefore conservatively assessed.

Preventative Controls

- Bunkering hoses are certified as suitable for a safe operating pressure range at purchase. The hoses and fittings are also compatible with supply vessel pump pressures;
- Relief valves on OSV pumps divert back to source in the event of excessive pressure build up in the transfer hose;
- Dry break and breakaway couplings are provided on the diesel bunkering hoses;
- The diesel unloading stations have isolation and vent valves to allow draining of bunkering hoses between uses;
- Filters provided on the diesel inlet to prevent blockage of the tank level devices;
- Bunding is present in areas where diesel bunkering occurs so as to capture diesel drips or spills. The open drains caisson has an oil recovery system; and
- Tank level indication and level alarms are provided in the CCR for the diesel storage tanks, tank level alarms will also sound at boat unloading stations.
- MGO is used in preference to MDO which will weather faster in the event of a spill.

Bunkering to the NE FPSO will be conducted in accordance with the NE Diesel Fuel System Bunker Diesel Operating Procedure [26/OP/GO/MN/P0019.0021]. This procedure sets out the physical and procedural controls that must be in place prior to, during and after bunkering. A general summary of controls during bunkering procedures and as part of facility operations is provided below.

Prior to bunkering

- Bunkering will proceed only in acceptable sea state conditions, as determined by the FPSO and OSV masters;
- Bunkering will commence during daylight hours only;
- Spill clean-up equipment will be available in proximity to the bunker station
- Communications will be maintained between the FPSO and the supplying vessel; and
- A bunker transfer plan (volume to be transferred) will be agreed between the supply point (vessel) and the delivery point (FPSO).

During bunkering

- A test of transfer pump emergency shutdown system will be conducted immediately following the start of bunkering;
- Communication (visual and/or radio) between the supply vessel and FPSO bunker station will be maintained throughout bunkering;
- Hoses, couplings and the sea surface will be visually monitored during refuelling; and
- Tank levels will be monitored continuously.

Following bunkering

Bunkering hose inventory will be drained to the supply boat before disconnection; and

- Bunker station will be isolated and equipment stowed.

Other operational control measures to prevent a bunkering spill include:

- Bunkering hoses and couplings are maintained in accordance with relevant maintenance requirements;
- Emergency shutdown (ESD) valve testing is conducted on a periodic basis;
- Training of relevant personnel is undertaken for operational and emergency roles, and
- OSVs will have in place their own bunkering plans and checklists, with similar controls to those outlined for the NE FPSO. In addition, OSVs may require mooring and/or hip-up plans, depending on the specifications of both the supplying and receiving vessel. OSVs will have in place a SMPEP capable of managing smaller spills. For larger spills, the response will be escalated to the NE Emergency Response Plan [26/HSEQ/GEN/PL03].

Hydrocarbon Release Caused by Subsea Well LoC (MEE-01)

Residual Risk	Medium	Category of Risk	Tolerable (as ALARP is demonstrated)	MEE Code *if applicable)*	MEE-01

Description and Cause of Risk

The hazard associated with this MEE is the loss of hydrocarbons contained within wellheads, manifolds, gas lift skids and xmas tree valves for subsea wells connected to the NE FPSO. The potential causes that may lead to a well loss of containment event include corrosion, erosion, mechanical/material failure, over-pressure of the annuli, fatigue and human error.

To assess the potential consequences, a worst credible hydrocarbon release scenario has been defined for a Corallina-2. Corallina-2 was selected as it is the only free-flowing well and represents the worst case in terms of heaviness (API 59.4 versus Laminaria API 61) and persistency. The hydrocarbon discharge rates are based on the average flow rate of an uncontrolled well over a 77-day period which represents a conservative uncontrolled release until a relief well kill can be performed using a Mobile Offshore Drilling Unit (MODU). The anticipated timeframe comprises the following activities:

- 8 to 9 weeks mobilise a rig and to drill the well to the planned intersect depth; and
- 1 to 2 weeks to perform well kill operations.

The remaining Laminaria Corallina production wells require artificial lift to flow. The gas injection well is completed below the water table so will self-kill.

Table 0-1: Maximum release rate of hydrocarbons as a result of well loss of containment from the NE FPSO

Well	GOR	Gas Volume	Oil Volume
Corallina-2	950 scf/ stb 169 m^3/m^3	41,697 sm^3 gas per day 3,210,652 m^3 gas over 77 days	246 sm^3 crude per day 18,962 m^3 crude over 77 days

Potential Environmental Impacts

This section discusses the outcomes of oil spill trajectory modelling undertaken for a hydrocarbon release from a NE FPSO subsea well (APASA, 2013).

For a pressurised discharge of gas and crude oil at the seabed, the blowout model calculated that the oil would be atomized into large droplets (1.6 to 10 mm) and entrained by the rising gas cloud. The droplets would separate from the gas cloud at approximately 350 m depth. Due to their large size, the droplets will be buoyant and rise, reaching the sea surface relatively quickly. These processes will promote weathering of the oil due to evaporation and the tendency of the crude oil to rise to the sea surface.

<u>Zone of Potential Impact</u>

- **Surface Hydrocarbons**: Oil spill modelling results predicted floating oil would remain below the 10 g/m^2 threshold concentration. There were no predicted instances where the 10 g/m^2 threshold concentration was exceeded. no ZPI plots have been provided for this result.
- **Accumulated Shoreline hydrocarbons**: Oil spill modelling results show that hydrocarbons have the potential to accumulate (≥ 100 g/m^2) at island receptors of Timor Leste, Timor (west) and Pulau Roti. Owens and Sergy (1994) define accumulated hydrocarbon <100 g/m^2 to have an appearance of a stain on shorelines. French McCay (2009) identified accumulated hydrocarbons ≥ 100 g/m^2 as a lethal threshold for intertidal invertebrates.
- **Entrained Hydrocarbons:** Oil spill modelling results for entrained hydrocarbons are presented in Error! Reference source not found.. In the event this scenario occurred, a plume of entrained hydrocarbons would form down current of the well site with the trajectory dependent on prevailing wind and current conditions at the time. The modelling indicates locations within reach of entrained hydrocarbon concentrations above the 500 ppb threshold concentration are confined to offshore areas extending up to approximately 490 km away, with potential to contact submerged shoals of the Sahul Shelf and the Oceanic Shoals CMR depending on the prevailing current conditions.
- **Dissolved Hydrocarbons:**. In the event this scenario occurred, a plume of dissolved oil would form down current of the well site with the trajectory dependent on prevailing current conditions at the time. The modelling indicates locations within reach of isolated patches of dissolved oil

concentrations above the 500 ppb threshold concentration are confined to offshore areas extending up to approximately 55 km away.

To further confirm that all potential impacts of hydrocarbons within the water column have been assessed, dissolved hydrocarbons below the set threshold (500 ppb) have been considered within this environmental risk assessment. The stochastic modelling probability plot shows there would be no additional sensitive receptors for the in-water dissolved hydrocarbon plume and associated toxicity effects with consideration of the ≥100 ppb dissolved hydrocarbon exposure concentration.

Preventative Controls

All systems in the FPSO and subsea systems are operated under controlling processes of the IMS, in particular operation of plant and facility, integrated safe system of work, maintenance and inspection, and technical control and operated by trained and competent personnel.

Wells and associated subsea infrastructure are planned, designed, drilled and constructed according to the latest engineering design concepts to avoid failures. The planning and implementation includes facilities and systems to maximise integrity, minimise any possibility of failure and minimise environmental impact should a failure occur. Where design issues are identified, subsea equipment replacement or well shutdown may be required depending on risk assessment results.
The design and construction of wells is detailed in a Well Operation Management Plan (WOMP) that is assessed and accepted by NOPSEMA under the Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011.

NOGA uses a range of industry standard well barrier designs, equipment, materials and procedures to ensure all permeable zones penetrated by a well bore, with the potential to contain hydrocarbons or over-pressured water, are isolated from the surface environment by a minimum of two barriers at all times during all phases of the well production. There are a range of procedures/assurance processes in place to verify the integrity of barriers, prior to use/installation, during use/installation and post installation, as required.

In addition to the well primary, secondary and emergency barriers, all production wells are provided with Surface Controlled Subsurface Safety Valves (SCSSSV) located approximately 100 m below the seabed which activate under a variety of pre-defined scenarios, or on manual activation, to shut-in the well and isolate the reservoir from that wellhead. The wells, subsea system and FPSO utilise corrosion resistant materials and chemical additives as per design to protect against integrity threats (e.g. corrosion, impact, erosion, low temperature embrittlement, etc.). Wellhead valve design and configuration allows safe operation and control of the well (open water trees).

Due to the reservoir depletion, only one well remains able to free flow, significantly reducing the risk of a well loss of containment. The gas injection well is designed and completed below the water line and so will be ‘self-killed’ by the aquifer if failure occurs.

Wellheads, manifolds and xmas trees for the NE FPSO subsea wells will be managed in accordance the Well Integrity Guidelines (01-MN-PC01) and the NE WOMP.

Hydrocarbon Release Caused by Cargo Tank LoC (MEE-05)

Residual Risk	Medium	Category of Risk	Tolerable (ALARP is demonstrated)	MEE Code *(if applicable)*	MEE-05

Description and Cause of Risk

The hazard associated with this MEE is the processed hydrocarbons (i.e. Laminaria crude) contained in the FPSO cargo tanks. The causes that may lead to a cargo tank loss of containment event are overfilling of cargo tanks, cargo tank vacuum, cargo tank over/under pressure, mechanical/material failure, cargo tank explosion, vessel collision or human error.

The potential consequence related to this event is the release of hydrocarbons in the form of processed oil to the environment. To assess the potential consequences, worst-case credible hydrocarbon release scenarios from a cargo tank loss of containment have been defined. The worst-case credible scenario is defined as 40,706 m^3 of crude oil over 24 hours, which is the loss of the entire inventory of the two adjacent FPSO cargo tanks, with the tank volume at 98% (which is the standard loading limit). This scenario is considered highly conservative given that a key mitigating measure would be to complete internal cargo transfers of oil to other tanks, thus limiting the potential release volume. Furthermore, for the entire inventory to be lost to sea from a single tank, it would require the point of rupture in the tank bottom plate where the oil would drain to the level of the surrounding sea. In reality, rupture from a vessel collision would be through the wing ballast tank above the water line and thus at the upper side of the tank.

Potential Environmental Impacts

This section discusses the outcomes of oil spill trajectory modelling undertaken for a hydrocarbon release from a cargo tank loss of containment (release of 40,706 m^3 crude oil) from the NE FPSO (APASA, 2013). It defines the worst-case possible extent from the release location that could be reached by oil at or above a particular threshold if the spill scenario occurred.

Zone of Potential Impact

Surface Hydrocarbons: Oil spill modelling results for floating oil are shown in Error! Reference source not found.. In the event this scenario occurred, a surface slick would form down current of the release location with the trajectory dependent on prevailing wind and current conditions at the time. The modelling indicates locations within reach of surface oil concentrations above the 10 g/m^2 threshold concentration are mainly confined to offshore areas up to as far as approximately 450 km away with potential to drift over submerged shoals of the Sahul Shelf Shoals and contact with the water surrounding Cartier Island as well as Timor and Roti Islands depending on the prevailing wind and current conditions.

