ICHTHYS PROJECT OFFSHORE FACILITY (OPERATION) ENVIRONMENT PLAN SUMMARY

EP Summary

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Abbreviations and acronyms

Abbreviation / acronym	Description
AFMA	Australian Fisheries Management Authority (Cwlth)
AHS	Australian Hydrographic Service
AIS	automatic identification system
ALARP	as low as reasonably practicable
AMOSC	Australian Marine Oil Spill Centre
AMSA	Australian Maritime Safety Authority (Cwlth)
APASA	Asia-Pacific Applied Science Associates
AR-AFFF	alcohol-resistant aqueous film-forming foam
ARP	applied research program
ASV	accommodation support vessel
BIA	biologically important area
BOM	Bureau of Meteorology
CBP	chlorination by-products
CCR	central control room
CMR	Commonwealth marine reserve
CPF	central processing facility
CRM	condensate rich MEG
DAWR	Department of Agriculture and Water Resources (Cwlth)
dB	decibel
DER	Department of Environment Regulation (WA)
DGPS	Differential Global Positioning System
DEE	Department of the Environment and Energy (Cwlth) (formerly the Cwlth Department of the Environment)
DER	Department of Environment Regulation (WA)

Abbreviation / acronym	Description
DEWHA	Department of the Environment, Water, Heritage and the Arts
DIIS	Department of Industry, Innovation and Science (formerly Department of Industry)
DoFWA	Department of Fisheries (WA)
DMP	Department of Mines and Petroleum
DoE	Department of the Environment (Cwlth)
DO	dissolved oxygen
DP	dynamic positioning
DPaW	Department of Parks and Wildlife (WA)
DPIF	Department of Primary Industries and Fisheries (NT)
DSWEPaC	Department of Sustainability, Environment, Water, Population and Communities
EMBA	environment that may be affected
EP	environment plan
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cwlth)
ERT	emergency response team
ESD	emergency shutdown
ESDV	emergency shutdown valve
Facility	the interlinked hydrocarbon processing system (comprising the CPF, FPSO and subsea production system)
FFFP	film-forming fluoroprotein (foam)
FFG	flash fuel gas
FIS	filtered inhibited seawater
FLET	flowline end termination
FMP	flaring management plan
FPSO	floating production, storage and offtake

Abbreviation / acronym	Description
FWAD	fixed-wing aerial dispersant
GEP	gas export pipeline
GERB	gas export riser base
ha	hectare
HFO	heavy fuel oil
HLV	heavy-lift vessels
HP	high pressure
HSEQ-MS	health, safety, environment and quality management system
IAP	incident action plan
IAPP	International Air Pollution Prevention
IHUC	installation, hook-up and commissioning
IMO	International Maritime Organization
IMP	invasive marine pest
IMR	inspection, maintenance and repair
IMT	incident management team
INPEX	INPEX Operations Australia Pty Ltd is the delegated operator
INPEX Ichthys Pty Ltd	INPEX Ichthys Pty Ltd is one of the upstream titleholders and Joint Venture Participants
IOPP	international oil pollution prevention
IP	intermediate pressure
ISV	inlet surge vessel
KEF	key ecological feature
kHz	kilohertz
km	kilometre
LAT	lowest astronomical tide

Abbreviation / acronym	Description
LEMP	liquid effluent management plan
LNG	liquefied natural gas
LP	low pressure
LPG	liquefied petroleum gas
MEG	monoethylene glycol
MGO	marine gas oil
MoC	management of change
MoU	memorandum of understanding
MPPE	macro porous polymer extraction
NaClO	sodium hypochlorite
NEBA	net environmental benefit analysis
NEC	no effect concentration
NMR	North Marine Region
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority (Cwlth)
NOPTA	National Offshore Petroleum Titles Administrator
NT EPA	Northern Territory Environment Protection Authority
NWMR	North-west Marine Region
OIW	oil-in-water
OM	operational monitoring
OPEP	oil pollution emergency plan
OPGGS (E) Regulations 2009	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cwlth)
OSMP	operational and scientific monitoring
OSRL	Oil Spill Response Limited

Abbreviation / acronym	Description
OSV	offshore support vessel
OVID	offshore vessel inspection database
OWR	oiled wildlife response
OWS	oil–water separator
PLONOR	pose little or no risk (to the environment)
PLR	pig launcher and receiver
PNEC	predicted no effect concentration
POB	persons on board
POTS Act	*Protection of the Sea (Prevention of Pollution from Ships) Act 1983*
ppb	parts per billion
ppm	parts per million
PPRR	prevention, preparedness, response, recovery
PSV	platform supply vessels
PSZ	petroleum safety zone
PTS	permanent threshold shift
PW	produced water
ROV	remotely operated underwater vehicle
RFSU	ready for start-up
SM	scientific monitoring
SOPEP	shipboard oil pollution emergency plan
SPS	subsea production system
STP	sewage treatment plant
TSS	total suspended solids
TTS	temporary threshold shift

Abbreviation / acronym	Description
URF	umbilicals, flowlines and risers
WA DoT	Department of Transport (WA)
WA-50-L	petroleum production licence area
WA EPA	Western Australia Environmental Protection Authority
WAFIC	Western Australian Fishing Industry Council
WestPlan MOP	State Emergency Management Plan for Marine Oil Pollution (WA)

1 INTRODUCTION

This Environment Plan (EP) summary has been prepared to meet Regulation 11(4) of the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS (E) Regulations 2009) and summarises the information provided within the Ichthys Project Offshore Facility (Operation) EP accepted by NOPSEMA.

1.1 Background

INPEX Ichthys Pty Ltd (INPEX), on behalf of the Ichthys Upstream Unincorporated Joint Venture Participants intends to develop the Ichthys Field in the Browse Basin off the north-west coast of Western Australia to produce liquefied natural gas (LNG), liquefied petroleum gases (LPGs) and condensate for export to markets in Japan and elsewhere.

The Ichthys Field is located within the area covered by production licence WA-50-L in the northern Browse Basin, approximately 210 km north-west of the coast of mainland Western Australia and 820 km south-west of Darwin. Gas from the Ichthys Field will undergo preliminary processing on an offshore central processing facility (CPF) to remove water and raw liquids, including the greater part of the condensate. This condensate will be pumped to a nearby floating production, storage and offtake (FPSO) facility from where it will be transferred to tankers for export to overseas markets. The gas will be transferred from the CPF via an 889 km gas export pipeline (GEP), covered by pipeline licences WA-22-PL and NT-PL/4 in Commonwealth waters, to an onshore processing plant at Bladin Point in Darwin (Figure 1-1).

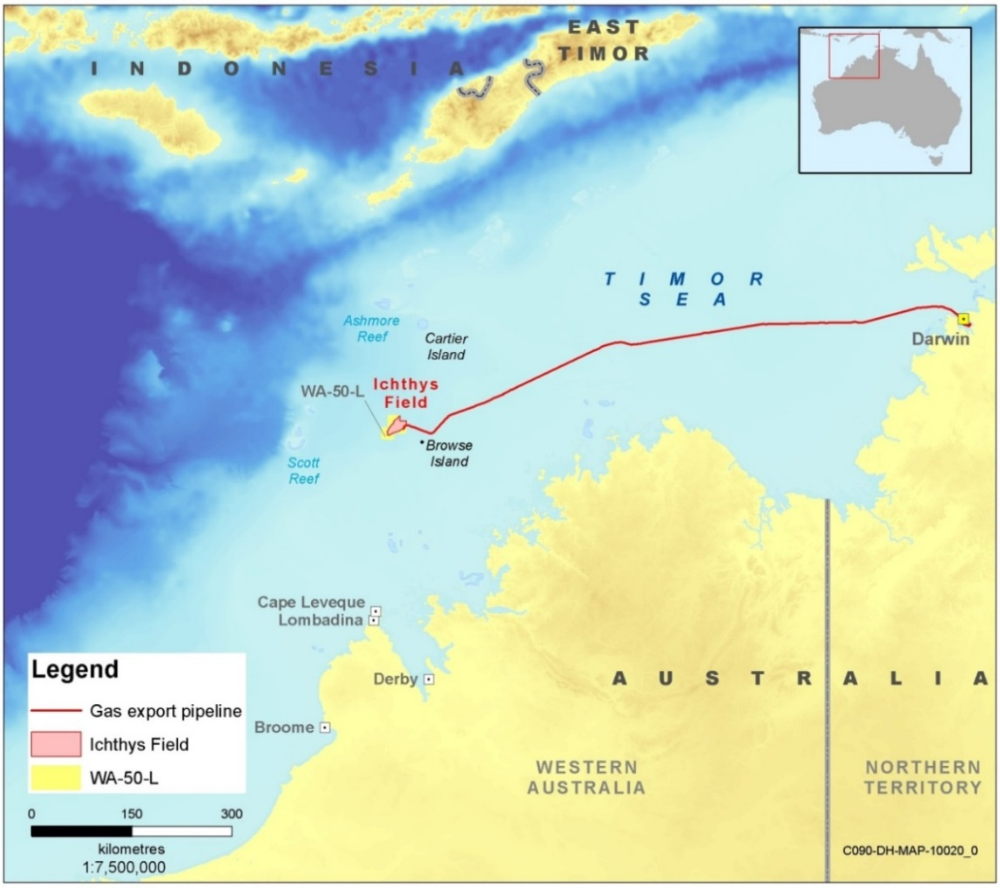


Figure 1-1: Location of the Ichthys Field

1.2 Activity overview

The *Ichthys Project Offshore Facility (Operation) Environment Plan* (the EP) describes how the interconnected FPSO, CPF and subsea production system will be hooked up, commissioned and operated.

Table 1-1 provides an overview of the offshore facility operation and works within title area WA-50-L, inclusive of the CPF, FPSO, subsea infrastructure and supporting vessels.

Table 1-1: Overview of activity description

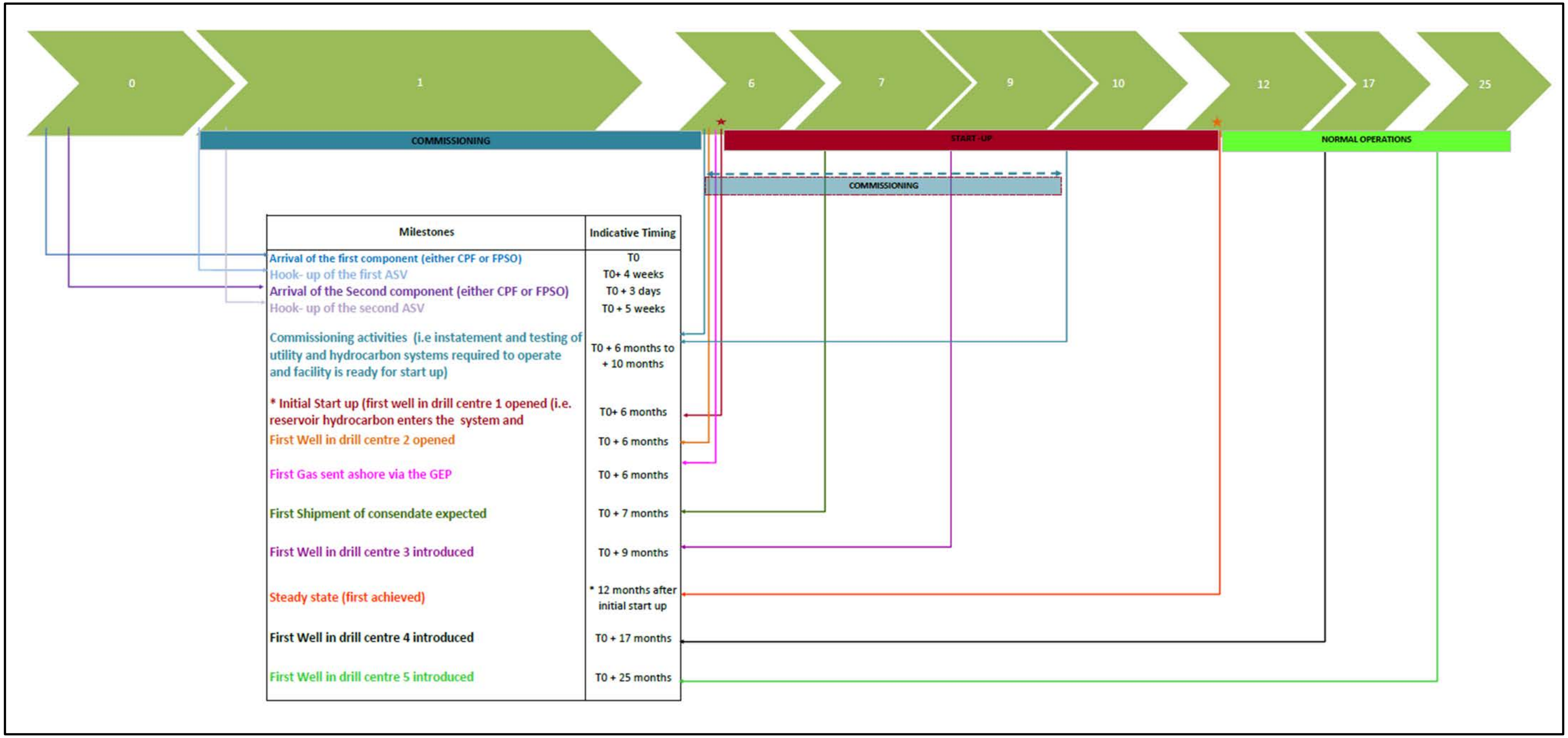
Item	Description
Petroleum production licence area	WA-50-L
Basin	Browse
Gas field	Ichthys Field
Location	Wholly located within Commonwealth waters, approximately 390 km north of Derby, Western Australia in the North-west Marine Region (NWMR) of the Timor Sea
Hydrocarbon type	Gas and condensate
Interlinked facility	The CPF (*Ichthys Explorer*) which is used to separate the reservoir fluid received from the gathering systems into liquid and gaseous phases, and export gas onshore for further processing. It has accommodation facilities and utilities, with a capacity of 200 beds, to support a workforce. The FPSO (*Ichthys Venturer*) which supports hydrocarbon processing systems and utilities by processing liquid hydrocarbons received from the CPF to produce a stabilised hydrocarbon condensate, which is then temporarily stored within the FPSO hull and, periodically, offloaded to tankers for export to market. The FPSO also has accommodation facilities and utilities, with a capacity of 200 beds, to support a workforce. The FPSO has been designed with inlet and discharge moonpools to enable seawater intake and liquid effluent discharge via flexible hoses. Subsea production system (SPS) infrastructure (e.g. xmas trees, manifolds, subsea control systems and umbilicals, risers and flowlines (URF), and the gas export riser base (GERB), which connect the wells to the CPF and FPSO). Reservoir fluids transfer from the CPF to the FPSO via two condensate and rich monoethylene glycol (MEG) lines (known as CRM lines) which consist of rigid flowlines on the seabed and flexible risers connected to the CPF and FPSO topsides. Two flexible flash-fuel gas (FFG) transfer lines are also connected for the transfer of flash gas and/or fuel gas between the CPF and the FPSO.
Vessels	Platform supply vessels, accommodation support vessels, tugs, heavy-lift vessels (HLVs) – potentially also operating as a facility, offtake support vessels, and other supply and support vessels required to support the operation and maintenance of the CPF, FPSO and subsea infrastructure,