Accumulated hydrocarbons: Hydrocarbons have the potential to accumulate (≥ 100 g/m^2) at the shorelines of Timor Leste, Timor (West), Pulau Roti and Ashmore Reef. Owens and Sergy (1994) define accumulated hydrocarbon <100 g/m^2 to have an appearance of a stain on shorelines. French Mckay (2009) defines accumulated hydrocarbons ≥ 100 g/m^2 to be the threshold that could impact the survival and reproductive capacity of benthic epifaunal invertebrates living in intertidal habitat.

Entrained Hydrocarbons:. In the event this scenario occurred, a plume of entrained hydrocarbon would form down current of the release location with the trajectory dependent on prevailing wind and current conditions at the time. The modelling indicates locations within reach of entrained hydrocarbon concentrations at or above the 500 ppb threshold concentration are mainly within offshore areas up to as far as approximately 1000 km away with potential for contact with submerged shoals of the Sahul Shelf Shoals, Oceanic Shoals CMR, Ashmore Reef and surrounding CMR area, Hibernia Reef, Cartier Island surrounding CMR area, Scott Reef as well as Timor and Roti Islands and Argo-Rowley Terrace CMR depending on the prevailing wind and current conditions.

Dissolved Aromatic Hydrocarbons:. A plume of dissolved aromatic hydrocarbons would form down current of the release location with the trajectory dependent on prevailing wind and current conditions at the time. The modelling indicates locations within reach of dissolved hydrocarbon concentrations at or above the 500 ppb threshold concentration are mainly confined to offshore areas up to as far as approximately 1000 km away with potential for contact the Sahul Shelf Shoals, Oceanic Shoals CMR, Ashmore Reef and CMR area, Hibernia Reef, Cartier Island and surrounding CMR area, and Seringapatam and Scott Reef as well as Timor and Roti Islands and Argo-Rowley Terrace CMR depending on the prevailing wind and current conditions.

To further confirm that all potential impacts of hydrocarbons within the water column have been assessed, dissolved hydrocarbons below the set threshold (≥ 500 ppb) have been considered within this potential impact assessment. Additional sensitive receptors potentially contacted by dissolved hydrocarbons ≥100 ppb include the islands of Sumba, Suva and East Flores (albeit at probabilities of <0.5%).

Preventative Controls

The NE FPSO is operated under controlling processes of the IMS, in particular operation of plant and facility, integrated safe system of work, maintenance and inspection, technical control, and operated by trained and competent personnel.

The NE FPSO is equipped with physical and instrumental control mechanisms to prevent release of hydrocarbons from its cargo tanks. Key measures to protect against threats or mitigate impacts if the threat occurs are:

- The NE FPSO is a double-sided single-bottom hull;
- The NE FPSO is marked on nautical charts;
- A 500 m safety exclusion zone is maintained around the NE FPSO at all times;
- The NE FPSO is equipped with AIS and radar and navigation lights;

- The cargo storage area is segregated into separate tanks, with capability for inter-tank transfer;
- Cargo loading and discharge is monitored by the 'Loadstar' computer program, with independent overfill alarms fitted to each cargo tank and monitored by CCTV;
- An inert gas system is used to maintain positive pressure in the vapour space of the tanks to prevent air ingress during offloading; and
- An ESD valve is incorporated in the rundown line from the process plant.

The cargo tanks on the NE FPSO are managed in accordance with the relevant SCE Performance Standards .

Hydrocarbon Release Caused by FPSO Offloading Equipment Loss of Containment (MEE-04)

Residual Risk	Medium	Category of Risk	Tolerable (as ALARP is demonstrated)	MEE Code (*if applicable)*	MEE-04

Description and cause of Risk

The hazard associated with this MEE is the loss of hydrocarbons from offloading equipment (hose rupture) and/or loss of hydrocarbons while offloading.

Potential Environmental Impacts

The potential consequence related to this event is the release of crude oil to the ocean. To assess the potential consequences, credible hydrocarbon release scenarios from an offloading equipment loss of containment have been defined. The worst-case credible scenario is defined as 1,000 m^3 of crude oil, which includes loss of the entire inventory of the offtake hose (50 m^3 of crude oil) with the addition of continued pumping at the maximum rate of 5,500 m^3 oil per hour for 10 minutes (resulting in a loss of 917 m^3). This scenario assumes the 24-hour watch would not immediately identify the incident, and instead assumes a worst-case credible time of 10 minutes for detection and then activation/actuation of shutdown systems.

This section discusses the outcomes of oil spill trajectory modelling undertaken for a hydrocarbon release from offloading equipment loss of containment (release of 1,000 m^3 Laminaria crude) at the NE FPSO (APASA, 2013). It defines the worst case possible extent from the release location that could be reached by oil at or above a particular threshold if the spill scenario occurred.

Zones of Potential Impact

Surface Hydrocarbons:. A surface slick would form down current of the release location with the trajectory dependent on prevailing wind and current conditions at the time. The modelling indicates locations within reach of surface hydrocarbon concentrations above the 10 g/m^2 threshold concentration are confined to offshore areas up to as far as approximately 85 km away, with the potential to drift over the Sahul Shelf Shoals such as the Big Bank Shoals.

Accumulated hydrocarbons: Oil spill modelling results show that hydrocarbons have the potential to accumulate ($\geq$ 100 g/m^2) at receptors Timor Leste, Pulau Roti and Ashmore Reef (103 g/m^2).

Entrained Hydrocarbons: Oil spill modelling predicted entrained hydrocarbon concentrations will remain well below 500 ppb. There were no predicted instances where the 500 ppb threshold concentration was exceeded.

Dissolved Aromatic Hydrocarbons: Oil spill modelling results for dissolved aromatic hydrocarbons are shown in Error! Reference source not found.. A plume of dissolved aromatic hydrocarbons would form down current of the release location with the trajectory dependent on prevailing wind and current conditions at the time. The modelling indicates locations within reach of isolated patches of dissolved aromatic hydrocarbon concentrations above the 500 ppb threshold concentration are confined to offshore areas up to as far as 210 km away with the potential to contact submerged shoals of the Sahul Shelf Shoals such as Big Bank Shoals.

Preventative Controls

The NE FPSO is operated under controlling processes of the IMS, in particular operation of plant and facility, integrated safe system of work, maintenance and inspection, technical control and operated by trained and competent personnel.

Design measures in place on the NE FPSO to mitigate against an offloading equipment loss of containment include:

- The offloading hose is comprised of a heavily reinforced material in sections approximately 10 m long, with flanged and bolted connections between sections. This allows each section to be independently tested and replaced if necessary. The hose also has a quick release mechanism and dry breakaway coupling which will release at a predetermined tension, minimising oil spillage by the closure action of the valves in each half of the parted dry break coupling;
- Loading is monitored by the control system, which provides addition flow to the CCR operator and alarms if loading volumes exceed the allowable envelope;
- Offloading tankers are moored at the stern of the FPSO via a stern mounted mooring hawser;
- Cargo tank levels are monitored in the CCR by the tank radar ullage system, which provides level alarms; and
- Offloading pump system pressure Alarms of high and low pressure
- An independent high level (overflow) alarm is fitted to each cargo oil tank.

The NE FPSO offloading equipment (cargo tanks, pumps, offtake hose, monitoring and control systems, static mooring lines), will be managed in accordance with the relevant SCE Performance Standards as identified on the MEE-04.

Hydrocarbon Release Caused by a Subsea Equipment LoC (ME-02)

Residual Risk	Medium	Category of Risk	Tolerable (as ALARP is demonstrated)	MEE Code *(if applicable)*	N/A

Description and Cause of Risk

The hazard associated with this MEE is hydrocarbons conveyed in the NE FPSO subsea equipment (flowlines and risers). The threats that may lead to a subsea loss of containment event are corrosion, erosion, material defect, welding defect, mechanical failure, equipment over-pressure, and human error.

The potential consequence related to this event is the release of hydrocarbons in the form of crude oil and gas to the environment. To assess the potential consequences, worst-case credible hydrocarbon release scenarios from a subsea loss of containment were assessed. As a result, a worst-case credible hydrocarbon release scenario has been defined as the rupture of one of the subsea production flowlines (that which holds the largest inventory of hydrocarbons within the NE FPSO subsea system). This could result in a release to the environment of up to 303 m^3 of well fluids, containing 24 m^3 of oil. This scenario is based on an instantaneous large borehole release (such as major rupture or failure of the flowline), and assumes that the entire inventory of the flowline is released, plus a 10-second delay to actuation of the ESD systems, limiting further release of hydrocarbons from the wells.

Potential Environmental Impacts

This section discusses the outcomes of oil spill trajectory modelling undertaken for a subsea loss of containment as a result of flowline rupture (release the contents of the pipeline (303 m^3) comprising oil (8%, i.e. 24 m^3), gas (1% gas) and water (91%) (APASA, 2013). It defines the worst-case possible extent from the release location that could be reached by oil at or above a particular threshold if the spill scenario occurred. The model (OILMAP-deep) calculated the pressurised discharge of oil and gas at the seabed (depth of 372 m) would atomise oil into droplets ranging from 115.6 to 693.5 µm and entrained by the rising gas cloud. The droplets would separate from the gas cloud at approximately 235 m depth. Due to their large size, the droplets will be highly buoyant and will tend to rise, reaching the sea surface relatively quickly. These processes will promote weathering of the oil due to evaporation and the tendency of the crude oil to rise to the sea surface.

<u>Zones of Potential Impact</u>

- **Surface Hydrocarbons:** Oil spill modelling predicted surface hydrocarbon concentrations would remain below 10 g/m^2. There were no predicted instances where the 10 g/m^2 threshold concentration was exceeded. This finding is reflected in Error! Reference source not found. for Australian waters and no plots are provided for this result.
- **Accumulated Hydrocarbons:** No sensitive receptors were predicted to be contacted by accumulated hydrocarbons (≥ 100 g/m^2).

- **Entrained Hydrocarbons:** Beyond the immediate nearfield zone of the release, oil spill modelling predicted entrained hydrocarbons concentrations would remain well below 500 ppb. There were no predicted instances where the 500 ppb threshold concentration was exceeded beyond the immediate nearfield zone.
- **Dissolved Aromatics Hydrocarbons:** Beyond the immediate nearfield zone of the release, oil spill modelling predicted dissolved aromatic hydrocarbon concentrations would remain below 500 ppb. There were no predicted instances where the 500 ppb threshold concentration was exceeded beyond the immediate nearfield zone.

Preventative Controls

All systems in the NE FPSO are operated under controlling processes of the IMS, in particular operation of plant and facility, integrated safe system of work, maintenance and inspection, technical control and operated by trained and competent personnel.

The flowline and riser design includes a range of measures that specifically aid in minimising the risk of external damage, these include:

- Material selection for strength and corrosion resistant properties;
- Subsea and surface valves to isolate pipelines/flowlines from the facility and vice versa;
- Subsea shutdown system closes on loss of hydraulic pressure;
- Construction and installation techniques such as tethering and flexible external protection in contact areas;
- Design of subsea equipment which takes into consideration minimising snag potential;
- Dynamic modelling of riser and mooring line position to prevent wear;
- Installation of flowline low pressure alarms (set above minimum operating pressure);
- Routine monitoring of carcase bleed for leaks;
- Flowline specifications upgraded in line with changing technologies; and
- The 500 m exclusion zone around the FPSO operating area.