Item	Description
	within the operational area.
Activities	**Hook-up to subsea infrastructure** Tugs will position the CPF and FPSO (so that they can be moored and hooked up to pre-installed subsea infrastructure in accordance with the INPEX *URF Installation Environment Plan*). Connecting the accommodation support vessels (ASVs) to the CPF and FPSO. **Commissioning** Preparing the CPF, FPSO and subsea infrastructure for the introduction of reservoir hydrocarbons. Commissioning is a series of tests and checks to ensure the integrity of the production and utility systems on the CPF and FPSO can operate as per their design and functional intent. The only emissions and discharges from the facility during this period are from the utility systems (i.e. cooling and potable water systems, power generation, lighting and inert gas systems). There are no production discharges or flaring from the production system until after start-up. Some non-production critical equipment may be commissioned after start-up. **Start-up and operations** Starting-up the SPS, CPF, and FPSO to allow the reservoir fluids and processing equipment to reach operational pressures and temperatures, as well as obtaining sufficient and stable equipment inlet flow to enable the equipment to perform to design criteria. Conveyance of fluids, comprising gas, hydrocarbon condensate, MEG and produced water (PW) from the reservoirs by means of the subsea infrastructure to the CPF and FPSO. Regeneration of MEG by the FPSO used during processing so that it can be recycled back to the SPS and wells. Processing and storage of gas and condensate via the CPF and FPSO, including transfer of condensate via an offtake hose to an offloading tanker; and gas export up to the GEP. IMR activities on the CPF, FPSO and subsea infrastructure (excluding well intervention or well workover activities).
Expected activity commencement	late Q1 2017
Duration	The Ichthys Project has a design life of 40 years. The EP will cover continuous operations, 24 hours per day, for a period of up to five years from acceptance of the EP.

1.2.1 Indicative schedule

Indicative milestones for the petroleum activity are shown in Figure 1-2.

Figure 1-2: Indicative milestones



At the time of preparation of this EP Summary, time (T) 0 is scheduled for late Q1 2017. The timing provided is indicative only and subject to potential delays caused by weather events (e.g.cyclone season).

1.3 Overview of design concept

The Ichthys Field consists of two reservoirs, an upper reservoir in the Brewster Member and a lower reservoir in the Plover Formation. The properties of these two reservoirs are the key drivers that have influenced the design and specification of the CPF and FPSO to enable the development to be feasible, both on technical and economic grounds.

The remote location, water depth, and high pressure and temperature of the gas and condensate within the reservoirs resulted in numerous design requirements that necessitate an interlinked facility. The CPF and FPSO are situated approximately 4 km apart.

The role of the CPF is to receive the reservoir hydrocarbons and provide the necessary separation and compression (both inlet and export) to transport mainly gas from the reservoirs along the 889 km GEP to the onshore processing plant in Darwin. The CPF is the largest of its kind in the world. Its large size is due to the high pressure of the received hydrocarbons and the necessity of maintaining pressure, in order to efficiently export the processed hydrocarbons through the GEP to Darwin. In addition, to the separation and compression equipment, the cooling required for the process has significant space and weight requirements, leaving limited available space on board the CPF to undertake other essential steps in hydrocarbon processing for the development of both reservoirs. Therefore, the separated liquids are transferred to the FPSO for further processing to meet offtake specifications.

Development of the reservoirs requires the continuous injection of MEG to avoid hydrate formation and, given the remote offshore location, the FPSO has been designed to accommodate an offshore MEG processing plant to enable the regeneration and recycling of MEG through the process. The FPSO is also one of the largest in the world because of the large space and weight of the necessary equipment to safely receive and manage high-pressure liquids from the CPF, in addition to the MEG processing plant, PW treatment and other systems, such as cooling and power generation. A schematic diagram to illustrate the layout of infrastructure is provided in Figure 1-3.

As well as process design requirements, the tropical climate and metocean conditions at the location have been a factor in the design to ensure that the CPF and FPSO can safely accommodate personnel and remain operational over 40 years, including during cyclone seasons.

To assist decision-making in the planning stage, INPEX considered a number of factors, including health, safety and environment, and financial and technical deliverability. Environmental criteria have been considered at all levels in the concept selection and decision-making process. Specific considerations and assessment of alternatives undertaken during the detailed design stage are further described in the ALARP demonstrations and justifications presented in the EP.

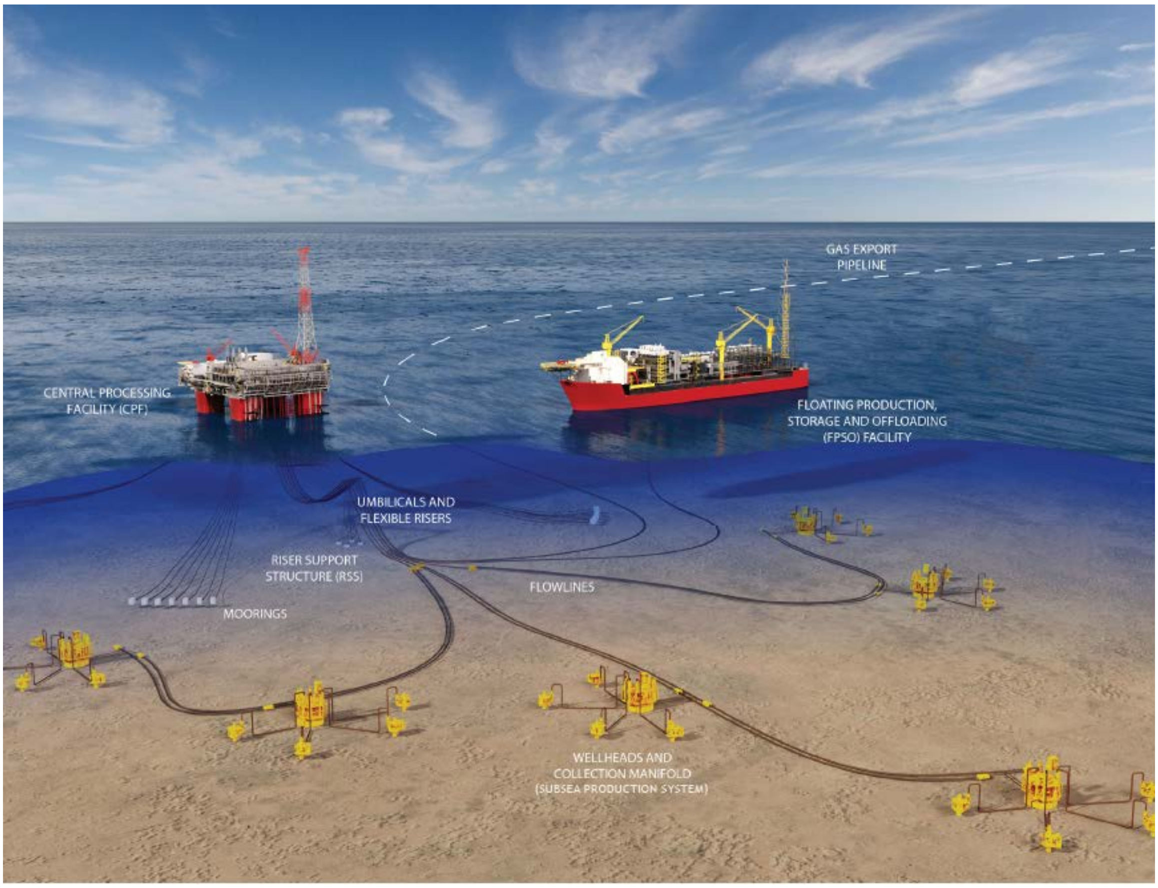


Figure 1-3: Indicative layout of the interlinked offshore facility

1.4 Titleholder’s nominated liaison person

In accordance with Regulation 15(2) of the OPGGS (E) Regulations 2009, details of the titleholder’s nominated liaison person are provided in Table 1-2.

Table 1-2: Titleholder’s nominated liaison person

Name	Jake Prout
Business address	Level 22 100 St Georges Terrace, Perth, WA 6000
Telephone number	+61 8 6213 6000
Email address	jake.prout@inpex.com.au

2 DESCRIPTION OF ACTIVITY

2.1 Operational area

The operational area (Zone 1) associated with the EP is defined by the petroleum safety zone (PSZ) (NOPSEMA 2014) at the sea surface and a 500 m buffer on either side of the subsea infrastructure on the seabed. These two areas (sea surface and seabed) are combined (Figure 2-1) to illustrate the area within which planned activities are likely to occur within WA-50-L.

The Ichthys Field management area defines the larger area within WA-50-L, in which INPEX may operate and moor vessels or conduct other petroleum activities concurrent to those described in the EP, in accordance with other accepted EPs (e.g. drilling, URF installation). Accordingly, the Ichthys Field management area is relevant to simultaneous operations, concurrent operations and emergency response management within the title.

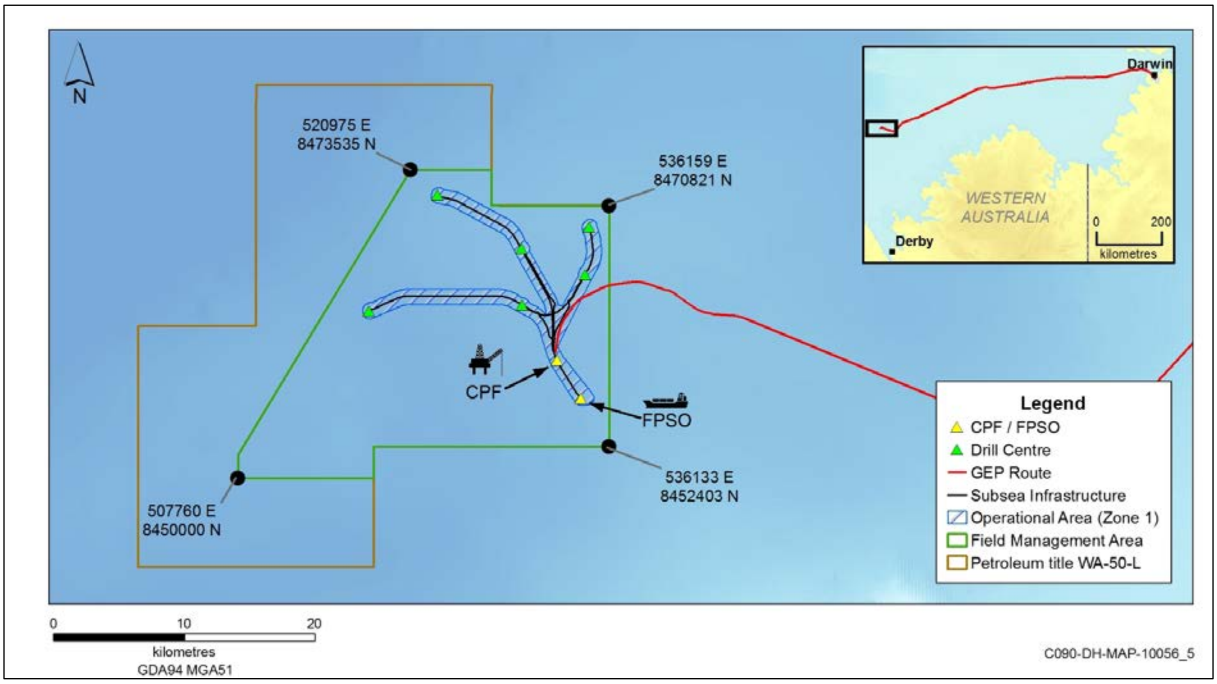


Figure 2-1: Operational area (Zone 1)

2.2 Mooring, installation, hook-up and commissioning

On arrival at Zone 1, the CPF/FPSO will be held in position by tugs (with towlines) using dynamic positioning (DP).

While the CPF and FPSO are held in position by the tugs, the pre-laid mooring chains are attached (note that the attachment of mooring chains by support vessels is managed under the INPEX URF Installation Environment Plan). The connection to the mooring chains for the CPF/FPSO is expected to take approximately one month to complete for each component.

Each of the accommodation support vessels (ASVs) is expected to attach to the CPF and FPSO shortly after each component of the facility is securely moored. The FPSO, CPF and ASVs are expected to become manned at maximum capacity during this time and will be operating utilities (i.e. power, water and sewage systems) to provide for the crew.

The CPF and FPSO are connected (hooked up) to the subsea system (i.e. risers and umbilicals). There are no subsea discharges from the SPS prior to start-up.

The commissioning processes involve other preparation activities conducted to confirm the integrity of the entire interconnected facility so it is ready for start-up (RFSU) with the introduction of reservoir hydrocarbons (i.e. gas-in). There will be no flaring until after start-up.

Some (non-production critical) equipment and systems, not required for the conditions expected at initial start-up, will be commissioned on the facility after production has commenced. Where practicable, commissioning activities will have been completed in the South Korean yards prior to sail-down. However, foreseeable activities that can only be done after arrival in the field include:

- installation and reinstatement testing of systems and equipment to operate the CPF and FPSO that may have been removed or disturbed during the tow
- removal of temporary equipment/waste (used during the sail-down)
- function (leak testing) testing of the hydrocarbon processing system using nitrogen to confirm integrity has not been lost during the tow
- final calibrations and testing of piping, alignment, hoses, safety systems, emergency shutdown valves, pumps, monitoring systems, heating, venting and air conditioning equipment and telecommunications connections.

2.3 Initial start-up and operations

After reservoir hydrocarbons are introduced (gas-in) and before a steady state of production can be achieved, an initial start-up period is required to allow the reservoir fluids and processing equipment to reach operational pressures and temperatures, as well as obtaining sufficient and stable equipment inlet flow to enable the equipment to perform to its design criteria.

To first flow the wells, MEG or nitrogen will be injected into the flowlines until flowline pressure is sufficient to avoid hydrate formation (and potential damage to the SPS) when the subsea hydraulic choke is opened. MEG circulation will be established from the FPSO via the well to the CPF.

A subsea choke will be opened slowly to allow the flow of reservoir fluids into the SPS to displace the MEG/nitrogen from the flowline via the CPF inlet surge vessel (ISV). Reservoir fluids / nitrogen will pass from the ISV to the high-pressure (HP) production separator. Initially reservoir gas / nitrogen will be flared from the HP separator until operating conditions are met. In HP operation, the gas will flow through to the glycol dehydration column. Similarly, gas from this column will be flared until the process dynamics of the dehydration process equipment are stabilised and the target gas dewpoint specification can be met. Until the target gas dewpoint specification is achieved, the gas is wet and will not be transferred to the FPSO. CPF production trains will be brought online one at a time. The above steps will then be repeated for the two remaining CPF production trains.

Liquids from the CPF ISV will be transferred to the FPSO and enter the intermediate pressure (IP) separator. The IP separator is used to separate flash gas from the liquids, and liquid hydrocarbons are forwarded to the medium pressure (MP) separator. From the MP separator, liquid hydrocarbons are fed to the MP coalescer, before being routed to the first and second low-pressure (LP) separators. The flash gas compression system cannot be brought online until sufficient flash gas is generated by the IP, MP and LP separators. During this time, before sufficient flash gas has been achieved, the gas will be flared. The above steps will be repeated for the second FPSO production train.

To finalise the testing of the CPF gas export compressor, the turbine will be decoupled from the compressor and run with produced gas. During this time, gas from the compressor will be flared. Once these tests are completed, the compressor and turbine will be recoupled, and the compressor put on recycle and tested with produced gas. This process will be repeated for the remaining three CPF gas export compressors. Once the first gas export compressor is running on recycle (hence not flaring), the glycol dehydration column can be fully commissioned, using hot gas from the gas export compressor discharge.

Initially, a single CPF and FPSO production train will be brought online and stabilised. GEP pressurisation and stabilisation will also occur. Additional CPF and FPSO production trains will only be brought online following this process, and when the Ichthys LNG plant has additional capacity.

During the start-up phase, emergency shutdown (ESD) blowdown testing will be conducted for the CPF and FPSO. The intention of an ESD test is to rapidly depressurise and shut down the facility to ensure it is placed in a safe state. To do this, flaring must occur to safely dispose of the produced gas. Following the start-up period, performance trials and ESD tests will continue to take place for some months, resulting in some additional flaring after the initial start-up period.

Normal operating conditions or a ‘steady state’ occurs during periods of production, when all systems on the CPF and FPSO are fully operational. These periods are not considered to occur during the initial start-up, during the introduction of new wells, when well clean-up activities occur, or during shutdowns (and subsequent restarts).

During periods considered to be ‘non-steady state’, such as during start-up, upset conditions, or when introducing new wells, increased concentrations of some production chemicals and oil-in-water (OIW) may be discharged to the marine environment. It is anticipated that elevated concentrations for OIW may occur for short periods (hours or days at a time) but no greater than (60 days in total) within the initial 12-month start-up period while equipment and wells are brought online.

2.3.1 Inspection, maintenance and repair (IMR) activities

During the life of the EP, IMR activities may be required to ensure the safe and efficient operation of the infrastructure. Inspection activities, generally involving the use of a support vessel and remotely operated underwater vehicles (ROVs) include, but are not limited to, inspection of the CPF and FPSO hulls and subsea infrastructure. In addition, marine acoustic surveys (e.g. side-scan sonar and multibeam echo sounders) may also be undertaken. These inspections are typically conducted from a vessel or autonomous underwater vehicle fitted with acoustic instruments. The exact frequency and nature of inspection activities is risk-based and, therefore, will depend on the specificities of individual systems/equipment. Inspections will be conducted in accordance with a risk-based inspection plan and the INPEX management of change process described in the EP.

Maintenance and repair activities are expected to be infrequent, depending on the results of inspections. Indicative maintenance and repair activities that could potentially be undertaken include those presented in Table 2-1.

The exact nature of specific repair activities following, for example, failure of a subsea infrastructure component, is unknown. In the event of a failure, an inspection will be undertaken to establish any maintenance or repair activities required. Potential maintenance and repair options available will be risk assessed in accordance with the methodology summarised in Section 5 of this EP summary. Each maintenance or repair activity assessment will identify hazards and threats that may occur with respect to potential environmental impacts and risks. Where the assessment determines that the activity may result in a change that introduces a new or increased environmental impact or risk, INPEX will manage the changes in accordance with the management of change process described in the EP.

Table 2-1: Potential maintenance and repair activities in Zone 1

Activity	Description
Pigging of GEP and SPS	Planned operational pigging of the GEP within WA-50-L is expected to occur up to twice within the life of the EP, where pigs will be launched from the GERB pig launcher and receiver (PLR) into the GEP. During operational pigging, MEG discharges may occur at the GERB PLR. Pigging equipment will be provided on the CPF, FPSO and within the SPS to enable the operational pigging of the pipelines, flowlines and risers, if required. Pigging may also be used to support the decommissioning and commissioning activities for the repair or replacement of subsea production infrastructure. During these pigging operations, filtered inhibited seawater (FIS) contained within the replacement flowlines, or MEG, may be discharged to sea.
Seabed intervention activities	This may involve activities within the operational area (i.e. within 500 m of installed infrastructure) such as physical seabed intervention/excavation alongside infrastructure to adjust sand levels to gain access to, or enable repairs of, infrastructure. Excavation may involve activities such as jetting or mass-flow excavation. Seabed intervention activities may also include the installation of grout bags, concrete mattresses, rock placement, or other physical structures to stabilise and protect infrastructure on the seabed. The area of seabed disturbance is directly related to the nature of the repair or inspection being performed; however, reasonably foreseeable activities, such as ROV set-downs, may occur for a matter of hours and disturb an area approximately 2–4 m^2. Potential excavations may vary in length from a few meters to 100 m and may be in the order of 2 m to 4 m wide. Installation of other physical structures, such as grout bags or mattresses, may vary from <1 m^2 up to approximately 50 m^2.
Marine growth / lime scale removal activities	This may involve the removal of marine growth and calcareous deposits on subsea infrastructure using mechanical techniques and/or chemical treatments using a vessel and ROV spread. Initially, physical removal with high-pressure or cavitation jets may be used to remove as much marine growth or calcium deposits as possible. If physical removal is unsuccessful (i.e. due to access issues) weak acids, such as vinegar or sulfamic acid, may be used to remove residual marine growth / calcium deposits.

Activity	Description
Riser replacement	Risers may be replaced as a result of damage or loss of integrity. A riser needing to be replaced will be isolated from the flowlines, and hydrocarbons will be displaced with MEG and/or treated seawater. The riser will then be depressurised and disconnected from the topsides and subsea facilities, then reeled onto an IMR vessel. A replacement riser will then be installed from a reel on the IMR vessel. The new riser will be flooded with treated seawater and hydrotested, before being pigged, to displace the seawater, and commissioned in a condition ready for operation (e.g. filled with either nitrogen or MEG).
Flowline replacement	In the event of significant damage to an infield flowline, it may be required that part, or all of the flowline, must be replaced. A flowline needing to be replaced will be isolated, and hydrocarbons will be displaced with MEG and/or treated seawater. The flowline will then be depressurised and disconnected from the SPS, and recovered onto an IMR vessel. A replacement flowline will be transported to site in sections. Each section will be welded and tested (for welding quality) before being lowered into the sea. The first end of the flowline will be fitted with a flowline end termination (FLET) which will exclude seawater. The final end of the flowline will also be fitted with a FLET which will prevent ingress of water before mechanical completion and pre-commissioning. Once the flowline is installed, it will be flooded with FIS and hydrotested, before being pigged, to displace the seawater, and commissioned in a condition ready for operation (e.g. filled with either nitrogen or MEG).

It should be noted that any significant repairs to subsea infrastructure that would require the use of a mobile offshore drilling unit or well intervention are out of the scope of the EP.

If maintenance or repairs are required, a support vessel may remain on site for approximately five to 60 days at a time, depending on the nature of the work required. Additional field time may, however, be required for any activity, depending on the specific circumstances. It is possible that performing some tasks (where a vessel is connected to the subsea facility) that it may be deemed as a ‘Facility’ under the OPGGS Act.

2.3.2 Vessels

A range of vessels will be required to support the activity. Indicative vessel characteristics and their purposes are described in Table 2-2. During an emergency situation, vessels used may not be subjected to all premobilisation controls; however, controls relating to relevant environmental risks from vessel activities during an emergency condition are described in the EP. Vessels will utilise different fuel types as detailed in Section 8 of the EP and will be equipped with onboard systems to manage solid and liquid waste streams.

The approximate durations described in Table 2-2 are indicative and subject to change, depending on operational requirements, potential delays caused by weather events and other factors.

Table 2-2: Vessels

Vessel type	Number	Purpose
Tugs	Five for the	Oceangoing tugs will tow the CPF and FPSO from the fabrication yards in South Korea to Zone 1. Once on

Vessel type	Number	Purpose
	CPF Four for the FPSO	location, the tugs will hold the floating structures on station (while permanent mooring chains are pulled in and the structures are secured by other support vessels in accordance with the URF EP). Tugs are expected to be in Zone 1 for approximately 30 days during the mooring of each structure. However, they could be required to assist in Zone 1 at a later date for a period of approximately 7 days for other hook-up activities conducted in accordance with the URF EP, such as riser hook-up.
Accommodation support vessels (ASVs)	Two	ASVs will link to the CPF or FPSO by means of gangways. ASVs will be held on station by means of dynamic positioning systems. ASVs can provide accommodation support in the order of 500 beds each, as well as helipads and storage/laydown areas. ASVs are expected to be in Zone 1 during periods of intense maintenance activity including the first months after commencement of the activity during installation, hook-up and commissioning, prior to start-up. For intensive maintenance activities, they could return to the field and reconnect to the CPF and/or FPSO.
Platform supply vessels (PSVs)	Two	PSVs primarily provide logistics support for materials between the supply bases, the CPF and FPSO (Zone 1). They transport and transfer items, such as fuel, bulk chemicals, provisions and waste for return to the mainland. PSVs will operate on a rotating basis. Nominally, PSVs within Zone 1 undertaking typical offloading/loading operations may be present every 3–4 days for 24–48 hours; however, subject to operational requirements, a PSV may remain in Zone 1 for up to two weeks continuously.
Offshore support vessel (OSV)	One	The primary role of the OSV is to assist and support offtake operations. It provides assistance with pilot transfer and during mooring/unmooring, hose-handling and static tow operations. The OSV will be present in Zone 1, except for crew changes in Broome, approximately every four to five weeks, or for other reasons, such as maintenance.
IMR support (including heavy-lift vessel) / ROV	Two	IMR support vessels, including heavy-lift vessels (HLVs) may be required, on an ad hoc basis, to conduct inspections, tests and maintenance on subsea infrastructure. On occasion, these activities may involve a vessel to perform tasks that define the vessel as a facility under the OPGGS Act. Foreseeable tasks for maintenance vessels include lifting and installation of pigging equipment to aid transfer of pigs through the GEP, between the GERB and the onshore LNG plant in Darwin. IMR vessels may also provide support during the tie-in of wells. These activities will typically be undertaken by dynamically

Vessel type	Number	Purpose
		positioned vessels supported using cranes and remotely operated underwater vehicles (ROVs).
Offloading tankers	–	Condensate offloading tankers will arrive at the facility approximately every 5 to 10 days. They will be piloted by an INPEX third-party contractor, who also acts as loading master during the hydrocarbon transfer. The transfer of condensate takes approximately 24 hours to complete. During the offloading process, the pilot directs the assisting OSV.

2.3.3 Summary of emissions, discharges and wastes

Emissions, discharges, and wastes resulting from the operation of the offshore facility and supporting vessels, and from IMR activities are identified in summary in Table 2-3.