The NE FPSO subsea equipment (flowlines and risers) will be managed in accordance with the relevant SCE Performance Standards as.

Hydrocarbon Release Caused by Topsides Equipment LoC (ME-03)

Residual Risk	**Medium**	**Category of Risk**	**Tolerable (as ALARP is demonstrated)**	**MEE Code *(if applicable)***	**N/A**

Description and Cause of Risk

A loss of containment from the topsides process equipment includes all high-pressure process crude oil equipment and piping manifolds and non-process hydrocarbon and chemical inventories. The scope of this ME includes hydrocarbon inventories that could be released to the environment from:

- Process gas releases;
- Process oil releases; and
- Non-process hydrocarbon and chemical inventory releases.

The causes that may lead to a loss of containment event are corrosion, erosion, material defect, welding defect, fatigue, mechanical failure, equipment over-pressure, loss of structural integrity, loss of marine vessel separation, loss of control of suspended load, and human error.

For a process release, the worst-case credible scenario is defined as the loss of the entire inventory of the electrostatic coalescer process equipment, which holds a maximum isolatable inventory of 142 m^3 of oil. This scenario is based on a large borehole release (such as major rupture or failure) where the inventory would be released in less than 10 minutes, and assumes that only the isolatable inventory of the process equipment is released due to activation of the ESD systems, thus limiting further release of hydrocarbons.

For a non-process release, the worst-case credible scenario is defined as the loss of the entire inventory of one of the emergency generator tanks, which holds a maximum inventory of 10 m^3 of diesel. This scenario is based on a large borehole release (such as major rupture or failure) where the entire inventory would be released in less than 10 minutes, and assumes the maximum inventory of a tank is released. ario as they are located below the FPSO accommodation and are protected by the blast wall structure of the hull.

A spill of 105 m^3 marine diesel to the environment due to Loss of Marine Separation (MEE-07) is assessed. As MEE-07's spill of this significantly larger volume of hydrocarbon did not result in contact with any sensitive receptor by surface, entrained, dissolved or accumulated hydrocarbons, it was considered appropriate to use the results of the 105 m^3 modelling to assess the risk of a spill for this scenario.

A spill of 1,000 m^3 of crude oil to the environment due to FPSO Offloading Equipment LoC (MEE - 04) is assessed. As MEE-04's spill is a significantly larger volume of hydrocarbon, it was considered appropriate to use the results of the 1,000 m^3 modelling to assess the risk of a spill for this scenario.

Potential Environmental Impacts

As discussed under Description and Cause of Risk, the potential impacts from hydrocarbon release caused by a topside loss of containment are those which would result from:

- FPSO Offloading Equipment Loss of Containment, (MEE - 04). Potential biological and ecological impacts as a result of this potential contact are discussed.
- Loss of Marine Vessel Separation,(ME - 07). A marine diesel spill due to topsides loss of containment is therefore conservatively assessed.
- The potential impacts of spilled hydrocarbon on receptors within the ZPI are discussed, with impacts to the open water being the most relevant for this spill scenario.

Preventative Controls

The NE FPSO is operated under controlling processes of the IMS, in particular operation of plant and facility, integrated safe system of work, maintenance and inspection, and technical control and operated by trained and competent personnel.

Bunding and drainage systems are in place to capture and collect any spills.

Topsides equipment on the NE FPSO will be managed in accordance with the relevant SCE Performance Standards

Hydrocarbon Release Caused by Loss of Structural Integrity (ME-06)

Residual Risk	**Low**	**Category of Risk**	**Negligible**	**MEE Code *if applicable)***	**ME-06**

Description and Cause of Risk

The hazard associated with this ME is release of hydrocarbons contained in the NE FPSO and associated infrastructure.

This ME relates to the potential for hydrocarbon release due to extreme environmental conditions or other threats (e.g. vessel stresses through loading and stability, cargo tank explosion of loss of control of suspended load)) which result in an exceedance of the design criteria and a catastrophic failure of the FPSO's primary or supporting structures. Loss of stability or structural failure could lead to loss of individual equipment (e.g. cranes, flare tower, etc.) which could cause damage to adjacent equipment/structures leading to hydrocarbon releases. In the worst case it could ultimately lead to sinking of the FPSO.

Severe environmental conditions (e.g. cyclones) inducing extreme loads on the facility and other threats (e.g. MEE-05, 07 and 08) could result in a loss of structural integrity of the FPSO resulting in a hydrocarbon release to the environment. Powered collision by a vessel may also result in loss of structural integrity of the FPSO .
Structural damage or loss of stability of the FPSO could be minor, or could in the most extreme situation result in sinking of the FPSO within the Operational Area as a result of flooding of the vessel. The type of

structural failure considered is restricted to major structural damage (e.g. catastrophic failure or damage to the hull) and subsequent release of hydrocarbons on or adjacent to the facility whilst on station.

The worst credible hydrocarbon release scenario is therefore deemed to result from major structural damage to the FPSO causing damage to a cargo tank, and therefore resulting in a spill to the ocean similar to that outlined in MEE-05 Cargo Tank Loss of Containment. A loss of structural integrity could also result in a spill to the ocean as described in ME-02 - Subsea LoC, and ME-03 - Topsides LoC. In addition, vessel cargo and diesel inventory could be spilled if the cause of the loss of structural integrity was from a powered collision from a vessel (ME-07 – Supply Vessel Diesel LoC).

It is deemed not to be credible that a loss of structural integrity could result in a well loss of containment (MEE-01) due to reservoir isolation and ESD system activation. Furthermore, the subsea wellheads are located at sufficient distance from the FPSO that direct impact if sinking was to eventuate is unlikely. It is also deemed not to be credible that the entire inventory of the FPSO would be lost if significant structural damage or sinking occurred primarily due to the damage stability design criteria and the inherent stability of the hull design. The design of the hull has been reviewed in accordance with Classification Society requirements including the damage stability analysis. This analysis shows that the hull retains stability in severe damage cases, as required by the maritime regulations.

The worst-case hydrocarbon release scenarios from a loss of structural integrity of the NE FPSO are therefore discussed in the relevant sections referenced above. Relevant trajectory modelling as applicable to these scenarios is also discussed in the abovementioned sections.

Potential Environmental Impacts

As discussed under Description of Risk, the potential impacts from hydrocarbon release caused by a loss of structural integrity are those which would result from:

- Subsea LoC, (ME-02);
- Topsides LoC, (ME-03);
- Cargo Tank LoC, (MEE-05);
- Loss of Marine Vessel Separation, (ME-07)

The potential impacts of spilled hydrocarbon on receptors within the ZPI are discussed, with impacts to the air quality, the open water, oceanic shoals, emergent reefs and islands relevant for this spill scenario.

In the event of loss of structural integrity, there is ultimate potential for sinking of the FPSO if catastrophic failure occurred. This would lead to an incremental increase of the facility's footprint on the seabed.
The NE FPSO is located on the continental slope over flat and featureless muddy benthic habitat which is well-represented and typical in the region. The potential area affected by foundering of the FPSO is very small in proportion of this habitat type. Therefore, the potential environmental consequence of the increase in footprint is considered insignificant.

Preventative Controls

- The NE FPSO is designed to withstand extreme and abnormal environmental loading;
- Design specification to protect against fire and blast;
- Material selection to protect against corrosion;
- Sub-structure and hull maintenance includes a cleaning program to control marine growth;
- The NE FPSO is double-hulled;
- A 500 m PSZ is maintained around the FPSO; and
- A 3-yearly hull class in-water survey is undertaken (last completed in mid-2016).

The NE FPSO subsea and topsides equipment will be managed to prevent a loss of structural integrity in accordance with the relevant SCE Performance Standards detailed in Table 7-2 of the Implementation Strategy.

OSV Diesel Tank LoC (ME-07)

Residual Risk	Medium	Category of Risk	Tolerable (as ALARP is demonstrated)	MEE Code *if applicable)*	ME-07

Description and Cause of Risk

The hazard associated with this ME is a vessel collision causing a loss of containment of diesel in the topsides equipment of the FPSO or diesel fuel tank rupture of the OSV.

A loss of containment caused by a vessel collision includes:

- Collision by a passing vessel with the NE FPSO due to loss of control (mechanical failure) or human error; and
- Collision with the NE FPSO, OSV or offtake tanker when approaching the structure, during manoeuvring or offloading due to loss of control (mechanical failure) or human error.

Rupture of an OSV tank would require direct collision from the side with enough force to rupture a wing tank. Direct stern and bow impacts are unlikely to rupture a fuel tank because the tanks in these areas are protected by an overhang of the deck of the OSV. The maximum volume likely to be released from rupture of a fuel tank has been estimated to be 105 m^3 on the basis that each wing Fuel Oil tank holds approximately 100 to 120 m^3 of diesel and a conservative assumption that 80% of the fuel would escape if it was full.

There is potential that the marine vessel or offtake tanker could also sustain sufficient damage from a collision to result in a hydrocarbon release to the ocean from its cargo or diesel inventory. The worst-case credible release scenario due to collision with an offtake tanker is less than that considered for loss of hydrocarbons from the FPSO cargo tank (MEE-05). This is due to the fact that offtake tankers approach from the stern of the FPSO under strict control and therefore any collision by the offtake tanker would be at low speed and only likely to penetrate the wing ballast tank of the FPSO and not the cargo tanks. When arriving, offtake tankers are also normally empty and therefore present a low risk in respect of additional hydrocarbon inventory that could be released.

Potential Environmental Impacts

This section discusses the outcomes of oil spill trajectory modelling undertaken for a hydrocarbon release from a loss of vessel separation resulting in supply vessel diesel tank rupture (release of 105 m^3 diesel) (APASA, 2013). It defines the worst-case possible extent from the release location that could be reached by hydrocarbons at or above a particular threshold if the spill scenario occurred. Information related to oil spill modelling methodology, receptor locations and thresholds is outlined in Section 0 (i.e. refer MEE-01).

The biological consequences of such a spill on open water sensitive receptors relate to the potential for minor impacts due to the spatial and temporal scale of the predicted spill affected area. Mmegafauna, plankton and fish populations (surface and water column biota) within the ZPI may be impacted by surface slicks and entrained plumes. Given the water depth at the NE FPSO, the surface spill of marine diesel will not impact directly on the seafloor benthos and it is unlikely to impact commercial fisheries given the localised and short-term nature of the predicted spill.

Zone of Potential Impact

Surface Hydrocarbons:. A surface slick would form down current of the release location with the trajectory dependent on prevailing wind and current conditions at the time. The modelling indicates locations within reach of surface oil concentrations above the 10 g/m^2 threshold concentration are confined to offshore areas up to as far as approximately 75 km away, with the potential to drift over the Sahul Shelf Shoals (including Big Bank Shoals), depending on the prevailing wind and current conditions.

Accumulated hydrocarbons: Oil spill modelling results show that hydrocarbons have the potential to accumulate (≥ 100 g/m^2) at Pulau Roti.