Table 2-3: Emissions (E), discharges (D) and wastes (W) from the CPF, FPSO and supporting vessels

System	E, D, W	Description	
Subsea production system	D	Production xmas trees, manifolds, well jumpers, flowlines and risers	In preparation for start-up there is potential for a controlled low-pressure release of nitrogen with trace amounts of MEG that may be released. Open-loop subsea valve actuation results in the release of small amounts of subsea control fluids, such as MEG, to sea. Maintenance and repair of subsea infrastructure may also result in discharges of MEG or FIS to sea (e.g. during pigging or riser replacement) and the use of weak acids (vinegar, sulfamic acid) to remove residual marine growth / calcium deposits.
Reception and separation system inlet surge vessels (ISVs) / sand treatment	W	CPF	Any sand in the well fluids should be removed in the CPF inlet surge vessels. Sand (solids) >66 µm in diameter will be collected by means of de-sanding through a three-phase separator and sent onshore for disposal.
		FPSO	Sand carryover from the CPF to the operators on the FPSO will be collected and disposed of onshore.
Gas export compression	E	CPF	Combustion gas emissions from gas export compressor gas-turbine drivers are emitted to the atmosphere via an exhaust stack.
Off-gas recovery (OGR)	W	CPF	Liquid mercury is collected in the CPF OGR mercury collector and periodically returned to the mainland for disposal or recycling. No emissions, discharges or wastes arise directly from the FPSO OGR system.
Fuel gas	W	CPF	Spent solid catalysts from the mercury removal unit (MRU) and the two sulfur removal units (SRUs) are periodically

System	E, D, W		Description
			replaced and returned to shore for disposal or recycling.
Nitrogen systems	E	CPF FPSO	Nitrogen gas used for purging, seal gas and blanket gas is displaced to the atmosphere.
Flare (HP/LP)	E	CPF FPSO	Combustion gas emissions from flare pilots, and when flaring during start-up, maintenance, process upsets and emergencies.
	E	CPF FPSO	Light emissions associated with flaring during start-up, maintenance, process upsets and emergencies.
Condensate and flash gas mercury removal	W	FPSO	Spent adsorbent and filters from the condensate mercury guard bed vessels and flash gas mercury guard bed vessels are periodically replaced and returned to the mainland for disposal or recycling.
Inert gas system	D	FPSO	Seawater containing residual heat; and, potentially, combustion residues generated by gas scrubbing in the inert gas system, is discharged to sea via the FPSO discharge moonpool.
Atmospheric vents	E	FPSO	Infrequent and unplanned process gas emissions are released via the atmospheric vent during upset conditions. Safe H_2S relief from the H_2S vent in the rare event that the H_2S injection scavenger in the fuel gas system is unavailable. Infrequent emissions of inert gases via the inert gas and tank maintenance vents during pressure relief or purging activities.
Power generation	E	CPF FPSO	Combustion gas emissions from gas turbine drivers and diesel-powered engines are emitted to the atmosphere via an exhaust stack.
	E	CPF FPSO	Noise emissions from power generation (and other facility systems and topside activities).
	E	Vessels	Combustion gas emissions from diesel-powered engines are emitted to the atmosphere via an exhaust stack.
	E	Vessels	Noise emissions from vessel engines and propulsion systems.
Seawater cooling	D	CPF	Seawater containing residual heat and sodium hypochlorite is returned to sea via the seawater dump caisson. The chlorinated seawater is filtered in the seawater coarse filter package which is designed to filter out any particles larger than 100 µm. The filter is periodically backwashed with filtered seawater to remove debris. The filtered backwash is discharged to sea via the seawater dump caisson.

System	E, D, W	Description	
	D	FPSO	Seawater containing residual heat and residual sodium hypochlorite is returned to sea via the FPSO discharge moonpool. The chlorinated seawater is filtered in the seawater coarse filter package which is designed to filter out any particles larger than 100 μm. The filter is periodically backwashed with filtered seawater to remove debris. The filtered backwash is discharged to sea via the discharge moonpools.
	D	Vessels	Seawater containing residual heat.
Open-drains system	D	CPF	Treated water is discharged to sea via the open-drains caisson.
	D	FPSO	Open-drains water and bilge is received in the slops tank system for treatment. Recovered hydrocarbons are recycled back through the process and treated water is discharged to sea via the FPSO discharge moonpool.
Closed-drains system	W	CPF FPSO	Hydrocarbon slurry from the CPF and FPSO closed drains is collected in the closed-drains drum on the FPSO and returned to shore for treatment and disposal.
Vessel deck drainage	D	Vessels	Vessel deck drainage water may be discharged to sea.
Bilge system	D	CPF	Bilge is pumped into the open-drains system for treatment to <15 ppm (v) OIW before discharge to sea via the open-drains caisson.
		FPSO	Bilge is pumped into the open-drains system for treatment to <15 ppm (v) OIW before discharge to sea via the FPSO discharge moonpool.
		Vessels	Treated contaminated bilge water with <15 ppm (v) OIW is discharged to sea.
PW treatment	D	FPSO	Treated PW (containing <30 mg/L OIW, inorganic salts, trace quantities of water-soluble production chemicals and dissolved organic compounds, such as H_2S) is commingled with other liquid waste streams, such as cooling water, and discharged to the sea via the FPSO discharge moonpool.
	W		Macro porous polymer extraction (MPPE) media/columns for PW treatment are periodically replaced and collected and disposed of onshore.
MEG system and storage	E	FPSO	Combustion emissions from the gas-fired heaters are emitted to the atmosphere via an exhaust stack.
	D		Low solubility divalent salts from MEG pretreatment are comingled with the PW discharge stream and discharged to sea via

System	E, D, W		Description
			the FPSO discharge moonpool. A continuous, low-volume bleed stream of high-viscosity liquid (salts and MEG) is comingled with the PW discharge stream and discharged to sea via the FPSO discharge moonpool. High-solubility salts from the MEG reconcentration system are mixed with PW and sent to the PW system before discharge to sea via the FPSO discharge moonpool. Periodic discharges of spent citric acid from descaling of the MEG system are discharged to sea with the PW discharge stream via the FPSO discharge moonpool.
Chemical injection systems	D	CPF FPSO	Trace quantities of water-soluble production chemicals and spent H_2S scavenger are sent to the PW treatment system and are then commingled with other liquid waste streams and discharged to the sea via the FPSO discharge moonpool.
			HCl gas scrubbing water from the pH controller in the FPSO chemical injection system is commingled with other liquid waste streams, such as cooling water, and discharged to the sea via the FPSO discharge moonpool.
Sewage, grey water and macerated food waste effluent	D	CPF	Treated sewage effluent, grey water and macerated food waste are discharged to sea via the sewage disposal caisson.
		FPSO	Treated sewage effluent, grey water and macerated food waste are discharged to sea via a dedicated subsea hose routed through the discharge moonpool.
		Vessels	Treated effluent produced by vessel sewage treatment plants is discharged to sea.
		ASV when attached	Sewage effluent from the ASVs will be macerated and treated using bio-treatment systems before discharge to sea.
Ballast system	D	CPF	Return ballast with residual sodium hypochlorite is discharged to sea via the seawater dump caisson.
		FPSO	Return ballast with residual sodium hypochlorite is discharged to sea via the FPSO discharge moonpool.
		Vessels	Return ballast from vessels is discharged to sea. The ASVs have UV treatment ballast water treatment plants.
Firewater system	E	CPF FPSO	Combustion gas emissions from diesel-fired electrical generators used to drive the firewater pumps during emergencies.
Foam	D	CPF	Alcohol-resistant aqueous film-forming foam (AR-AFFF) and film-forming fluoroprotein

System	E, D, W	Description	
fire-extinguishing			(FFFP) foam is routed to the open-drains system and may be released to sea in the event of system deployment.
		FPSO	FFFP foam is routed to the open-drains system and may be released to sea in the event of system deployment.
		ASVs	The AFFF systems include AFFF foams released via deck drainage in the event of a fire. The foam has a shelf life of 10 years and will not be tested during the project.
Fresh/potable water	D	CPF	Saline reject-water stream will be discharged to sea via the seawater dump caisson.
		FPSO	Saline reject-water stream on the FPSO is routed back to the seawater uptake and is therefore not discharged to sea.
		Vessels	Saline reject-water stream will be discharged to sea.
Waste incineration	E	Vessels	Combustion gas emissions from onboard incineration of permitted wastes.
	W		Ash from incinerators will be stored as waste for disposal on the mainland.
Sundries / miscellaneous	E	CPF FPSO Vessels	Combustion gas emissions from diesel-powered equipment engines (e.g. crane engines, temporary generators).
	E		Light emissions from deck and navigation lights on facility topsides and vessels.
	W		Solid and liquid wastes from general maintenance operations, equipment replacement, etc., and domestic wastes are transported to the mainland for disposal.

3 EXISTING ENVIRONMENT

The Ichthys Project offshore facility is situated in the northern Browse Basin, approximately 210 km north-west of the coast of mainland Western Australia and 820 km south-west of Darwin. In the event of a spill, the environment that may be affected (EMBA) covers a considerably larger area than the area of planned activities. Consequently, these areas have been defined as follows:

- Zone 1: The area of planned activities, including subsea production system, CPF and FPSO as shown in Figure 2-1.
- Zone 2: The outer extent of the EMBA – a conservative estimate based upon the sum of many overlayed stochastic runs (of worst-case oil spill models), for all seasons – as shown in Figure 3-1.

3.1 Physical environment

The air temperature at Browse Island shows mean maximum temperatures of 33.3 degrees Celsius (°C) and a minimum of 25.1 °C (BOM 2015). Air temperatures in the Browse Basin remain warm throughout the year with means and maxima ranging from 26–30 °C and 32–35 °C, respectively (INPEX 2010).

The climate of northern Australia shows two distinct seasons: winter, from April to September; and summer, from October to March. There are rapid transitional periods between the two main seasons, generally in April and September/October (RPS MetOcean Pty Ltd 2011). The region has a pronounced monsoon season between December and March, which brings with it heavy rainfall. Heaviest rainfall is typically associated with tropical cyclones.

Broad-scale oceanography in the north-west Australian offshore area is complex, with major surface currents influencing the region, including the Indonesian Throughflow, the Leeuwin Current, the South Equatorial Current, and the Eastern Gyral Current. The Indonesian Throughflow current is generally strongest during the south-east monsoon from May to September (Qiu et al. 1999). The Indonesian Throughflow is a key link in the global exchange of water and heat between ocean basins. It brings warm, low-nutrient, low-salinity water from the western Pacific Ocean, through the Indonesian archipelago, to the Indian Ocean. It is the primary driver of the oceanographic and ecological processes in the region (DSEWPaC 2012).

The surface waters of the region are tropical year-round, with summer sea surface temperatures around 26 °C, and winter temperatures around 22 °C (DSEWPaC 2012a). Baseline monitoring in the offshore development area recorded surface water temperatures of ~30 °C in summer (March) and ~26–27 °C in winter (July) (INPEX 2010).

The tides are semidiurnal, with two daily high tides and two daily low tides (McLoughlin et al. 1988). Both the semidiurnal and diurnal tides appear to travel north-eastwards in the deep water leading to the Timor Trough before propagation eastwards and southwards across the wide continental shelf. The NWMR experiences some of the largest tides along a coastline adjoining any open ocean in the world. Mean sea level in the vicinity of Zone 1 is about 2.7 m above lowest astronomical tide (LAT), with a spring tidal range of about 5.0 m.

Summertime tropical cyclones generate waves propagating radially out from the storm centre. Depending upon the storm size, intensity, relative location and forward speed, tropical cyclones may generate swell with periods of 6–18 seconds (s) from any direction and with wave heights of 0.5–9.0 m. During severe tropical cyclones, which can generate major short-term fluctuations in current patterns and coastal sea levels (Fandry & Steedman 1994; Hearn & Holloway 1990), current speeds may reach 1.0 m/s and occasionally exceed 2.0 m/s in the near-surface water layer. Such events are likely to have significant impacts on sediment distributions and other aspects of the benthic habitat.

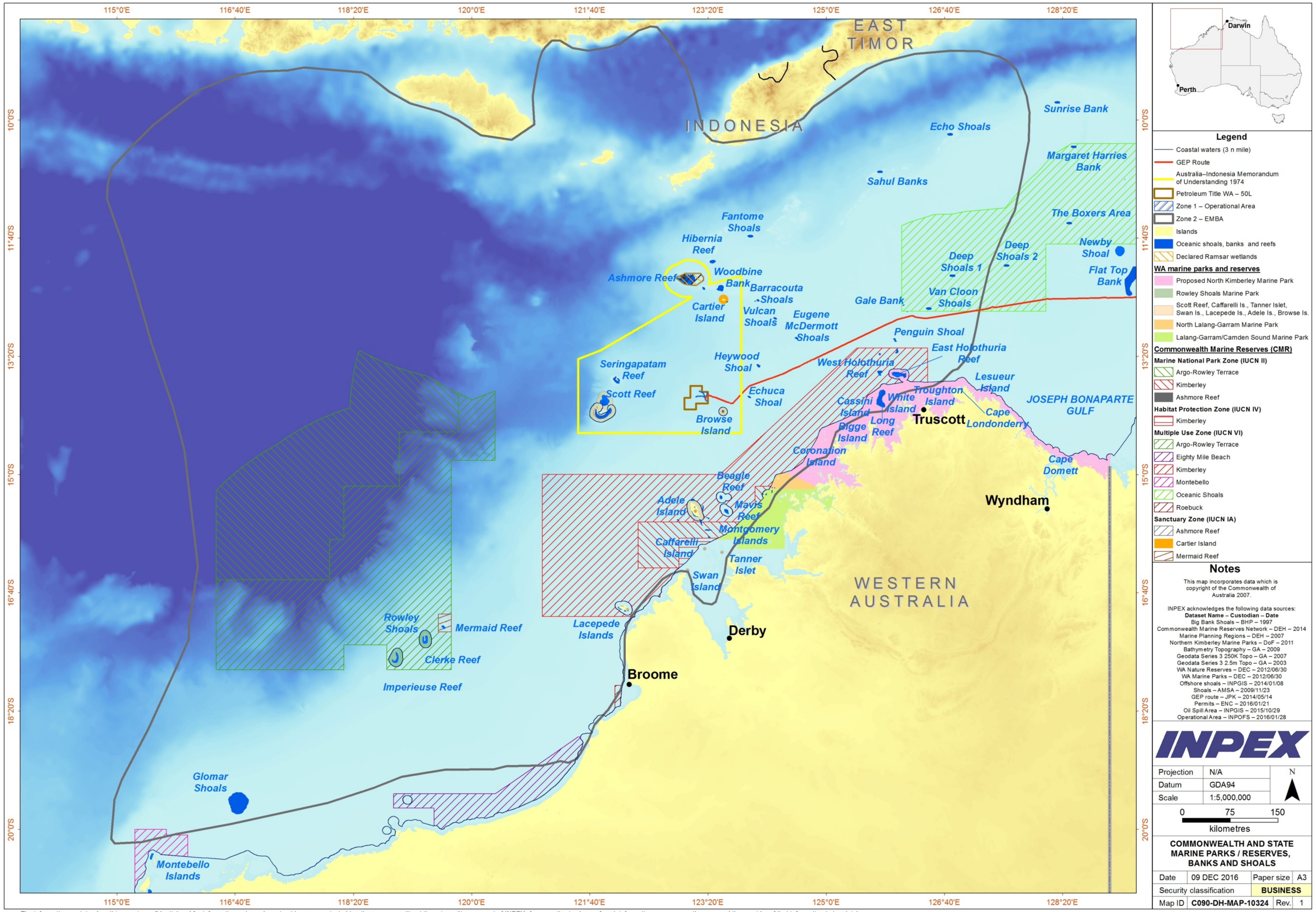


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Figure 3-1: Environment that may be affected and Commonwealth and state marine parks, reserves, banks and shoals in the region

3.2 Biological environment

3.2.1 Benthic habitats

Studies using sub-bottom profiling, multibeam echo sounder, side-scan sonar and visual ROV transects did not identify any obstructions or features on the seafloor, such as boulders, reef pinnacles or outcropping hard layers (Fugro Survey Pty Ltd. 2005a; Fugro Survey Pty Ltd 2005b and RPS 2007). The surveys indicate benthic habitats in the development area are limited to flat and featureless, soft substrate areas that are typical of deep continental shelf seabed and are widely distributed in the deeper parts of the Browse Basin. The lack of seabed features and soft sediment conditions, in Zone 1, have been confirmed during the installation of the subsea infrastructure in 2014 and 2015. Because of the large area associated with Zone 2, a large number of different benthic habitats exist within it, including banks, shoals, coral reefs and seagrasses (Figure 3-1).

There are no banks and shoals within Zone 1; however, there are many shoals that occur within the region. The closest to Zone 1 include Echuca Shoal and Heywood Shoal at a distance of 79 km and 96 km, respectively. Shoal and bank habitats are thought to provide additional regional habitat for marine fauna, including sharks and seasnakes (AIMS 2012).

There are no coral reefs within Zone 1. Coral reefs within the region can be categorised into three general groups: fringing reefs, large platform reefs, and intertidal reefs. Browse Island is the nearest landform to Zone 1 (33 km away) and is a Class C nature reserve. It is an isolated sand cay surrounded by an intertidal reef platform and shallow fringing reef. Other coral reefs in Zone 2, in particular Ashmore Reef, are recognised as having the highest richness and diversity of coral species in Western Australia (Mustoe & Edmunds 2008, cited in Department of State Development (2010).

There are no seagrasses within Zone 1 (due to water depth and lack of suitable habitat). Ashmore Reef within Zone 2 has a high coverage of seagrass that supports a small dugong population (Whiting & Guinea 2005), as does a strip north and south of Broome, which partially overlaps Zone 2, identified as a dugong foraging area.

3.2.2 Shoreline habitats

There are many islands that occur within the NWMR and North Marine Region (NMR). However, there are no islands within Zone 1. There are numerous small islands within Zone 2, including literally thousands of islands along the Kimberley coastline. Sandy beaches are the dominant shoreline habitat on all the offshore islands within Zone 2 and considered significant habitat for turtles and seabird nesting.

Mangrove communities make up a common shoreline habitat along the northern Western Australian coastlines with extensive mangrove communities along the Kimberley coastline (Zone 2).

3.2.3 Marine fauna

Species of conservation significance within Zone 2 were identified through a search of the EPBC Act Protected Matters Database. The search identified a total of 39 “listed threatened” species (23 of which are marine species) and 76 “listed migratory” species (43 of which are marine species) that potentially use, or pass through, Zone 2.

In addition, 132 “listed marine” species were identified, of which 30 are “whales and other cetaceans” that may occur at, or immediately adjacent to, the EMBA.

Marine mammals

There are no identified Biologically Important Areas (BIAs) for marine mammals within Zone 1. However, within Zone 2, numerous BIAs are present. Marine mammals associated with a BIA within Zone 2 are described in more detail within this subsection.

Humpback whale

There are two humpback whale (*Megaptera novaeangliae*) BIAs located within Zone 2; a migratory corridor and a breeding and calving area. During their annual northern and southern migrations, transitory humpback whales will pass through Zone 2 generally between June and October. The migratory habitat for the humpback whale around mainland Australia is primarily coastal waters less than 200 m in depth and generally within 20 km of the coast (Jenner et al. 2001).

Breeding and calving generally occurs between the Lacepede Islands and Camden Sound. Camden Sound is considered the northernmost limit and is considered an important calving and breeding area (Jenner et al. 2001).

Blue Whale

There are two recognised subspecies of blue whale in the southern hemisphere, which are both recorded in Australian waters. They are the southern (or 'true') blue whale (*Balaenoptera musculus intermedia*) and the ‘pygmy' blue whale (*Balaenoptera musculus brevicauda*) (DoE 2015). In general, southern blue whales occur in waters south of 60°S and pygmy blue whales occur in waters north of 55°S (i.e. not in the Antarctic) (DoE 2015). On this basis, the blue whales sighted are likely to be pygmy blue whales.

The 2015 Conservation Management Plan for the Blue Whale (DoE 2015) outlines the distribution of blue whales in Australian waters, and associated BIAs (migratory corridor and foraging areas). Of these, one BIA, a migratory corridor is present within Zone 2.

Pygmy blue whale migration is thought to follow deep oceanic routes. More recently, the migration route has been defined as along the shelf edge at depths between 500 m to 1000 m (DoE 2015). Observations suggest most pygmy blue whales pass along the shelf edge out to water depths of 1000 m but centred near the 500 m depth contour (McCauley & Jenner 2010). Satellite tagging (2009–2011) confirmed the general distribution of pygmy blue whales was offshore in water depths >200 m and commonly >1000 m (Double et al. 2014).

Dugong

Within Zone 2, there are two dugong BIAs, one at Ashmore Reef and another along the Dampier Peninsula, near Broome.

Dugongs are considered Specially Protected under Schedule 4 of the *Wildlife Conservation Act 1950* (WA) and are listed as migratory species under the EPBC Act. However, a significant proportion of the world’s dugong population occurs in the coastal waters of the west-Pilbara nearshore, as well as Ningaloo Reef and Exmouth Gulf (Marsh et al 2011) which are outside of Zone 2. Dugongs generally inhabit shallow waters (around 10 m depth) and are commonly found in mangrove channels of inshore islands and shallow areas near the seagrass habitats on which they feed (DoE 2016k). There is a dugong foraging BIA located along the Kimberley Coastline near Broome.

Dolphins

The coastal dolphin BIAs are located within Zone 2 and there are three species of coastal dolphin to which this BIA relates, discussed below.

Indo-Pacific humpback dolphin

The Indo-Pacific humpback dolphin (*Sousa sahulensis*) occurs along the northern coastline of Australia down to Exmouth on the WA coastline. The total population size of the Indo-Pacific humpback dolphin in Australian waters is unknown. Given that the required shallow habitat preferred by this species occurs continuously throughout its recorded range, the distribution of the Indo-Pacific Humpback Dolphin is considered to represent one continuous location (DoE 2016a).

Indo-Pacific bottlenose dolphin

The Indo-Pacific spotted dolphin (*Tursiops aduncus*) is generally considered to be a warm-water subspecies of the common bottlenose dolphin (*Tursiops truncatus*). The Indo-Pacific spotted dolphin appears to occupy inshore waters, often in depths of less than 10 m (Bannister et al. 1996). It is known to occur from Shark Bay, north to the western edge of the Gulf of Carpentaria, and is regarded as a migratory species under the EPBC Act (DoE 2016b). The coastal dolphin BIA is located within Zone 2.

Australian snubfin dolphin

All available data on the distribution and habitat preferences of Australian snubfin dolphins indicate that they mainly occur in one location: shallow coastal and estuarine waters of Queensland, Northern Territory and north Western Australia (Beasley et al. 2002). There are no data to estimate any past or potential future declines in the area of occupancy for snubfin dolphins in Australia; however, incidental catches in gillnets (albeit at unknown levels), plus habitat degradation, may lead to a reduction of area of occupancy over the next three generations for Australian snubfin dolphins. (DoE 2016c)

Marine turtles

The EPBC Act Protected Matters search identified five species of marine turtle which may occur within Zone 2: the green turtle, loggerhead turtle, flatback turtle, hawksbill turtle and olive ridley turtle. While there are no known BIAs for marine turtles within Zone 1, there are a range of BIAs for turtle breeding, foraging and internesting within Zone 2.

Four of the turtle species (green, loggerhead, flatback and hawksbill) have nesting rookeries on beaches along the mainland coast and internesting areas associated with islands in the wider region. Nesting rookeries within Zone 2 include Browse Island, Ashmore Reef, Cartier Island, Cassini Island, Scott Reef and the Lacepede Islands.

Fishes and sharks

While there are no BIAs for fishes and sharks within Zone 1, the following BIAs are present within Zone 2:

- sawfish (green, dwarf and largetooth) on the extreme periphery of the EMBA south-west and north-east of Broome
- whale shark foraging, largely following the 125 m ancient coastline.

Sawfish

Green sawfish are currently distributed from about the Whitsundays in Queensland, across northern Australian waters, to Shark Bay in Western Australia. These sawfish prefer shallow water environments within inshore marine areas and bays, although adults can be found in the ocean in water 70 m deep or more (Stevens et al. 2005).

The dwarf sawfish Australian distribution extends north from Cairns around the Cape York Peninsula in Queensland, across northern Australian waters to the Pilbara coast in Western Australia (Stevens et al. 2008). In the Kimberley region of Western Australia, dwarf sawfish have been recorded in the Fitzroy, May and Robinson Rivers, and three were captured in marine waters of King Sound (Thorburn et al. 2007).

The largetooth sawfish is predominately a freshwater/river fish and known to drain from the Durack and Ord Rivers in Western Australia. It is a marine/estuarine species predominantly occurring in rivers and estuaries, while large mature animals tend to occur more often in coastal and offshore waters up to 25 m depth (Stevens et al. 2005).

Whale shark

The whale shark is a solitary planktivorous species that spends the greater part of its foraging time at water depths above 100 m, often near the surface (Brunnschweiler et al. 2009; Nelson & Eckert 2007; Wilson et al. 2006). However, whale sharks are also known to engage in mesopelagic and even bathypelagic diving when in bathymetrically unconstrained habitats (Brunnschweiler et al. 2009; Wilson et al. 2006).

This species is widely distributed in tropical Australian waters. Within Western Australia, whale sharks aggregate seasonally (March–June) to feed in coastal waters off Ningaloo Reef (Wilson et al. 2006). Individuals tagged at Ningaloo Reef have been shown to migrate north, north-east or north-west into Indonesian waters, using both inshore and offshore habitats (Sleeman et al. 2010; Wilson et al. 2006).

Within Zone 2, the whale shark BIA largely follows the 125 m ancient coastline KEF.

Marine avifauna

The offshore facility is located within what is known as the East Asian–Australasian Flyway (EAA Flyway), an internationally recognised migratory bird pathway that covers the whole of Australia and its surrounding waters. 'Flyway' is the term used to describe a geographic region that supports a group of populations of migratory waterbirds throughout their annual cycle. There are 54 species of migratory shorebirds that are known to specifically follow migration paths within the EAA Flyway (Bamford et al. 2008).

There are no BIAs for marine avifauna within Zone 1. However, Zone 2 overlaps a large number of BIAs present for a number of different marine avifauna species. Shoreline habitats are generally used for resting and breeding, while adjacent offshore waters are used for foraging activities. Specifically, BIAs are located at:

- Ashmore Reef CMR
- Cartier Island CMR
- Adele Island Nature Reserve
- Lacepede Islands Nature Reserve
- Scott Reef Nature Reserve
- Rowley Shoals Marine Park
- Eighty Mile Beach CMR
- Shorelines along the Kimberley coastline, including several existing and proposed marine parks.

3.3 Socioeconomic and cultural environment

3.3.1 Traditional fishing

The Australian and Indonesian governments signed a memorandum of understanding (MoU), in 1974 (DSEWPaC 2012), which permits fishing by Indonesian and Timorese fishers, using traditional fishing methods only, in an area of Australian waters in the Timor Sea. The MoU area, which has become known as the MoU box, covers Scott Reef and surrounds, Seringapatam Reef, Browse Island, Ashmore Reef, Cartier Island and various banks and shoals. The MoU box overlaps Zone 1 and Zone 2 as shown in Figure 3-1.

Aboriginal traditional fishing occurs along the majority of the Kimberley coastline. The practice of traditional fishing includes taking turtles, dugong, fish and other marine life. The Bardi Jawi Indigenous Protected Area (IPA) is located on Dampier Peninsula and Karajarri IPA is located at the northern end of Eighty Mile Beach. Further north, other Traditional Owners include, but are not limited to, the Dambimangari people, situated in the Buccaneer Archipelago and the Traditional Owners of the Uunguu Native Title claim, which includes the islands and waters of the Bonaparte Archipelago.

3.3.2 Recreational fishing

A wide range of recreational activities occurs within the NWMR and NMR. Recreational fishing activities peak in winter and are concentrated in coastal waters along the Kimberley coastlines, generally around the populations of Broome and Wyndham.

Offshore islands, coral reef systems and continental shelf waters are increasingly targeted by fishing-based charter vessels (Fletcher & Santoro 2014). Extended fishing charters are known to operate during certain times of the year to fishing spots off the WA coast, including Scott Reef (approximately 140 km from Zone 1) and the Rowley Shoals (approximately 500 km from Zone 1). Generally, there is little recreational fishing that occurs within Zone 1 because of its distance from land, lack of features of interest and the deep waters.