Entrained Hydrocarbons:. A plume of entrained hydrocarbons would form down current of the release location with the trajectory dependent on prevailing wind and current conditions at the time. The modelling indicates locations within reach of entrained hydrocarbons at concentrations at or above the 500 ppb threshold are confined to offshore areas up to 25 km away.

Dissolved Aromatic Hydrocarbons: Oil spill modelling predicted dissolved aromatic hydrocarbon concentrations will remain well below 500 ppb. There were no predicted instances where the 500 ppb threshold concentration was exceeded.

Preventative Controls

To prevent vessel collision, the following controls are in place as described in NE Performance Standards, Ship Intrusion Detection Systems (P34), Navaids (P33), Critical Communication Systems (E04) - Critical communication, Substructures (P21):

- FPSO Navigational Aids/lights;
- Radar Coverage;
- AIS;
- VH&HF marine-band radio;
- FPSO hull structure designed to withstand low-energy vessel impact;
- Offloading Tanker Vessel Approach Speed and Static Tow by a Pilot as described in the Terminal Handbook;
- Proximity warning;
- CCTV and a 24-hr watch during offloading operations;
- Vessel DP
- Operational limits during adverse weather and weather monitoring;
- Pre-Activity dynamic positioning drift trials;
- Relevant Operational Procedures;
- SIMOPS Management; and
- ISSOW permits to work in the area

Hydrocarbon Release Caused by Loss of Control of Suspended Load (ME-08)

Residual Risk	Medium	Category of Risk	Tolerable (ALARP is demonstrated)	MEE Code (*if applicable)*	ME-08

Description and Cause of Risk

The hazard associated with loss of control of a suspended load is hydrocarbons contained in NE FPSO subsea and topsides equipment and marine vessels.

A loss of containment caused by a loss of control of suspended load includes:

- Crane or lifting equipment failure;
- Incorrectly slung/excessive loads;
- Crane operator error;
- Dropped/swing load impacts to topsides during supply vessel loading/offloading operations; and
- Dropped anchors/objects from passing vessels onto subsea hydrocarbon equipment.

The risk of hydrocarbon exposure related to this event are:

- Hydrocarbon release from subsea equipment (ME-02);
- Hydrocarbon or chemical release from topsides equipment (ME-03); and
- Hydrocarbon release from loss of structural integrity (ME-06).

The events listed above are applicable representations of worst credible hydrocarbon release scenarios caused by a loss of suspended load, and therefore potential release scenarios and impacts are as per those discussed in the previous sections.

Potential Environmental Impacts

Information related to oil spill modelling methodology, receptor locations and thresholds is outlined in (i.e. refer MEE-01).

Preventative Controls

The platform cranes include a range of measures that specifically aid in minimising the risk of external damage, these include:

- Crane and lifting equipment specifications;
- Crane and lifting equipment safety devices;
- Crane rated capacity indicators; and
- Crane operator competency.

OSVs are also equipped with DP systems, which enable them to hold station without the need to anchor, thus minimising the risk of dropped anchors on subsea equipment.

NE FPSO lifting equipment and subsea, well and topsides equipment will be managed to prevent a loss of control of suspended load in accordance with the relevant SCE Performance Standards

Potential Impacts of Released Hydrocarbons to the Ocean

The potential impacts of a major hydrocarbon spill from the NE facility are described in the following sub-sections and complete the quantitative risk assessment for hydrocarbon spills as outlined above.

In the event of a major hydrocarbon spill from the NE facility or its subsea system, the potential impacts as delineated by the ZPI for an exposure threshold for each of the four hydrocarbon fates have been investigated. The ZPIs include the sensitive oceans of the submerged shoals of the Sahul Shelf (including Big Banks Shoal), Ashmore Reef and Cartier Island, Hibernia Reef, Seringapatam Reef, Scott Reef and West Timor and Roti Islands. The ZPI also includes CMRs in offshore waters and sensitive receptors in the open waters.

Key characteristics of the evaluated MEEs are important to understanding the different environmental consequences or potential impacts of the six light crude and two marine diesel spills assessed and these are summarised below:

- MEE-01 (well blow-out scenario) – had a maximum continuous liquid hydrocarbon release rate and duration of 250 m^3/day for 77 days (Laminaria light crude). The majority of hydrocarbons surface and evaporate over a period of seven days, resulting in a small ZPI.
- MEE-05 (cargo tank loss of containment scenario) – had a maximum instantaneous liquid hydrocarbon release (over 24 hours) of 41,000 m^3 (Laminaria stabilised crude). The surface release and large volume of released hydrocarbons results in a more extensive ZPI.

With consideration of the light crude spill scenarios (MEE-01, -02, -04, -05, -06, and ME-08):

- Surface hydrocarbons were primarily dispersed through the open water environment, making no contact with Australian shorelines (including oceanic reef systems with emergent features) but making contact with the shorelines of Roti Island (Indonesia) in six days.
- Entrained and dissolved hydrocarbons disperse over a wide area with the largest surface release (i.e. MEE-05). Entrained and dissolved hydrocarbons at or above exposure thresholds occurs at Ashmore Reef, Cartier Island, Hibernia Reef, Scott and Seringapatam Reefs and Roti Island. The minimum time for entrained or dissolved hydrocarbons to reach surface receptors is Roti Island in seven days and Hibernia Reef in eight days. The minimum time to for entrained hydrocarbons to reach submerged receptors is 49 hours (2 days) to the Big Bank Shoals.

Potential Impacts to Air Quality

A well blowout has the potential to result in temporary elevated methane levels in the immediate vicinity of the surface expression of the gas release. The weathering of surface hydrocarbons will also result in elevated levels of VOCs, due to approximately 85% of surface hydrocarbons weathering within the first 24hrs.

The ambient concentrations of methane and VOCs released from diffuse sources are difficult to accurately quantify, although their behaviour and fate is predictable in open offshore environments as it is dispersed rapidly by wind. Methane and VOC emissions from a hydrocarbon release in such environments are rapidly degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals.

Due to the temporary nature of any methane or VOC emissions (from either gas surfacing or weathering of liquid hydrocarbons from a well blow out), the predicted behaviour and fate of methane and VOCs in open offshore environments, and the significant distance from the NE FPSO Operational Area to the nearest sensitive air shed (155 km away), the potential impacts are expected to be minor and temporary.

Potential Impacts in Open Water

In the unlikely event of a major hydrocarbon spill from the NE facility, megafauna such as marine mammals, marine reptiles and seabirds may be present in the ZPI. This spill will potentially expose the fauna to surface, entrained and/or dissolved hydrocarbons, resulting in physical oiling and toxicity effects.

Modelling of oil spill scenarios indicate that surface slicks and entrained/dissolved hydrocarbons could be far-reaching, as hydrocarbons have the potential to be transported over long distances. The modelling predicted a surface slick exceeding the 10 g/m^2 threshold could occur up to as far as 450 km in the event of a cargo tank loss of containment (MEE-05), 85 km in the event of an offloading equipment loss of containment (MEE-04) and 75 km in the event of a marine vessel loss of separation (MEE-07) with the ZPIs mainly confined to deep offshore waters. In the event of a subsea well loss of containment (MEE-01) and subsea loss of containment (MEE-02), a surface slick exceeding the 10 g/m^2 threshold is not expected to form.

Marine Mammals

In the event of a major spill, there is potential for surface, entrained and dissolved hydrocarbons exceeding threshold concentrations to disperse across the migratory routes of EPBC Act listed whale species, such as the pygmy blue whale (northbound and southbound migrations). For example, a major spill in April to August or October to January would coincide with pygmy blue whale migration between Australia and Indonesia. Ocean cetacean species traversing offshore openwater or frequenting the oceanic reef systems may also be impacted if exposed to hydrocarbons.

Accurate information on the measured impacts of hydrocarbon spills on marine mammals is limited due to the paucity of historical data from actual spills, due in most part to their reclusive and migratory behaviour, such as that of whales. The information presented herein is available from AMSA (2012), Etkins (1997) and IPIECA (1995).

The nature of the oil, location, volume, concentration levels, exposure time and how much it has weathered may also affect the potential impacts. Potential physiological effects, which (depending on species) are documented to likely include to varying degrees:

- Hypothermia due to conductance changes in skin, resulting in metabolic shock (expected to be more problematic for non-cetaceans in colder waters);
- Toxic effects and secondary organ dysfunction due to ingestion of oil;
- Congested lungs;
- Damaged airways;
- Interstitial emphysema due to inhalation of oil droplets and vapour;
- Gastrointestinal ulceration and haemorrhaging due to ingestion of oil during grooming and feeding;
- Eye and skin lesions from continuous exposure to oil;
- Decreased body mass due to restricted diet; and
- Stress due to oil exposure and behavioural changes.

Individual mammals exposed to hydrocarbons early in a spill may be exposed to its more toxic components by direct contact and ingestion and suffer greater toxicity per unit time and volume than those affected by a more weathered hydrocarbon.

Cetaceans in particular have mostly smooth skins with limited areas of pelage (hair covered skin) or rough surfaces such as barnacled skin. Oil tends to adhere to rough surfaces, hair or calluses of animals, so contact with hydrocarbons by whales and dolphins may cause only minor hydrocarbon adherence, with the likely biological consequences of this being irritation and sub-lethal stress.

The way a cetacean consumes its food affects the likelihood of it ingesting spilled hydrocarbon. Baleen whales (such as humpbacks) skim the surface for krill and are more likely to ingest oil than 'gulp feeders' (toothed whales). Further, oil may stick to the baleen while they 'filter feed' near slicks. Sticky, tar-like residues are particularly likely to foul the baleen plates. Fouling of whale baleen (e.g. pygmy blue whales) may disrupt feeding by decreasing the ability to intake prey. If prey (fish and plankton) is also contaminated, this can result in the absorption of toxic components of the hydrocarbons (PAHs). Feeding activity by pygmy blue whales has been recorded in the deeper offshore waters off southern Timor so there potential for impact associated with ingestion of hydrocarbons if the spill and timing of whale occurrence coincide. Toothed whales, including dolphins, are ‘gulp-feeders’ targeting specific prey at depth in the water column away from the surface slick and are likely to be less susceptible to the ingestion of hydrocarbons.

It has been stated that pelagic species will avoid hydrocarbon, mainly because of its noxious odours, but this has not been proven (though a number of field and experimental observations indicate whales and dolphins may be able to detect and avoid surface slicks). To the contrary, there have been observed instances where animals have swum directly into oiled areas without seeming to detect the slicks or because the slicks could not be avoided. The strong attraction to specific areas for breeding or feeding may override any tendency for cetaceans to avoid the noxious presence of hydrocarbons. So weathered or tar-like oil residues can still present a problem by fouling baleen whales feeding systems. Researchers have also indicated that inhalation of oil droplets, vapours and fumes is a distinct possibility if whales surface in slicks to breathe. Exposure to hydrocarbons in this way could damage mucous membranes, damage airways or even cause death.

Seabirds

Offshore waters are potential foraging grounds for seabirds, which are vulnerable to contacting surface slicks during feeding or resting on the sea surface. Seabirds generally do not exhibit avoidance behaviour to floating hydrocarbons. Physical contact of seabirds with surface slicks is by the primary exposure pathways of immersion, ingestion and inhalation this may result in plumage fouling and hypothermia (loss of thermoregulation), decreased buoyancy and potential to drown, inability to fly or feed, anaemia, pneumonia and irritation of eyes, skin, nasal cavities and mouths (AMSA, 2012; IPIECA, 2004) resulting in mortality due to oiling of feathers or the ingestion of hydrocarbons.

Longer-term exposure effects that may potentially impact seabird populations include a loss of reproductive success (loss of breeding adults) and malformation of eggs or chicks (AMSA, 2012). Given the long distance from the nearest seabird roosting, feeding and breeding areas, and the likely low abundance of seabirds foraging in the ZPI, the potential impact to seabird populations is considered low.

Marine Reptiles

Adult sea turtles exhibit no avoidance behaviour when they encounter an oil slick (Odell and MacMurray, 1986). Contact with surface slicks can therefore result in hydrocarbon adherence to body surfaces (Gagnon and Rawson, 2010) causing irritation of mucous membranes in the nose, throat and eyes leading to inflammation and infection (Etkins, 1997). Oiling can also irritate and injure skin, which is most evident on pliable areas such as the neck and flippers (Lutcavage *et al*, 1995). A stress response associated with this exposure pathway includes an increase in the production of white blood cells, and even a short exposure to oil may affect the functioning of their salt gland (Lutcavage *et al*, 1995). Oil in surface waters may also impact turtles when they surface to breathe and inhale toxic vapours. Their breathing pattern, involving large ‘tidal’ volumes and rapid inhalation before diving, results in direct exposure to petroleum vapours which are the most toxic component of the oil spill (Milton and Lutz, 2002). This can lead to lung damage and congestion, interstitial emphysema, inhalant pneumonia and neurological impairment (Etkins, 1997 and IPIECA, 1995).

Impacts to sea snakes from direct contact with surface hydrocarbons would result in similar physical effects to those recorded for turtles and would include potential damage to the dermis and irritation to mucous membranes of the eyes, nose and throat (Etkins, 1997). They may also be impacted when they return to the surface to breathe and inhale the toxic vapours associated with the hydrocarbons, resulting in damage to their respiratory system.

While marine turtles may be present in deep offshore open waters, offshore waters within the ZPI are distant from emergent features and individuals are likely to occur in low densities. Whether sub-lethal or lethal effects occur will depend on the weathering stage of the hydrocarbon and its inherent toxicity.

Plankton

Exposure to hydrocarbons in the water column can result in changes in species composition with declines or increases in one or more planktonic species or taxonomic groups (Batten, 1998). Phytoplankton may also experience decreased rates of photosynthesis (Goutz *et al*., 1984; Tomajka, 1985). For zooplankton, direct effects of contamination may include suffocation, changes in behaviour, or environmental changes that make them more susceptible to predation (Chamberlain and Robertson, 1999).
If phytoplankton are exposed to hydrocarbons at the sea surface, this may directly affect their ability to photosynthesize and would have implications for the next trophic level in the food chain (e.g. small fish). In

addition, the presence of surface hydrocarbons may result in a reduction of light penetrating the water column, which could affect the rate of photosynthesis for phytoplankton in instances where there is prolonged presence of surface hydrocarbons over an extensive area such that the phytoplankton was restricted from exposure to light.

Oil can affect the rate of photosynthesis and inhibit growth in phytoplankton, depending on the concentration range. For example, photosynthesis is stimulated by low concentrations of oil in the water column (10-30 ppb), but become progressively inhibited above 50 ppb. Conversely, photosynthesis can be stimulated below 100 ppb for exposure to weathered oil (Volkman et al., 2004).

Impacts on plankton communities are likely to occur in areas where dissolved or entrained hydrocarbon threshold concentrations are exceeded, but communities are expected to recover quickly (within weeks or months). This is due to high population turnover with copious production within short generation times that also buffers the potential for long-term (i.e., years) population declines (ITOPF, 2011).

Fish Populations

Fish mortalities are rarely observed to occur as a result of oil spills (ITOPF, 2011). Scholz *et al*, (1992) concluded that fish do not generally experience acute mortality due to oil spills, and that it is rare to find fish kills after a spill, especially in open water environments. This has generally been attributed to the possibility that pelagic fish are able to detect and avoid surface waters underneath oil spills by swimming into deeper water or away from the affected areas. Fish that have been exposed to dissolved hydrocarbons are capable of eliminating the toxicants once placed in clean water; hence individuals exposed to a spill are likely to recover (Concawe, 1996). Where fish mortalities have been recorded, the spills (resulting from the groundings of the tankers *Amoco Cadiz* in 1978 and the *Florida* in 1969) have occurred in sheltered bays. Fish are most vulnerable when at the larval stage, however impacts would be over a small portion of the sea area in which they may occur and unlikely to result in any measurable impacts at a population level (especially in comparison to natural predation).

A spill of diesel or condensate from the NE facility is therefore unlikely to cause a major impact on short-term survival of open water pelagic fish but may result in a level of sub-lethal stress on fish. The potential impacts to fish populations in offshore open waters are considered to be minor.

Submerged Shoals

The waters overlying the submerged shoals of the Sahul Shelf shoals (such as Big Bank Shoal) have the potential be contacted by surface slicks (greater than 10 g/m^2) (MEE-04, MEE-05 and MEE-08) and benthos, particularly for the shallowest extent of the shoals, may be exposed to dispersed entrained oil droplets (greater than 500 ppb) (MEE-01 and MEE-05) and dissolved hydrocarbons (greater than 100 and 500 ppb) (MEE-04 and MEE-05).

Submerged shoals in the region support sensitive open water benthic community receptors such as macrolagae, corals (hard and soft), sponges and associated site-attached fish. Many of the shoals extend to depths as shallow as 20 m to 40 m depth range and for example, Big Banks Shoals range in depth from 15 m to 70 m below the sea surface.

Shoal communities may be exposed to entrained and dissolved hydrocarbons, however are susceptible to surface hydrocarbon exposure more so in intertidal habitats as opposed to subtidal habitats, such as those of the Big Bank Shoals. Smothering, fouling and asphyxiation are some of the physical effects that have been documented from oil contamination in marine plants (Blumer, 1971; Cintron *et al*., 1981). In macroalgae, oil can act as a physical barrier for the diffusion of CO_2 across cell walls (O'Brian & Dixon, 1976). The effect of hydrocarbons however is largely dependent on the degree of direct exposure and how much of the hydrocarbon adheres to algae, which will vary depending on the oils physical state and relative 'stickiness'. The morphological features of macroalgae, such as the presence of a mucilage layer or the presence of fine 'hairs' will influence the amount of hydrocarbon that will adhere to the algae. A review of field studies conducted after spill events by Connell *et al* (1981) indicated a high degree of variability in the level of impact, but in all instances, the algae appeared to be able to recover rapidly from even very heavy oiling. The rapid recovery of algae was attributed to the fact that for most algae, new growth is produced from near the base of the plant while the distal parts (which would be exposed to the oil contamination) are continually lost. Other studies have indicated that oiled kelp beds had a 90% recovery within 3-4 years of impact, however full recovery to pre-spill diversity may not occur for long periods after the spill (French-McCay, 2004).

Intertidal macroalgal beds are more prone to oil spills than subtidal beds because although the mucous coating prevents oil adherence, oil that is trapped in the upper canopy can increase the persistence of the oil, which impacts upon site-attached species. Additionally, when oil sticks to dry fronds on the shore, they can become overweight and break as a result of wave action (IPIECA, 2002). The toxicity of macroalgae to hydrocarbons varies for the different macroalgal life stages, with water-soluble hydrocarbons more toxic to macroalgae (Van Overbeek & Blondeau, 1954; Kauss *et al*., 1973; cited in O'Brien and Dixon, 1976). Toxic effect concentrations for hydrocarbons and algae have varied greatly among species and studies, ranging from 0.002 ppm to 10,000 ppm (Lewis & Pryor, 2013). The sensitivity of gametes, larva and zygote stages however have all proven more responsive to petroleum oil exposure than adult growth stages (Thursby & Steele, 2003; Lewis & Pryor, 2013).

In addition to the potential impacts from direct smothering or exposure to entrained and dissolved hydrocarbons, the presence of entrained hydrocarbon within the water column can affect light qualities and the ability of macrophytes to photosynthesise.

Experimental studies and field observations indicate all coral species are sensitive to the effects of oil, although there are considerable differences in the degree of tolerance between species. Differences in sensitivities may be due to the ease with which oil adheres to the coral structures, the degree of mucous production and self-cleaning, or simply different physiological tolerances. Direct contact of coral by hydrocarbons may impair respiration and also photosynthesis by symbitotic zooanthellae (Peter *et al*., 1981; Knap *et al*., 1985). Coral gametes or larvae in the surface layer where they are exposed to the slick may also be fouled (Epstein *et al*., 2000). Physical oiling of coral tissue can cause a decline in metabolic rate and may cause varying degrees of tissue decomposition and death (Negri and Heyward, 2000). Oil may also cling to certain types of sediment causing oil to sink to the seafloor, covering corals in oiled sediment (IPIECA, 2011).

Where corals come into direct contact with surface exposures (i.e., intertidal/shallow areas), they are more susceptible due to physical presence, than toxicity associated with dissolved oil components within the water column which, in some cases, may be more toxic than the floating surface slicks (Volkman *et al*., 1994). A range of impacts is reported to result from toxicity including partial mortality of colonies, reduced growth rates, bleaching and reduced photosynthesis. The lowest entrained exposure threshold for chronic exposure for entrained hydrocarbons in accordance with the ANZECC (2000) water quality guidelines has been set at 10 ppb. Due to the potential for accumulation of build up over the duration of a spill, the low entrained exposure has been identified as having the potential to impact on coral reefs.

Chronic effects of oil exposure have been consistently noted in corals and, ultimately, can kill the entire colony. Chronic impacts include histological, biochemical, behavioural, reproductive and developmental effects. Field studies of chronically polluted areas and manipulative studies in which corals are artificially exposed to oil show that some coral species tolerate oil better than other species (NOAA, 2010c).

Studies undertaken after the Montara well blowout in the Timor Sea (2009) included diver surveys to assess the status of Ashmore, Cartier and Seringapatam coral reefs. These found that other than a region-wide coral bleaching event caused by thermal stress (i.e., caused by sea water exceeding 32°C), the condition of the reefs was consistent with previous surveys, suggesting that any effects of hydrocarbons reaching these reefs was minor, transitory or sub-lethal and not detectable (Heyward *et al*., 2010). This is despite AMSA observations of surface slicks or sheen nears these shallow reefs during the spill (Heyward *et al*., 2010). Surveys in 2011 indicated that the corals exhibiting bleaching in 2010 had largely survived and recovered (Heyward *et al*., 2012), indicating that potential exposure to hydrocarbons while in an already stressed state did not have any impact on the healthy recovery of the coral.

In addition, surveys undertaken after the Montara blowout on the plateau areas of Barracouta and Vulcan shoals (Heyward *et al*., 2010), which occur about 20-30 m below the water line in otherwise deep waters (generally >150 m water depth), and contain algae, hard coral and seagrass, found no obvious visual signs of major disturbance.