3.3.3 Commercial fisheries

Within Zone 1 and Zone 2, three Commonwealth-managed commercial fisheries have the potential to operate. They are the North West Slope Trawl Fishery (NWSTF), the Western Tuna and Billfish Fishery and the Western Skipjack Fishery with further details provided in Table 3-1.

Table 3-1: Commonwealth-managed commercial fisheries

Commercial fishery	Fishery summary
North West Slope Trawl Fishery	The North West Slope Trawl Fishery (NWSTF) targets scampi (*Metanephrops australiensis*, *Metanephrops boschmai* and *Metanephrops velutinus*) and deepwater prawns (pink prawn, red prawn, striped prawn, scarlet prawn, red carid and white carid prawn). The NWSTF is a deepwater (>200 m) fishery which coincides with a small section of Zone 1 (from approximately Browse Island to the Ichthys Field). The NWSTF is the only active fishery in the region and fishes at low levels with only negligible trawl fishing occurring in the Ichthys Field between 2002 and 2009 (AFMA 2012).
Western Tuna and Billfish	The Western Tuna and Billfish Fishery targets bigeye tuna

Commercial fishery	Fishery summary
Fishery	(*Thunnus obesus*), yellowfin tuna (*Thunnus albacares*), broadbill swordfish (*Xiphias gladius*) and striped marlin (*Tetrapturus audax*). The fishery targets areas of reef which are present within Zone 2. In 2013, there were 95 boats with statutory fishing rights (AFMA 2015a).
Western Skipjack Fishery	The Western Skipjack Fishery targets skipjack tuna (*Katsuwonus pelamis*) and overlaps Zone 2. The fishery employs purse seine, pole and line, and longline methods as the main fishing techniques (AFMA 2015b). Although permits are in place, no Australian fishing boats have been active since 2009.

There are five state-managed commercial fisheries with the potential to operate in Zone 1 and Zone 2. They are the Kimberley Prawn Managed Fishery (KPMF), Northern Demersal Scalefish Fishery (NDSF), the Mackerel Managed Fishery, the North Coast Shark Fishery and the Pearling Oyster Managed Fishery with further details provided in Table 3-2.

Table 3-2: State-managed commercial fisheries

Commercial fishery	Fishery summary
Kimberley Prawn Managed Fishery	The Kimberley Prawn Managed Fishery (KPMF) predominantly targets banana prawns (*Penaeus merguiensis*) but also catches tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus endeavouri*) and western king prawns (*Penaeus latisulcatus*). The fishery operates off the north of the state, between Koolan Island and Cape Londonderry, i.e. potentially in Zone 2. Reported fishing effort is low, with the lowest recorded catch of 145 tonnes of banana prawns in 2011 (Fletcher & Santoro 2014).
Northern Demersal Scalefish Fishery	The Northern Demersal Scalefish Fishery (NDSF) is primarily a trap-based fishery which targets red emperor and goldband snapper. The fishery operates off the north-west coast of Western Australia in the waters east of 120°E longitude and overlaps Zone 2. During 2013, eight vessels collectively held and operated the effort individually assigned to the 11 licences. NDSF catches over the past 6 years have all been in excess of 1000 tonnes and represent the highest recorded catches since the inception of the fishery in 1998 (Fletcher & Santoro 2014).
Mackerel Managed Fishery	The Mackerel Managed Fishery in Western Australia targets Spanish mackerel in coastal areas around reefs, shoals and headlands, potentially including some locations within Zone 2. There are currently 50 licences in the fishery, with 15 located in the Kimberley area where the majority of the catch is taken (Fletcher & Santoro 2014).

Commercial fishery	Fishery summary
North Coast Shark Fishery	The northern shark fisheries comprise the state-managed WA North Coast Shark Fishery in the Pilbara and western Kimberley, and the Joint Authority Northern Shark Fishery in the eastern Kimberley (DoF 2012). Target species of the northern shark fisheries include the sandbar, hammerhead, blacktip and lemon sharks (DoF 2012). Fishing within the Joint Authority Northern Shark Fishery has been minimal, with only two vessels operating on an opportunistic basis from 2005 to 2009 (WA Fisheries pers comm. 2009). There was no reported fishing activity in the northern shark fisheries during 2009–2010 or 2010–2011 (DoF 2012).
Pearling Oyster Managed Fishery	The fishery is made up of four zones of which zones 1 to 3 (North Cape (Exmouth) to Sandy Point (west of Truscott) overlap with Zone 2 for this EP. The main fishing grounds are off Eighty Mile Beach, with smaller catches being taken around the Lacepede Islands (Fletcher & Santoro 2014). The fishery is deemed sustainable with fishing effort commencing in January and extending for a period of approximately 7 months. The catch for 2014 was reported by DoFWA to be 6 276 634 oysters representing 89% of the total allowable catch (Fletcher & Santoro 2015).

3.3.4 Shipping

Based on historical Australian Maritime Safety Authority (AMSA) data, 128 ships per year pass within 20 nm of Zone 1 (approximately 2 to 3 vessels per week).

The closest ports to Zone 1 are Derby, Broome and Wyndham. These are small ports, exporting nickel, lead, zinc and cattle, and importing products to support their local communities. The Port of Broome provides supply facilities for the petroleum industry operating in the Browse Basin.

3.3.5 Oil & gas industry

There are currently no active oil and gas production facilities in operation in proximity to WA-50-L; however, the Browse Basin is subject to considerable exploration activity. The closest operational production facilities to the Zone 1 (within the EMBA) are those associated with PTTEP Australia’s Montara project located in the Vulcan sub-basin approximately 130 km from the closest point of Zone 1.

Shell is in the process of constructing a floating liquefied natural gas (FLNG) facility for its Prelude and Concerto gas fields; this will be located approximately 17 km from the Ichthys facility, to the north-east of Zone 1 within the Browse Basin.

3.4 Summary of particular values and sensitivities

A summary of the particular values and sensitivities potentially occurring in both Zone 1 and Zone 2 is described in Table 3-3 and Table 3-4.

Table 3-3: Particular values and sensitivities potentially within Zone 1

<table>
<tr><th colspan="2">Value and sensitivity</th><th>Description</th></tr>
<tr><td colspan="2">Receptors that are considered socially important as identified during stakeholder engagement (including social and cultural heritage)</td><td>Fisheries (traditional and commercial).</td></tr>
<tr><td colspan="2">Benthic primary producer habitat, defined by the Western Australian Environmental Protection Authority (WA EPA) Environmental Assessment Guideline No. 3 Environmental Assessment Guidelines for Protection of Benthic Primary Producer Habitat in Western Australia's Marine Environment as functional ecological communities that inhabit the seabed within which algae (e.g. macroalgae, turf and benthic microalgae), seagrass, mangroves, corals, or mixtures of these groups, are prominent components.</td><td>None identified within this area.</td></tr>
<tr><td colspan="2">Regionally important areas of high diversity (such as shoals and banks).</td><td>None identified within this area.</td></tr>
<tr><td colspan="2">World heritage values of a declared World Heritage property within the meaning of the EPBC Act.</td><td>None identified within this area.</td></tr>
<tr><td colspan="2">National heritage values of a National Heritage place within the meaning of the EPBC Act.</td><td>None identified within this area.</td></tr>
<tr><td colspan="2">Ecological character of a declared Ramsar wetland within the meaning of the EPBC Act.</td><td>None identified within this area.</td></tr>
<tr><td colspan="2">Presence of a listed threatened species or listed threatened ecological community within the meaning of the EPBC Act.</td><td rowspan="2">A number of threatened species or migratory species have been identified as having the potential to transit Zone 1.
These have been categorised as marine fauna:
• marine mammals
• marine turtles
• fish and sharks
• marine avifauna.</td></tr>
<tr><td colspan="2">Presence of a listed migratory species within the meaning of the EPBC Act.</td></tr>
<tr><td rowspan="2">Any values and sensitivities that exist in, or in relation to, part or all of:</td><td>a Commonwealth marine area within the meaning of the EPBC Act.</td><td>Productivity and diversity associated with planktonic communities and benthic communities.</td></tr>
<tr><td>Commonwealth land within the meaning of the EPBC Act.</td><td>None identified within this area.</td></tr>
<tr><td colspan="2">BIAs associated with EPBC-listed species.</td><td>There are no known BIAs associated with listed threatened species or migratory species within Zone 1.</td></tr>
</table>

Table 3-4: Particular values and sensitivities potentially within Zone 2

Value and sensitivity	Description
Receptors that are considered socially important as identified during stakeholder engagement (including social and cultural heritage).	Fisheries (commercial, traditional and recreational).
Benthic primary producer habitats, defined by the WA EPA Environmental Assessment Guideline No. 3 as functional ecological communities that inhabit the seabed within which algae (e.g. macroalgae, turf and benthic microalgae), seagrass, mangroves, corals, or mixtures of these groups, are prominent components.	Benthic primary producer habitats are described in Section 3.2.1 and include the Commonwealth and state marine reserves and KEFs listed below.
Regionally important areas of high diversity (such as shoals and banks).	KEFs: • Ancient coastline at 125 m depth contour. • Carbonate bank and terrace system of the Sahul Shelf. • Continental slope demersal fish community. • Ashmore Reef and Cartier Island and surrounding Commonwealth waters. • Seringapatam Reef and Commonwealth waters in the Scott Reef complex. • Pinnacles of the Bonaparte Basin • Canyons linking the Argo Abyssal Plain with Scott Plateau • Glomar Shoals • Mermaid Reef and Commonwealth waters surrounding Rowley Shoals Benthic habitats: • Seagrasses (Ashmore Reef and within the dugong BIA foraging area north of Broome). • Various shoals and banks. • Various coral reefs. Shoreline habitats: • Islands, mangroves and sandy beaches.
World heritage values of a declared World Heritage property within the meaning of the EPBC Act.	None identified within this area.
National heritage values of a National Heritage place within the meaning of the EPBC Act.	The West Kimberley identified as a natural National Heritage Place. Ashmore Reef, Scott Reef and Mermaid Reef were listed as Commonwealth Heritage Places.
Ecological character of a declared Ramsar wetland within the meaning of the EPBC Act.	Ashmore Reef Commonwealth Marine Reserve – a designated Ramsar wetland.

<table>
<tr><th colspan="2">Value and sensitivity</th><th>Description</th></tr>
<tr><td colspan="2">Presence of a listed threatened species or listed threatened ecological community within the meaning of the EPBC Act.</td><td rowspan="2">A number of threatened species and/or migratory species have been identified as having the potential to transit the area.
These have been categorised as marine fauna:
marine mammals
marine turtles
fishes and sharks
marine avifauna.</td></tr>
<tr><td colspan="2">Presence of a listed migratory species within the meaning of the EPBC Act.</td></tr>
<tr><td rowspan="2">Any values and sensitivities that exist in, or in relation to, part or all of:</td><td>a Commonwealth marine area within the meaning of the EPBC Act.</td><td>Productivity and diversity associated with:
planktonic communities
benthic communities.</td></tr>
<tr><td>Commonwealth land within the meaning of the EPBC Act.</td><td>Commonwealth land identified. However, this is not a marine sensitivity and not discussed further.</td></tr>
<tr><td colspan="2">BIAs associated with EPBC-listed species.</td><td>A large number of BIAs are present within Zone 2. They are mainly associated with coastlines and the adjacent shallow waters, and include:
Marine mammals:
humpback whale migration route and breeding/resting areas
pygmy blue whale migration route; breeding, calving and foraging areas
coastal dolphins calving and foraging areas
dugong foraging areas.
Marine turtles:
nesting, internesting and adjacent foraging areas, including Browse Island, Ashmore Reef, Cartier Island, Lacepede Islands, Cassini Island and Sandy Islet (Scott Reef).
Fishes and sharks:
a whale shark foraging area
nearshore BIAs for green, dwarf and largetooth sawfish foraging
KEFs associated with increased species diversity and abundance (i.e. continental slope demersal fish communities, the ancient coastline at 125 m contour).
Marine avifauna:
a number of resting and breeding areas associated with shoreline habitats (the Ashmore Reef National Nature Reserve, Browse Island, Sandy Islet (Scott Reef) and Cartier Island)
a large number of offshore foraging areas that are adjacent to these shoreline habitats.</td></tr>
</table>

4 STAKEHOLDER CONSULTATION

INPEX has been a member of the Australian business community since 1986 and, during this time, has engaged with stakeholders on a regular basis for a broad range of activities. In addition to the Ichthys Project webpage (http://www.inpex.com.au) that provides project information, INPEX also participates in industry forums, conferences and community meetings in order to facilitate opportunities for meaningful engagement.

In 2013, when construction environment plans were being prepared, INPEX commenced an annual engagement campaign, designed to provide up-to-date information to relevant stakeholders for various activities. The intent of the annual engagement was to reduce stakeholder fatigue while still providing an avenue for engagement on an ongoing basis.

The first round of engagement in 2013 provided an overview of proposed construction activities from 2013 to 2016 including development drilling, gas export pipeline construction, installation of the umbilicals risers and flowlines and precommissioning, commissioning and start-up of the facility. This round of engagement made reference to the FPSO and CPF for context but only limited information was available at the time. More detailed information on the Offshore facility and its operation was provided from 2014 onwards.

This section provides a description of the consultation process undertaken in subsequent years during the development of the EP. The engagement was carried out in accordance with a corporate process and involved the following:

- stakeholder identification and classification
- stakeholder engagement
- stakeholder monitoring and reporting
- stakeholder grievance management.

4.1 Stakeholder identification and classification

A workshop with key INPEX personnel was conducted to outline the requirement for engagement, establish the context of the proposed activities, and identify stakeholders in accordance with Regulation 11A(1) of the OPPGS (E) Regulations 2009 and NOPSEMA's additional clarifications of Regulation 11A(1) as provided in Issues Paper IP1411 (NOPSEMA 2014).