Given the depth of the shoals in the region, there is potential for biological impact including sub-lethal stress and in some instances, total or partial mortality of sensitive benthic organisms such as corals and the early life (larval) stages of corals, resident fish and invertebrate species. However, based on the post-Montara studies of shoals, it is unlikely that a large release of light hydrocarbons will have any significant or long-term impacts on the health of submerged shoal habitats and site-attached fauna.

Benthic Communities

The primary modes of exposure deep-water communities in oil spills include:

- Direct exposure to dispersed oil (e.g. physical smothering) where bottom discharges stay at the ocean bottom;
- Direct exposure to dissolved and entrained oil (e.g. physical smothering) where oil sinks down from higher depths of the ocean;
- Direct exposure to dissolved and entrained oil and/or portioned onto sediment particles; and
- Indirect exposure to dissolved and entrained oil through the food web (e.g. uptake of oiled plankton, detritus, prey, etc.) (NRDA, 2012).

In the event of a major hydrocarbon release at the seabed (MEE-01 and MEE-02), the model predicts hydrocarbons droplets would be entrained by the rising gas cloud, rapidly transporting them to more than 60 m (MEE-01) or 130 m (MEE-02) above the seabed, before continuing to rise depending on their buoyancy. As such, deep-water benthic communities are generally protected from exposure to hydrocarbons.

The benthic communities of the region (refer to Section 4) are thought to be widespread, and the buoyant nature of a subsea hydrocarbon release combined with the absence of known sensitive benthic communities means it is unlikely that benthic communities will be significantly impacted by a hydrocarbon release.

Physical Displacement of Fauna from Gas Plume

The effect of the physical extent of the gas plume in the water column is expected to have a limited and localised effect on identified receptors. The physical barrier created by the gas plume that may temporarily displace transient and/or mobile biota, for example, pelagic fish, megafauna species and plankton populations. The extent of the plume is relatively small in the context of the open offshore environment and therefore, the overall impact to pelagic fauna is expected to be minor.

Potential Impacts on Oceanic Emergent Reefs and Associated Island Shoreline Receptors

Based on the modelling results, a single modelled scenario (MEE-05, cargo tank loss of containment) has potential for the spill to contact waters adjacent to shorelines above threshold concentrations if the scenarios occurred. The model predicted:

- Surface slick (greater than 10 g/m^2) would have potential to contact shoreline receptors at Cartier Island CMR, Hibernia Reef, Timor Island and Roti Island.
- Entrained hydrocarbons (greater than 500 ppb) in the water column would have the potential to contact Ashmore Reef, Cartier Island, Hibernia Reef, Scott Reef, Timor Island and Roti Island.
- Dissolved aromatic hydrocarbons (greater than 100 and 500 ppb) in the water column would have the potential to contact Ashmore Reef, Cartier Island, Hibernia Reef, Scott Reef, Seringapatam Reef and Timor, Roti, Suva, Sumba and East Flores Islands.
- Shoreline accumulation of hydrocarbons (at or greater than 100 g/m^2) for Ashmore Reef and the islands of Timor and Roti.

Coral Reefs

Modelling of scenarios indicated that if a cargo tank loss of containment occurred (MEE-05), there would be potential for a slick to reach reef areas above 10 g/m^2 threshold concentrations at highly localised areas at Cartier Island, Timor Island and Roti Island. The earliest contact time for Cartier Island is 16 days, which means the crude will be in a highly weathered state as predominantly in the form of paraffinic waxy flakes of relatively low toxicity. The impacts to coral reefs below are that of fresh unweathered crude.

Shallow coral habitats are most vulnerable to oil coating by direct contact with surface slicks during periods when corals are tidally-exposed at spring low tides. Water-soluble hydrocarbon fractions associated with surface slicks are known to cause high coral mortality (Shigenaka, 2001) via direct physical contact of hydrocarbon droplets to sensitive coral species (such as the branching coral species) (NOAA, 2010a). The duration of surface slick contact with the reef flat may be reduced as the slick will likely be lifted off the reef by the flooding tide, however exposure will be prolonged where oil adheres. There is significant potential for lethal impacts due to the physical coating of sessile benthos, with likely significant mortality of corals (adults, juveniles and established recruits) at the small spill affected areas. This particularly applies to branching corals which are reported to be more sensitive than massive corals (Shigenaka, 2001).

Modelling of spill scenarios indicated that entrained oil >500 ppb threshold concentration may reach reefs at a number of offshore emergent reefs (Ashmore Reef, Cartier Island, Hibernia Reef and Scott Reef) and fringing reefs at Timor and Roti islands, resulting in exposure of sub-tidal corals. In addition, results of the modelled scenarios indicated there was potential for these locations, in addition to Seringapatam Reef, to be exposed to dissolved aromatic hydrocarbons above the threshold concentration, which may heighten the potential for impacts as it is the water soluble fractions that are considered to induce most toxicity effects.

Exposure to entrained oil and dissolved aromatic hydrocarbon (greater than 500 ppb) has potential to result in lethal or sub-lethal toxic effects to corals and other sensitive sessile benthos within the upper ten metres of the water column. Mortality in a number of coral species is possible, resulting in the reduction in coral cover and change in the composition of coral communities where threshold concentrations are exceeded. Sub-lethal effects to corals may include polyp retraction, changes in feeding, bleaching (loss of zooxanthellae), increased mucous production resulting in growth rates and impaired reproduction (Negri and Heyward, 2000).

In the unlikely event of a spill occurring at the time of coral spawning at potentially affected coral locations, there is potential for a significant reduction in successful fertilization and coral larval survival due to the sensitivity of coral early life stages to hydrocarbons (Negri and Heyward, 2000). Such impacts will result in the failure of recruitment and settlement of new population cohorts. In addition, some non-coral species may be affected via direct contact with the entrained hydrocarbons or exposure to dissolved aromatic hydrocarbons, resulting in sub-lethal impacts and in some cases mortality. This is with particular reference to the early life-stages of coral reef animals (reef attached fishes and reef invertebrates), which can be relatively sensitive to hydrocarbon exposure. Coral reef fish are site-attached, have small home ranges and as are at higher risk from oil exposure than non-resident, more wide-ranging fish species. The exact impact on resident coral communities will be entirely dependent on actual hydrocarbon concentration, duration of exposure and water depth of the affected communities.

Intertidal and Shallow Sub-Tidal Shoreline Habitats (Seagrasses, Sandy Shores and Mangrove Habitat)

Modelling for scenarios (loss of well containment) to (loss of control of suspended load) predicted entrained oil and/or dissolved aromatic hydrocarbon at or above 500 ppb (and at or above 100 ppb for MEE-01 and MEE-05) have the potential to contact a number of shoreline sensitive receptors such as those supporting biologically diverse, shallow subtidal and intertidal communities (Ashmore Reef, Cartier Island, Hibernia Reef, Scott Reef, Seringapatam Reef, Timor Island and Roti Island). Surface slicks that have undergone some weathering have the potential to contact areas at Cartier Island, Timor and Roti Islands.

Shallow, subtidal and intertidal communities at these locations comprise a variety of habitat and community types, from the upper sublittoral to the upper intertidal zones and are utilised as important foraging and nursery grounds. Depending on the trajectory of the plume of entrained oil and dissolved aromatic hydrocarbons, macroalgal/seagrass communities including at the Ashmore Reef, Cartier Island, Scott Reef and Timor and Roti Islands plus mangrove habitat of Timor and Roti Islands have the potential to be exposed. In addition, depending on the trajectory, surface slicks may also contact intertidal and subtidal macroalgal/seagrass communities at Ashmore Reef, Cartier Island, Timor Island and Roti Island plus mangroves at Timor and Roti Islands.

Sandy Shores

In areas affected by surface oiling, there is significant potential for lethal impacts due to the direct physical coating of intertidal sessile benthos, with likely high mortality of macroalgae/seagrass and mangroves and associated intertidal benthic fauna. Furthermore, mortality of intertidal fauna associated with these communities may occur due to the inherent toxicity of the surface slicks. Shoreline oiling on soft sediment foreshores may accumulate and have the potential to percolate into sediments and burrows, resulting in lethal and sub-lethal impacts to benthic fauna (such as crabs and molluscs).

Entrained and dissolved hydrocarbons contacting nearshore areas may adhere to the sediments, depositing to the shore or seabed. Persistence may be limited by the small proportion (4%) of persistent residual fractions (boiling point >380°C) of the oil. Impacts may include sub-lethal stress and mortality to certain sensitive biota in these habitats, including infauna and epifauna. Likely ecological consequences may include changes in the composition and structure of benthic communities and affect recovery given the susceptibility of invertebrate larvae to the toxic effects of in-water hydrocarbons (particularly dissolved aromatics), larval and juvenile fish, and other invertebrates that depend on these shallow subtidal and intertidal habitats as nursery areas. This may result in mortality or impairment of growth, survival and reproduction (Heintz *et al*, 2000). In addition, there is the potential for significant secondary impacts on shorebirds, fish, sea turtles, rays and crustaceans that utilise these intertidal habitat areas for breeding, feeding and nursery habitat purposes.

Mangroves

Mangroves (distributed throughout the shorelines of islands of West Timor and Roti) may be impacted by oiling due to physical suffocation of leaves and aerial roots. The potential for chronic sub-lethal toxicity impacts beyond immediate physical and acute effects (which may delay recovery in an affected area), may be reduced as the oil comprises a small proportion (4%) of persistent residual fractions (boiling point >380°C).

The impacts of surface hydrocarbons on mangroves include damage as a result of smothering of lenticels (mangrove breathing pores) on pneumatophores or aerial roots, or by the loss of leaves (defoliation) due to chemical burning. It is also known that mangroves take up hydrocarbons from contact with leaves, roots or sediments, and it is suspected that this uptake causes defoliation through leaf damage and tree death (Wardrop *et al*., 1987).

Entrained and dissolved hydrocarbons may potentially impact mangrove communities through the sediment/mangrove root interface. Entrained and dissolved hydrocarbons contain contaminants that may become persistent in the sediments (e.g. trace metals, PAHs), leading to direct effects on mangroves due to direct uptake, or indirect effects due to impacts on benthic infauna and thus leading to reduced rates of bioturbation and subsequent oxygen stress on the plants root systems.

The following information is from IPIECA (1993) and NOAA (2014). Oil slicks enter mangrove forests when the tide is high, and are deposited on the aerial roots and sediment surface as the tide recedes. This process commonly leads to a patchy distribution of the oil and its effects, because different places within the forests are at different tidal heights. Mangroves can be killed by heavy or viscous oil that covers the trees' breathing pores thereby asphyxiating the subsurface roots, which depend on the pores for oxygen. This is also likely to apply to oil emulsions that may flow into mangrove forests. Observed thresholds for impacts are likely to vary depending on the health of the system, the spilt hydrocarbon and the environmental conditions, however observations by Lin and Mendelssohn (1996), demonstrated that more than 1 kg/m^2 of oil during the growing season would be required to impact marsh or mangrove plants significantly.

Mangroves can also be killed through the toxicity of substances in the oil, especially lower molecular weight aromatic compounds, which damage cell membranes in the subsurface roots. This in turn impairs the normal salt exclusion process, and the resulting influx of salt is a source of stress to the plants. The organisms among and on the mangrove trees are also affected by the oil. There may be heavy mortalities as a direct result of the oil penetrating burrows in the sediments, killing crabs and worms, or coating molluscs present on the sediment surface and aerial roots. Dead trees lead to loss of habitat for organisms living in the branches and canopy of the trees, and in the aerial root systems.

Over time, several factors reduce the toxicity of oil that has been deposited in mangrove forests. The amount of oil in the soil is reduced by rain and tides. As the oil weathers, chemical changes such as oxidation make the residual oil less toxic. Eventually the soil can support mangrove growth once more, with this time-scale varying according to local conditions such as the amount of water circulation in the immediate area.

Seagrass

Seagrass beds occurring in the intertidal zone are the most susceptible to the toxicity effects that can occur due to absorption of soluble fractions of hydrocarbons into tissues (Runcie *et al*, 2004) given the potential for contact with entrained and dissolved hydrocarbons. Exposure to entrained and dissolved hydrocarbons may result in seagrass mortality, depending on physical covering and actual entrained hydrocarbon concentration received and duration of exposure. Physical contact with entrained droplets could cause sub-lethal stress, causing reduced growth rates and a reduction in tolerance to other stress factors (Zieman et al, 1984).

Submerged vegetation in nearshore areas can be exposed to oil by direct contact (i.e., smothering) and by uptake by rhizomes through contaminated sediments. Exposure also can take place via uptake of hydrocarbons through plant membranes. In addition, seeds may be affected by contact with oil contained within sediments (NRDA, 2012).

When seagrass leaves are exposed to petroleum oil, sub-lethal quantities of the WAF can be incorporated into the tissue, causing a reduction in tolerance to other stress factors (Zieman *et al*., 1984). The toxic components of petroleum oils are thought to be the PAH, which are lipophilic and therefore able to pass through lipid membranes and tend to accumulate in the thylakoid membranes of chloroplasts (Ren *et al*., 1994). As such, the susceptibility of seagrasses to hydrocarbon spills will depend largely on distribution. Deeper communities will be protected from oiling under all but the most extreme weather conditions. Shallow seagrasses are more likely to be affected by dispersed oil droplets or, in the case of emergent seagrasses, direct oiling. Theoretically, intertidal seagrass communities would be the most susceptible because the leaves and rhizomes may both be affected.

Studies report that the phytotoxic effect of petroleum oil on seagrasses can lead to a range of sub-lethal responses including reduced growth rates (Howard & Edgar, 1994), bleaching, decrease in the density of shoots, reduced flowering success (den Hartog & Jacobs, 1980; Dean *et al*., 1998) and blackened leaves that can detach from the plant following oil contamination (den Hartog & Jacobs, 1980). Direct exposure, however, does not always induce toxic effects (Kenworthy *et al*., 1993; Dean *et al*., 1998), even under laboratory conditions (Wilson & Ralph, 2012).

Studies of actual spills have found no significant differences between oiled and un-oiled seagrass meadows comprising *Halodule uninervis*, *Halophila ovalis* and *Halophila stipulacea* following large spills of crude oil during the Gulf War (Kenworth *et al*., 1993). Similarly, a spill of heavy fuel oil contaminated by lighter fuel products in Gladstone Harbour (Queensland) did not result in measurably short- or long-term impacts on meadows of *Zostera capricorni*, *H. ovalis*, *H. decipiens*, *H. spinulosa* or *H. uninervis* (Taylor & Rasheed, 2011). Conversely, one laboratory study using Bass Strait crude and diesel fuel did observe mortality of affected seagrass, with slow recovery (Clarke & Ward, 1994).

One reason why seagrasses appear to be less vulnerable to oil impacts is that 50-80% of their biomass is in their rhizomes, which are buried in sediments, thus less likely to be adversely impacted by oil. Thus, even if the fronds are affected, the plant may still be alive and able to regrow (Zieman *et al*., 1984).

Because seagrasses require light to photosynthesise, in addition to the effects described, the presence of entrained hydrocarbons within the water column can affect light qualities and the ability of seagrass to photosynthesise.

The potential for toxicity effects of shoreline stranding/accumulation was identified for Ashmore Reef but it is likely that toxicity effects will be reduced by weathering processes that will serve to lower the content of soluble aromatic components before contact occurs. Impacts on seagrass communities are likely to be seen in areas where hydrocarbon threshold concentrations are exceeded.

Marine Mammals

In addition to a number of whale species and small cetaceans that may occur in nearshore waters off Timor and Roti Islands, populations of dugongs are known to reside in waters of Ashmore Reef.

Marine mammals are mobile and may detect and avoid surface slicks to a certain extent. In the nearshore environment at Ashmore Reef, additional environment impacts may also include the potential for dugongs to ingest hydrocarbons when feeding on contaminated seagrass stands or indirect impacts to dugongs due to loss of this food source due to dieback in worse affected areas.

Seabirds and Shorebirds

There is potential for seabirds, and resident and non-breeding over-wintering shorebirds that utilise shoreline habitats (beaches, mudflats and reef flat) and nearshore waters for foraging and resting, to be exposed to surface slicks, entrained and dissolved aromatic hydrocarbons and shoreline accumulation (for Ashmore Reef). This could result in lethal or sub-lethal effects. Although breeding oceanic seabird species can travel long distances to forage in offshore waters, most breeding seabirds will tend to forage in nearshore waters near their breeding colony, resulting in intensive feeding by higher seabird densities in these areas during the breeding season, and making these areas particularly sensitive in the event of a spill.

Pathways of biological exposure that can result in lethal and sub-lethal impacts of hydrocarbons contacting these receptors are likely to be immersion and ingestion. Shorebirds that confine feeding to shorelines are likely to be less susceptible to severe oiling compared to seabirds that fully immerse during feeding. Contact with surface slicks may lead to physical oiling of both seabirds and shorebirds. Matting of feathers on heavily oiled birds may lead to hypothermia, starvation due loss of ability to fly and forage, and drowning due to loss of buoyancy. Oiled birds may ingest hydrocarbons directly when preening or indirectly by consuming contaminated fish (nearshore waters) or invertebrates (oiled intertidal foraging grounds such as beaches and reefs). Ingestion and oiling can also lead to internal injury to sensitive membranes and organs (IPIECA, 2004; AMSA, 2012). Whether the toxicity of ingested oil is lethal or sub-lethal will depend on the weathering stage and its inherent toxicity. Exposure to hydrocarbons may have longer-term effects, with impacts to population numbers due to decline in reproductive performance and malformed eggs and chicks, affecting survivorship and loss of adult birds.

Ashmore Reef and Cartier Island are of particular sensitivity given their importance in supporting resident and migratory bird populations. Direct impacts from hydrocarbon contact may occur as a result of surface slicks (Cartier Island) or shoreline accumulation (Ashmore Reef) as well as ingestion of hydrocarbons directly or indirectly through consumption of contaminated prey.

Marine Reptiles

Several marine turtle species utilise nearshore waters and shorelines for foraging and/or breeding in potentially impacted locations such as Ashmore Reef, Cartier Island, Hibernia Reef, Seringapatam Reef, Scott Reef, Timor Island and Roti Island.Turtles are vulnerable to lethal and sub-lethal effects due to direct physical oiling and ingestion of hydrocarbons. In the nearshore environment, turtles can ingest hydrocarbons when feeding on oiled macroalgae or seagrass or can be indirectly affected by loss of this food resource due to dieback from heavy oiling (Gagnon and Rawson, 2010).

The reproductive success of nesting turtles can be reduced where eggs are exposed to hydrocarbons as a result of the transfer of hydrocarbons from oiled female turtles during egg laying (NOAA, 2010a). Oiling of gravid adult females or hatchlings will have the potential to occur in nearshore waters or whilst traversing beaches where surface, stranded and entrained hydrocarbons are expected to make shoreline contact. Weathered oil has been shown to have little impact on egg survival, while fresh oil significantly reduced egg survival (Milton and Lutz, 2002). Given turtles nest above the highwater mark, buried eggs are unlikely to be directly exposed to any hydrocarbons percolating through the sand (NOAA, 2010c). In the event of shoreline contamination, as identified for Ashmore Reef, there is potential for significant impacts to turtles utilising the affected area of nearshore waters and stretch of shoreline. During the breeding season, turtle aggregations near nesting beaches will be most vulnerable due to greater turtle densities.

Fish Populations

Fish (and other commercially-targeted taxa) in their early life stages (eggs, larvae and juveniles) are at their most vulnerable to lethal and sub-lethal impacts from exposure to hydrocarbons, particularly if a spill coincides with spawning season or if a spill reaches nursery areas close to the shore (e.g. seagrass and mangroves) (ITOPF, 2011).

Oil spill modelling indicates that there is potential for entrained and dissolved concentrations to occur in the surface water layers above threshold concentrations in nearshore waters including Ashmore Reef, Cartier Island, Hibernia Reef, Scott Reef, Seringaptam Reef and Timor, Roti, Suva and Sumba and East Flores Islands. This has the potential to result in lethal and sub-lethal impacts to a certain portion of fish larvae in affected areas, depending on concentration and duration of exposure and the inherent toxicity of the hydrocarbon.

Nearshore Fisheries

Kimberley Prawn Managed Fishery and Northern Prawn Fishery: The modelling of scenarios presented indicated that the designated fisheries management areas of the Kimberley Managed Fishery and Northern Prawn Fishery are within the ZPI. However, the ZPI does not extend to nearshore waters closest to the mainland Kimberley coast or Josephe Bonaparte Gulf. The majority of the demarcated area for this fishery off the Kimberley is outside the ZPI.

Prawn habitat utilisation differs between species in the post-larval, juvenile and adult stages (Dall *et al*, 1990) and direct impacts to benthic habitat due to a major spill has the potential to impact prawn stocks. For example, juvenile banana prawns are found almost exclusively in mangrove-lined creeks (Ronnback *et al*, 2002), whereas juvenile tiger prawns are most abundant in areas of seagrass (Masel and Smallwood, 2000). Adult prawns also inhabit coastline areas but tend to move to deeper waters to spawn.

In the event of a major spill, the model predicts that shallow subtidal and intertidal habitats along the Kimberley coast would not be exposed to hydrocarbon concentrations above threshold concentrations. As such, significant direct impacts on prawns are unlikely given their benthic habit and because in-water hydrocarbons are likely to be confined to the upper water column. However, a major loss of containment from the NE facility may lead to an exclusion of fishing from the spill area for an extended period.

Tourism and Recreational Fishing: low levels of tourism (nature-based) and recreational fishing do take place around and within the protected areas of Ashmore Reef and Cartier Island. Contamination of the ocean within the protected areas will have impacts to tourism and recreational fishing activities with a cessation of such activities and a direct economic loss to the charter operators. With reference to recreational fishing activities, as discussed previously, targeted pelagic species are mobile and are unlikely to cause significant direct impacts on the target species. A major spill is unlikely to cause a major impact on short-term survival of open water pelagic fish but may result in a level of sub-lethal stress on fish.