4.2 Stakeholder engagement

In order to facilitate the engagement process, INPEX prepared consultation fact sheets (in 2013, 2014 2015 and 2016) which described the following:

- description of activities
- the Ichthys Project schedule
- operating process overview
- logistics support
- field management (including what is now described as Zone 1)
- regulatory requirements
- environmental sensitivities
- emissions and discharges
- environmental management

- enquiries and feedback information.

The fact sheets were produced in both electronic and printed formats to enable all modes of engagement.

4.3 Stakeholder monitoring and reporting

All queries and feedback were recorded and forwarded for follow-up, where applicable. All responses provided to stakeholders were appropriate to the nature of their communication, e.g. technical queries were investigated by area experts and responses were provided.

4.4 Stakeholder complaints and grievance management

Any queries received in response to the proposed activities were treated as issues and dealt with in the course of developing the EP and associated oil pollution emergency plan (OPEP). Any complaints raised in relation to the conduct of engagement would have been treated as grievances and managed in accordance with the INPEX Community Grievance Management Procedure. However, no grievances were recorded during the engagement process.

4.5 Consultation summary

A summary of relevant stakeholders, and any concerns of merit they identified during the consultation process, is provided in Table 4-1. A summary of the relevant matters raised by those stakeholders and their feedback is provided in Table 4-2.

Table 4-1: Stakeholder engagement summary

Stakeholder	Relevant matter raised
Commonwealth Government departments and agencies; Ministers of relevant portfolios	
Australian Maritime Safety Authority (AMSA)	Yes
Australian Fisheries Management Authority (AFMA)	Yes
Minister for Agriculture and Water Resources Parliamentary Secretary to the Minister for Agriculture (jurisdiction for Fisheries)	No
Department of Agriculture and Water Resources (DAWR) (Biosecurity)	No
Department of Industry, Innovation and Science (DIIS) (formerly Department of Industry)	No
National Offshore Petroleum Titles Administrator (NOPTA)	No
Minister for Resources, Energy and Northern Australia (formerly Minister for Industry)	No
Department of the Environment (DoE)	No
Minister for the Environment	No

Stakeholder	Relevant matter raised
Department of Defence (Northern Command)	No
Department of Defence (RAN Australian Hydrographic Service – AHS)	No
Australian Border Force (formerly Australian Customs and Border Protection Service (Broome, Darwin and Canberra offices)	No
Western Australian Government departments and agencies; Ministers of relevant portfolios	
Department of Environment Regulation (DER) – Hazard Management and Contaminated Sites branches	Yes
Department of Parks and Wildlife (DPaW) – Environmental Management Branch	Yes
Minister for the Environment	No
Department of Transport (WA DoT) – Marine Safety Branch	Yes
Department of Fisheries (DoFWA)	Yes
Minister for Fisheries	No
Department of Mines and Petroleum (DMP)	No
Minister for Mines and Petroleum	No
Minister for Energy	No
Shire of Broome	No
Shire of Derby / West Kimberley	No
Kimberley Ports Authority	No
National Native Title Tribunal, relevant Aboriginal and Torres Strait Islander (ATSI) land councils and prescribed bodies corporate, traditional owners and relevant land councils in areas potentially impacted by the operations activities	
National Native Title Tribunal	No
Kimberley Land Council	No
Indigenous Land Corporation	No
Bardi and Jawi Niimidiman Aboriginal Corporation (prescribed body corporate) (represents traditional owners in Dampier Peninsula and other areas)	No
Wanjina-Wunggurr (Native Title) Aboriginal Corporation	No

Stakeholder	Relevant matter raised
(represents traditional owners in Kalumburu and other areas)	
Nyamba Buru Yawuru Ltd (Yawuru Native Title Holders Aboriginal Corporation) (represents traditional owners of Broome)	No
Djarindjin Community (Dampier Peninsula)	No
Kooljaman at Cape Leveque (Dampier Peninsula)	No
Lombadina Community (Dampier Peninsula)	No
Commonwealth-managed fisheries stakeholders	
Commonwealth Fisheries Association	No
Australian Southern Bluefin Tuna Industry Association	No
Jamaclan Marine Services	No
Individual licence/permit holders in the following fisheries: • North West Slope Trawl Fishery • Western Skipjack Fishery • Western Tuna and Billfish Fishery	No
Western Australian-managed fisheries stakeholders	
Western Australian Fishing Industry Council (also represents Commonwealth-managed fisheries located offshore WA)	No
Pearl Producers Association of Western Australia	No
Individual licence/permit holders in the following fisheries: • Kimberley Prawn Managed Fishery • Mackerel Managed Fishery • Northern (North Coast) Shark Fishery • Northern Demersal Scalefish Fishery • Pearl Oyster Managed Fishery (through Pearl Producers Association)	No
Recreational fishing associations	
Recfishwest (WA)	No
Environmental, heritage and marine research groups	
Australian Conservation Foundation	No
Australian Institute of Marine Science (AIMS)	No

Stakeholder	Relevant matter raised
Centre for Whale Research (WA) Inc.	No
Commonwealth Scientific and Industrial Research Organisation	No
Conservation Council of WA	No
Western Australian Marine Science Institution	No
World Wildlife Fund for Nature	No
Oil spill response	
Australian Marine Oil Spill Centre (AMOSC)	Yes
RPS Asia-Pacific Applied Science Associates (RPS APASA)	No
Oil Spill Response Limited (OSRL)	No
Other businesses and industries (an representative bodies)	
Australia's North West Tourism	No
Broome Chamber of Commerce	No
Industry Capability Network	No
KRED Enterprises	No
Mermaid Marine Australia Limited	No

Table 4-2: Summary of relevant objections or claims associated with stakeholder consultation

Category, jurisdiction, subcategory	Stakeholder	Engagement	Feedback summary
Authority, Australia, central authority	AFMA	Engagement in 2013, 2014, 2015 and 2016 with AFMA for determinations of relevant fisheries (potentially impacted by the Project activities), updated contact details for licence holders in relevant fisheries and representative industry associations.	AFMA advised INPEX to continue engagement with identified fisheries, and that the identified fisheries remained accurate according to their records. INPEX continues to check the validity of the licence holders with AFMA and issues fact sheets on an annual basis to inform licence holders of Project updates.
Authority, Australia, central authority	AMSA	Fact sheets were sent to AMSA in addition to regular engagement from 2013 through to 2016 on a variety of topics. INPEX has sought to confirm interpretation of the requirements and compliance obligations in relation to the *Navigation Act 2012*, the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (the POTS Act) and Marine Orders applicable to the activity, including an interpretation of the transition point from the *Navigation Act 2012* to the OPGGS Act. INPEX and AMSA have agreed upon the frequency and process for auditing and reporting of compliance under the POTS Act.	AMSA acknowledged that when the CPF/FPSO transition from being a vessel to being a ‘facility’ by the definition provided in Clause 4 of Schedule 3 to the OPGGS Act is once they are connected to the seabed. AMSA suggested that INPEX should not immediately surrender *Navigation Act 2012* certification until INPEX is satisfied that each component of the facility is moored in a manner to be structurally secured at its location. Furthermore, AMSA stated that, any environmental conditions/ emergencies causing either the CPF or FPSO to disconnect during the mooring installation phase would mean that the *Navigation Act 2012* would be reapplied. MARPOL 73/78, Annex I (Oil pollution prevention) is applicable to the CPF and FPSO. The CPF and FPSO will each have a full-term (five-year) certificate issued before sail-away. Ongoing compliance will be measured by a third-party classification society recognised as per Marine Order 01, including annual surveys and recertification to provide evidence of compliance with the POTS Act. MARPOL 73/78, Annex IV (Sewage pollution prevention) AMSA acknowledged that once the CPF and FPSO are attached to the seabed, they are no longer on an international voyage and thus the provisions are not

Category, jurisdiction, subcategory	Stakeholder	Engagement	Feedback summary
			applicable. (Note: a short-term certificate of compliance will be issued for the tow phase from South Korea). MARPOL 73/78, Annex V (Garbage pollution prevention) does not require a formal certificate to be issued; however, a statement of compliance will be issued for the FPSO and CPF. Ongoing compliance will be measured by a third-party classification society recognised as per Marine Order 01. MARPOL 73/78, Annex VI (Air pollution prevention). The CPF and FPSO will each have a full-term (five-year) International Air Pollution Prevention (IAPP) certificate. Ongoing compliance will be measured by a third-party classification society recognised as per Marine Order 01.
	AMSA	INPEX and AMSA developed a memorandum of understanding in 2013. INPEX has participated in industry forums and events coordinated by AMSA since this time.	INPEX provides AMSA with a copy of all NOPSEMA accepted OPEPs. Relevant text from the MoU is included within the OPEP.
Authority, Western Australia, state/local authority	DoFWA	Engagement in 2013, 2014, 2015 and 2016 requesting determination of relevant fisheries with respect to the petroleum activity, offering to consult DoFWA at its discretion.	DoFWA advised INPEX to continue engagement with identified fisheries and representative bodies (WAFIC, Recfishwest, PPA), and that the identified fisheries remained accurate according to their records. INPEX continues to check the validity of the licence holders with DoFWA and issues fact sheets on an annual basis to inform licence holders of Project updates.

Category, jurisdiction, subcategory	Stakeholder	Engagement	Feedback summary
Authority, Western Australia, state/local authority	DER: Hazard Management Branch Contaminated Sites Branch	Emails in 2014, 2015 and 2016 to DER Pollution Reporting Line and Contaminated Sites contacts regarding spill notifications (OPEP emergency contacts list).	DER requested that, should there be an oil spill with the potential to impact upon Browse Island in WA state waters, INPEX should notify DER about the oil spill as soon as possible, as per Section 72 of the *Environmental Protection Act 1986* (WA). Notification can be made to DER at any time, all-year round, via the Pollution Reporting Line Tel: 1300 784 782.
			In DER's response to the 2016 fact sheet, information was sought from INPEX (and provided) regarding the types of firefighting foam to be used on the offshore facility (FPSO and CPF). DER stated in the correspondence that provision of the information was not a direction or regulatory requirement. In addition, the firefighting foams will not be used on land or within state waters and are, therefore, outside of the scope of the petroleum activity, as defined in this EP.
Authority, Western Australia, state/local authority	NOPSEMA	In 2013, INPEX sought clarification from NOPSEMA on the transition point from the *Navigation Act 2012* to the OPGGS Act.	NOPSEMA indicated that, given the type of situation described (i.e. the arrival of the CPF and FPSO in Zone 1 at completion of their voyage from the fabrication yard), it is likely that NOPSEMA would consider the transition point for the vessel (CPF/FPSO) becoming a 'facility', under the definition provided in Clause 4 of Schedule 3 to the OPGGS Act, as the point at which the vessel is connected to the seabed (i.e. once the facility's first mooring anchor chain is in place).

Category, jurisdiction, subcategory	Stakeholder	Engagement	Feedback summary
Authority, Western Australia, state/local authority	WA DoT – Marine Safety Branch	Email of fact sheets 2014 and 2015. Briefing held in 2014.	A 2014 briefing discussed the potential for credible spill scenarios to enter WA state waters. INPEX committed to ensuring that the OPEP will be aligned with state and national response networks and that INPEX will continue to engage with WA DoT in the following ways: • INPEX will provide a copy of the final approved OPEP before the activity begins. • The OPEP will include a description of proposed Operational and Scientific Monitoring Programs to be implemented in the event of spill. • INPEX will include early notification of incidents that could potentially impact state waters (i.e. within two hours). The notification will be directed to the Oil Spill Response Coordination Unit's 24-hour reporting number (08) 9480 9924. • INPEX will notify WA DoT of any change of activity where the functions, interests and activities of WA DoT are altered from the previous consultation in relation to this EP.
		November 2015 – Meeting to discuss potential use of dispersant application zones in relation to potential impacts on state waters.	The regulatory framework for dispersant application and notification as confirmed via meetings with WA DoT/Marine Safety Branch.

Category, jurisdiction, subcategory	Stakeholder	Engagement	Feedback summary
		October 2015–April 2016 – INPEX was invited to attend industry workshops to discuss revision of the WestPlan MOP and associated WA DoT technical guidance note on marine response and consultation arrangements.	WA DoT indicated to industry that there is a potential change in control agency. A series of workshops were scheduled to engage with industry to discuss proposed changes and associated guidance in relation to the WestPlan MOP. INPEX attended each workshop and provided comments on the draft guidance note. A technical guidance note was issued on 1 April 2016 inclusive of interim arrangements to be implemented before 1 July 2017. The interim arrangements are reflected within the EP and the OPEP.
		April 2016 – INPEX wrote a letter to WA DoT providing updated information in relation to items specified in Annex 2 of the industry guidance note. This included: • a brief description of activities and intended schedule • worst-case spill scenarios • oil types and properties • a description of the environment and protection priorities • key inputs and outputs of the environmental risk assessment • outcomes of spill trajectory modelling • initial response actions and activation timeframes • Incident Control Centre arrangements • potential staging areas and forward operating bases	INPEX had not received a response to the letter sent 26 April 2016 at the time of submission of this EP. INPEX received a response from WA DoT on 9 September 2016, stating that the project update and consultation submitted by INPEX to WA DoT contained adequate information on risk assessment and response strategies. WA DoT requested that INPEX acknowledge that the activities will be undertaken in the transitional period as outlined in the WA DoT industry guidance note.