Protected Areas/Heritage/Shipwrecks: Depending on the spill scenario, the ZPI potentially includes the Sahul Shelf, Oceanic Shoals CMR, Ashmore Reef CMR, Cartier Island CMR and the heritage listed areas of Scott Reef and Seringapatam and their surroundings. A number of historic shipwrecks are identified for the wider region, however, only two wrecks, the *Ann Millicent* (Cartier Island) and the *Yarra* (Scott Reef) may be exposed to hydrocarbons resulting from the larger spill scenarios (MEE-05 and ME-07). The spill results do not predict surface slicks contacting the identified wrecks, however, shipwrecks occurring in the subtidal zone may be exposed to entrained and dissolved hydrocarbons. Potential ecological consequences to marine life that shelter and take refuge in and around these wrecks may occur due to in-water toxicity of dispersed hydrocarbons. The consequences of such hydrocarbon exposure may include large fish species moving away and/or resident fish species and sessile benthos such as hard corals exhibiting sub-lethal and lethal impacts (which may range from physiological effects to mortality).

Petroleum Activities: In the unlikely event of a major spill, surface hydrocarbons may affect production from existing petroleum facilities (platforms and FPSOs). For example, facility water intakes for cooling and fire hydrants could be shut off which could in turn lead to the temporary cessation of production activities. Spill exclusion zones established to manage the spill could also prohibit support vessel access as well as offtake tankers approaching facilities in the surrounding Timor Sea. The impact on ongoing operations of regional production facilities would be determined by the nature and scale of the spill and metocean conditions. Furthermore, decisions on the operation of production facilities in the event of a spill would be based primarily on health and safety considerations. The only petroleum production facility within the ZPI is Bayu-Undan (consisting of two platforms and FPSO).

Monitoring of Impacts

Note: It is acknowledged that the ZPI is an indicative area used to identify receptors at risk from a worst-case oil spill and plan for monitoring of the environmental impacts of an oil spill within this area. It should be noted however, that in the event of a real spill, operational and scientific monitoring will extend beyond the ZPI if operational OSTM indicates the ZPI is different, or for the purposes of collecting baseline ('pre-impact') data. Please see the OSMP 01-HSE-PL05 for threshold levels for Oil spill response.

Summary of Potential Impacts

There are unlikely to be major long-term environmental impact on the offshore deepwater environment, whereas long- term impacts may occur at sensitive shallow subtidal, intertidal and shoreline habitats of oceanic emergent reefs, as a result of a major spill of hydrocarbons from the NE facility.

SPILL RESPONSE ACTIVITIES

Source Control Strategies

Well Kill from FPSO

In the scenario where there is a loss of well control and the Laminaria and Corallina tree valves fail to shut in or there is a failure of other primary or secondary barriers between the reservoir and the tree valves, implementation of an Emergency Well Kill Plan (01/HSEPL17) control strategy is required. The existing well services facilities on the NE do not have the capacity to perform an effective well kill in the event of a significant loss of well control. Additional equipment will need to be mobilised from onshore via the OSV and set up on the NE FPSO to complete the task.

Preparedness Routine Controls

Emergency well kill procedures are in place.
Availability of well services pump (WSP) skid for rapid deployment.
OSVs are readily availability to deploy a well services pump to the FPSO.
An MSA is in place with a logistics (road services) provider.

Response Controls

Seawater is treated with oxygen scavenger and biocide prior to well kill.
Emergency well kill is undertaken in accordance with established procedures.

Subsea Tree Replacement

In the scenario where there is a full loss of well control and the Laminaria and Corallina tree valves fail to shut in or there is a failure of other primary or secondary barriers between the reservoir and the tree valves, implementation of the Emergency Tree Replacement control strategy is required. The response is to deploy the emergency standby tree to the location from Darwin, remove the damaged tree and replace with the dedicated emergency standby tree.

Preparedness routine controls

Emergency standby tree ready for immediate deployment from NOGA Darwin warehouse.
Subsea engineering expertise is available to write and implement detailed emergency tree replacement procedures.
Subsea well control expertise is in place to advise on emergency tree replacement.
Emergency Tree Replacement procedures are in place for deployment.
APPEA MOU is in place.
A LWI vessel is readily available to NOGA.

Response Controls

SST replacement is undertaken in accordance with established procedures

Relief Well

The drilling of a relief well is viewed as a last resort measure for source control due to its long implementation time (> 70 days), high level of technical difficulty and higher level of environmental impacts and risks than the control strategies previously discussed. The environmental impacts and risks are comparable to a normal drilling program (in terms of routine MODU discharges), while the existing data for the Laminaria field reduces the risk of unplanned risks associated with drilling from eventuating

Response Preparedness Controls

A relief well plan is in place.
MODU, vessel support, helicopter support and personnel resources are readily available.
Well control specialists can be mobilised on request.
Well engineering specialists can be mobilised on request
Drilling environmental advisors can be mobilised on request.
OPEP readiness reviews are undertaken.

Response Controls

Well kill is undertaken in accordance with established procedures.
Relief Well Kill is undertaken in accordance with an accepted EP.

Offshore Response Strategies – Crude Oil –

Marine Exclusion Zones

Marine exclusion zones can be created in an emergency situation to ensure the safety of third-party vessels near a hydrocarbon release. The protocol for this is for the Control Agency (NOGA) to communicate with the AMSA RCC and request that a marine exclusion zone be declared. The way this will be implemented is through the issue of a Temporary Notice to Mariners (TNTM). A TNTM is issued where the information will remain valid only for a limited period. A TNTMwill not be initiated where the information will be valid for less than one month. In such circumstances, this information may be promulgated as a Radio Navigation Warning or as a local Notice to Mariners.

Response Preparedness Controls

A request to declare a marine exclusion zone is made to the AMSA RCC

Operational Monitoring

Operational monitoring includes the gathering and evaluation of data to inform the oil spill response planning and operations. This includes OSTM , spill tracking, weather updates and field observations. Existing OSTM indicates that entrained and dissolved hydrocarbon plumes could impact on oceanic shoals as well as contact or accumulate (above ecological thresholds) on distant shorelines.

Response Preparedness Control

For the duration of FPSO operations, NOGA has a plan in place for undertaking operational monitoring and has response resources contractually ready for deployment
OSMP readiness reviews are undertaken.

Response Controls

Operational monitoring is undertaken in accordance with established procedures.
Operational Monitoring Vessel in-water cleaning

Scientific Monitoring

The SMP would be informed by the Operational Monitoring Program (OMP) described in Section 6.11.2, but differs from the OMP in being a long-term program independent of and not directing the operational oil spill response. The SMP comprises nine targeted environmental monitoring programs to address condition assessment of a range of physical-chemical (water and sediment) and biological (species and habitats) receptors including EPBC Act-listed species, environmental values associated with protected areas and socio-economic values such as fisheries.

Response Preparedness Controls

For the duration of FPSO operations, NOGA has a plan in place for undertaking scientific monitoring and has resources contractually ready for deployment.
OSMP readiness reviews are undertaken

Response Controls

Scientific monitoring is undertaken in accordance with established procedures.
Scientific Monitoring Vessel in-water cleaning

Containment and Recover

In the Timor Sea, containment and recovery is a potentially effective measure to reduce the quantity of hydrocarbons reaching receptor locations. Depending on the time of season, metocean conditions and the distance from shorelines, containment and recovery operations can be effective. However, industry experience indicates that no more than 10% to 15% of floating oil is likely to be recovered. In addition, the remoteness of the region poses challenges in mounting and sustaining a large-scale response.

Suitable vessels with containment and recovery equipment would be mobilised as soon as safe and practicable after the release and would follow the spill until recovery was no longer effective. Priority would be given to surface oil approaching sensitive receptors. This includes attempting to minimise surface oil, which could become entrained in the water column and therefore potentially contact submerged shoals.

Response Preparedness Controls

For the duration of FPSO operations, NOGA has a plan in place for undertaking containment and recovery resources, and has response resources contractually ready for deployment
Containment and recovery personnel are competent to undertake their duties.
Sufficient quantities of containment and recovery equipment are readily available.

Response Controls

Containment and recovery operations are undertaken in accordance with established procedures
Vessel in-water cleaning protocols are followed.
On-water decanting controls are followed

Onshore and Nearshore Response Strategies

Shoreline Protection

Shorelines identified as being at risk of contact and/or oil accumulation are:

- Ashmore Reef islets — reached after 9 days in a weathered state; and
- Cartier Island – 0.5% probability of contact above 10 g/m^2 threshold after 19 days in a weathered state, likely to be of low toxicity.

In the unlikely event of residual surface oil moving towards the shorelines, the ongoing open water containment and recovery operations would be prioritised to intercept the oil before contacting shorelines.

Response Preparedness Controls

For the duration of FPSO operations, NOGA has a plan in place for undertaking shoreline protection and has response resources contractually ready for deployment.
OPEP readiness reviews are undertaken
Personnel involved in shoreline protection are trained and competent

Response Controls

Only undertake Shoreline Protect and Deflect response if there is a demonstrated net environmental benefit
Shoreline Deflect and Protect activities carried out in a planned, controlled manner to minimise unnecessary impacts on responder personnel and affected and non-affected fauna
Daily checks are undertaken for trapped fauna in booms.
Deflect and Protect Boom Deployment Vessel in-water cleaning

Oiled Wildlife Response

An oiled wildlife response (OWR) would be undertaken in accordance with NOGA's policy and values and recognition of societal expectations. It would form part of both the open ocean response and the shoreline response, and resources and may be required in both locations. The critical species identified as at risk from an event in the Timor Sea are presented in Section 4 of the EP. For an overview of species with potential to be impacted at each receptor, refer to Section 4 and Section 6 of the EP.

Response Preparedness Controls

For the duration of FPSO operations, NOGA has OWR equipment resources contractually ready for deployment
For the duration of FPSO operations, NOGA has trained OWR personnel resources contractually ready for deployment.
OPEP readiness reviews are undertaken

Response Controls

Only undertake OWR if there is a net environmental benefit
OWR carried out in a planned, controlled manner to minimise unnecessary impacts on responder personnel and affected and non-affected fauna
Waste from OWR oil washings and carcasses are contained on board OWR vessels and transported ashore for disposal at licensed waste treatment facility
OWR Monitoring Vessel in-water cleaning

Waste Management Response

Waste generated and collected during an oil spill response requiring management and disposal may consist of:

- Liquids (recovered oil/water mixture), recovered from containment and recovery or shoreline protection operations;

- Semi-solids/solids (oily solids), collected during shoreline protection and deflection operations; and
- Debris (e.g. seaweed, sand, woods, plastics), collected during shoreline protection and shoreline cleanup operations.

Expected waste volumes during an event will vary depending on volume released, mitigation controls employed and how fresh / weathered oil is. Waste management, handling and capacity should be scalable to ensure continuous response operations can be maintained

Response Preparedness Controls

For the duration of FPSO operations, NOGA has a plan in place for undertaking spill-related waste management and has response resources contractually ready for deployment
OPEP readiness reviews are undertaken

Response Controls

Waste management activities are undertaken in accordance with the Waste Management Plan.
Waste Management vessel in-water cleaning