Category, jurisdiction, subcategory	Stakeholder	Engagement	Feedback summary
		• response strategies • proposed IMT structure • exercise and testing arrangements of spill response plans.	
Authority, Western Australia, state/local authority	DPaW	Fact sheet and emails in 2013 and 2014. Feb - March 2015 – Phone call and follow-up emails. May- August 2015 – Briefing provided on INPEX activities and follow-up emails with minutes of briefing March 2016- provided fact sheet and clarified names of reserves.	DPaW confirmed they have an interest in petroleum industry activities or facilities, including any potential oil spill trajectories or significant emissions e.g. of noise or light, that are likely to affect DPaW managed lands or waters, or areas documented or likely to be important for conservation significant wildlife. INPEX provided further information to DPaW in relation to light emissions and seabirds in the Browse area. INPEX and DPaW discussed the possibility of including metadata within the Industry–Government Environmental Metadata (I-GEM) project, where possible. DPaW advised that INPEX would require a permit (from DPaW) to haze birds or conduct pre-emptive capture. DPaW advised they do not issue these permits prior to an incident. DPaW advised INPEX to consider the risk of oiled wildlife occurring on Browse Island be considered higher than the risk of surface or entrained oil reaching the island because birds affected closer to a spill may fly back to, and seek refuge, on the island. INPEX has considered this risk. The OPEP includes various observation techniques (i.e. vessel or aerial) to assess the extent and location of a spill to inform the response strategy. INPEX has also considered the resources that may be required to perform a pre-wildlife and post-wildlife response.

Category, jurisdiction, subcategory	Stakeholder	Engagement	Feedback summary
			In addition, DPaW confirmed that it may support a wildlife response but that INPEX should maintain its own independent capacity to respond. INPEX describes its resources and capability to implement a wildlife response within Section 4 of the OPEP.
Oil spill response	AMOSC	Fact sheets sent 2014, and 2015 and 2016.	Receipt of fact sheets was acknowledged.
		January 2016 – Draft OPEP (Rev 0) sent for review. The comments received were included within the OPEP.	AMOSC requested INPEX to include information pertaining to the AMOSC service contract and the authorisation process within the OPEP for the IMT. AMOSC clarified its ability to make aviation assets available and advised INPEX to confirm availability of search and rescue aircraft with AMSA. AMOSC suggested that it should be made clearer that the example IAP template is just the ‘structure’ and that it is a dynamic template that will be able to grow as required. AMOSC sent a letter advising that the OPEP accurately describes the interface between INPEX and AMOSC. AMOSC confirmed equipment and resources described in the plan can be made available.
		March 2016 – INPEX requested advice from AMOSC in relation to limitations and timeliness of mobilising fixed-wing aerial dispersant resources within 24 hours. INPEX also sought advice on the likely rate at which dispersant may reasonably be applied from a vessel during a response.	AMOSC and INPEX determined that use of fixed-wing aerial dispersant was not an achievable first strike response option (i.e. within 24 hours) given the remote location of Zone 1 and the location of the fixed-wing assets. AMOSC provided some guidance based on vessel application rates that were achieved during the Montara spill. This advice assisted INPEX to develop a dispersant

Category, jurisdiction, subcategory	Stakeholder	Engagement	Feedback summary
			response strategy.
		May 2016 – A draft of the revised OPEP (Rev 1) was sent for comment.	Comments provided and incorporated. AMOSC sent a letter advising that the OPEP accurately describes the interface between INPEX and AMOSC. AMOSC confirmed equipment and resources described in the plan can be made available.
		Sept–Oct 2016 – A draft of the revised OPEP was sent to AMOSC for comment.	The revised OPEP included updates to the plan that were made in order to address NOPSEMA comments (provided in the opportunity to modify and resubmit letter, dated 26 August 2016). The revision included new information on the arrangements and capability of INPEX (and AMOSC) to mobilise oil spill equipment from mainland stockpiles in the event that available response equipment could be an appropriate response strategy. AMOSC sent a letter advising that the OPEP accurately describes the interface between INPEX and AMOSC.

4.6 Ongoing stakeholder consultation

Regulation 14(9) of the OPGGS (E) Regulations 2009 specifies a requirement for consultation with relevant authorities of the Commonwealth, states or territories, and other relevant interested persons or organisations. The mechanisms to provide ongoing opportunities for consultation in relation to the EP's implementation are summarised in Table 4-3.

Table 4-3: Ongoing stakeholder consultation

Stakeholder	Information supply	Frequency
AMSA	Project updates. INPEX will attend MoU forums with AMSA representatives.	Annually
AFMA	AFMA will be advised of any engagement with Commonwealth-managed fisheries' stakeholders, highlighting the issues raised.	As required
DoFWA	DoFWA will be advised of any engagement with WA-managed fisheries' stakeholders, highlighting the issues raised.	As required
DMP	DMP will be notified of the start and cessation of any offshore activities (to a nominated email address).	As required
All nominated industry associations of relevant Commonwealth-managed and WA-managed fisheries: • Commonwealth Fisheries Association (CFA) • Australian Southern Bluefin Tuna Industry Association (ASBTIA) • Jamaclan Marine Services • Western Australian Fishing Industry Council (WAFIC) • Pearl Producers Association of Western Australia (PPA).	These bodies will be advised of any engagement with individual operators in a fishery for which they have jurisdiction (that has been deemed relevant by the corresponding authority), highlighting any issues that are raised.	As required
Commonwealth Government: • Parliamentary Secretary to the Minister for Agriculture (jurisdiction for Fisheries) • Department of Agriculture and Water Resources (DAWR) (Biosecurity) • Department of Industry, Innovation and Science (DIIS) • National Offshore Petroleum Titles	Project updates.	Annually (stakeholder relevance reviewed at same date)

Stakeholder	Information supply	Frequency
Administrator (NOPTA) • Minister for Industry • Department of the Environment (DoE) • Minister for the Environment • Department of Defence (Northern Command) • Australian Customs and Border Protection Service (Broome Office) WA Government: • DER – Hazard Management and Contaminated Sites branches • DPaW – Environment Management Branch • Minister for the Environment • DoT WA – Marine Safety Branch • Minister for Fisheries • Department of Mines and Petroleum (DMP) • Minister for Mines and Petroleum • Minister for Energy. WA local government authorities: • Kimberley Ports Authority • Shire of Broome • Shire of Derby / West Kimberley Aboriginal and Torres Strait Islander (ATSI) bodies corporate and communities: • National Native Title Tribunal • Kimberley Land Council • Bardi and Jawi Niimidiman Aboriginal Corporation (prescribed body corporate) • Wanjina-Wunggurr (Native Title) Aboriginal Corporation • Nyamba Buru Yawuru Ltd (Yawuru Native Title Holders Aboriginal Corporation) • Djarindjin Community (Dampier Peninsula) • Kooljaman at Cape Leveque (Dampier Peninsula) • Lombadina Community (Dampier Peninsula). Individual licence/permit holders in relevant Commonwealth-managed fisheries: • North West Slope Trawl Fishery • Western Skipjack Fishery • Western Tuna and Billfish Fisheries. Individual licence/permit holders in relevant WA-managed fisheries: • Kimberley Prawn Managed Fishery • Mackerel Managed Fishery • Northern (North Coast) Shark Fishery • Northern Demersal Scalefish Fishery • Pearl Oyster Managed Fishery (through Pearl Producers Association).		

Stakeholder	Information supply	Frequency
Recreational fishing associations: • Recfishwest (WA). Environmental NGOs and research bodies: • Centre for Whale Research (WA) Inc. • Australian Conservation Foundation • World Wildlife Fund for Nature • Conservation Council of WA. Oil Spill Response: • Australian Marine Oil Spill Centre • Asia-Pacific Applied Science Associates (APASA) • Oil Spill Response Limited. Other businesses: • Mermaid Marine Australia Limited.		

5 ENVIRONMENTAL IMPACTS AND RISKS

In accordance with Division 2.3, Regulation 13(5) of the OPGGS (E) Regulations 2009, an environmental risk assessment was undertaken to evaluate impacts and risks arising from the petroleum activity.

Environmental hazard identification workshops were undertaken for the EP, chaired by independent facilitators. The workshops involved numerous environmental, health, safety, project, and emergency response personnel, pipeline integrity engineers, subsea engineers and marine advisers. The workshops were undertaken in accordance with INPEX risk management processes. The approach generally aligns with the processes outlined in Standards Australia and Standards New Zealand AS/NZS ISO 31000:2009, *Risk management—Principles and guidelines* and the AS/NZS handbook HB 203:2012 *Managing environment-related risk*.

The environmental impact and risk evaluation process was undertaken in nine distinct stages:

1. the establishment of context
2. the identification of aspects, hazards and threats (and evaluation of interaction to determine an impact pathway)
3. the identification of potential consequences (severity)
4. the identification of existing design safeguards and control measures
5. the proposed additional safeguards (ALARP evaluation)
6. an assessment of the likelihood
7. an assessment of the residual risk
8. an assessment of the acceptability of the residual risk
9. the definition of environmental performance outcomes, standards and measurement criteria.

The impact and risk evaluations were based on the INPEX risk matrix. A modified version of the matrix adapted for Environment, and Cultural & Social Heritage is provided in Figure 5-1.

Risk Matrix

			LIKELIHOOD TABLE						
			Frequency Continuous Operation	Once every 10 000 – 100 000 years at location	Once every 1,000 – 10 000 years at location	Once every 100 - 1000 years at location	Once every 10 - 100 years at location	Once every 1 - 10 years at location	More than once a year at location or continuously
CONSEQUENCE TABLE									
CONSEQUENCES			Severity	Likelihood Level					
Severity Level	Environment	Cultural & Social Heritage		6 Remote	5 Highly Unlikely	4 Unlikely	3 Possible	2 Likely	1 Highly Likely
A	Regional scale event, permanent impact on environment. Eradication of local populations of protected species	Permanent, long-term impact on social structure, and destruction of highly-valued heritage, aesthetic, economic or recreational items	A Catastrophic	6	5	4 Critical Risk	3	2	1
B	Large scale event, long term impact on environment. Extensive impact on populations of protected species	Widespread disruption to a number of communities with damage to highly-valued heritage, aesthetic, economic or recreational items	B Major	7	6	5	4	3	2
C	Medium to large scale event, medium term impact on environment. No threat to overall population viability of protected species	Significant impact to regional communities, and to heritage, economic or recreational items of significant value	C Significant	8	7	6 High Risk	5	4	3
D	Local to medium scale event with short to medium term impact on environment. No threat to overall population viability of protected species	Regional community disruption with moderate impact on heritage, aesthetic, economic or recreational values	D Moderate	9	8	7	6	5	4
E	Local scale event with short term impact on the environment. Minor and temporary impact on a small portion of the population of protected species	Isolated community disruption with limited adverse impact on heritage, aesthetic, economic or recreational values	E Minor	10	9	8 Moderate Risk	7	6	5
F	Local scale event with temporary impact on environment. Behavioural responses inconsequential ecological significance to protected species	Minor impact on heritage, aesthetic, economic or recreational values	F Insignificant	10	10	9 Low Risk	8	7	6

Figure 5-1: Adapted INPEX Risk Matrix

The first stage in the process involved defining the activity, characterising the environment and identifying the particular values and sensitivities of that environment. An assessment was then undertaken to identify the aspects associated with the petroleum activity. The aspects identified for the petroleum activity were as follows:

- emissions and discharges
- waste management
- noise and vibration
- loss of containment
- biodiversity and conservation protection
- land disturbance (or seabed disturbance)
- social and cultural heritage protection.

Hazards and threats were then identified using the following definition:

"A physical situation with the potential to cause harm to people, damage to property, damage to the environment".

Therefore, for an environmental risk or impact to be realised, there needs to be a pathway to expose an environmental value or sensitivity to a hazard. If there is no credible potential for exposure, there is no risk of harm or damage. Subsequently, there is no potential for impact (or consequence).

Given the various receptors present in the environment, they have been refined to environmentally sensitive or biologically important receptors (values and sensitivities). They have been selected using regulations, government guidance and stakeholder feedback.

For the purposes of the evaluation, environmental values and sensitivities to be considered include the following:

- receptors that are considered socially important as identified during stakeholder engagement (including social and cultural heritage)
- benthic primary producer habitat, defined by the Western Australian Environmental Protection Authority (WA EPA) Environmental Assessment Guideline No. 3 Environmental Assessment Guidelines for Protection of Benthic Primary Producer Habitat in Western Australia's Marine Environment as functional ecological communities that inhabit the seabed within which algae (e.g. macroalgae, turf and benthic microalgae), seagrass, mangroves, corals, or mixtures of these groups, are prominent components
- regionally important areas of high diversity (such as shoals and banks)
- particular values and sensitivities as defined by Regulation 13(3) of the OPGGS (E) Regulations 2009:
  - the world heritage values of a declared World Heritage property within the meaning of the EPBC Act
  - the national heritage values of a National Heritage place within the meaning of the EPBC Act
  - the ecological character of a declared Ramsar wetland within the meaning of the EPBC Act
  - the presence of a listed threatened species or listed threatened ecological community within the meaning of the EPBC Act

  - the presence of a listed migratory species within the meaning of the EPBC Act
  - any values and sensitivities that exist in, or in relation to, part or all of:
    - a Commonwealth marine area within the meaning of the EPBC Act – note that this value and sensitivity includes receptors (e.g. planktonic and benthic communities) that, when exposed, have the potential to affect regionally significant ecological diversity and productivity from benthic and planktonic communities
    - Commonwealth land within the meaning of the EPBC Act.
- biologically important areas associated with EPBC-listed species.

An evaluation of the hazards and threats associated with aspects of the activity that interact with the environment was undertaken and where the evaluation determined credible exposure of a "value and sensitivity", that aspect has been further assessed. The outcome of the exposure evaluation is presented in Table 5-1.

Table 5-1: Environmental exposure evaluation summary

Hazards (grouped by aspects and activities)	Potential to result in environmental impact and risk?
Mooring, hook-up and commissioning (before the introduction of reservoir hydrocarbons)	
All aspects	
Potential aspects identified to interact with the environment during the mooring and hook-up and commissioning stage, such as emissions and discharges, waste management, loss of containment, physical presence of vessels, and biodiversity and conservation protection, will be the same as those identified during Facility Operations, as the facility is located in the same area. Hazards related to the hook-up and commissioning stage are included within the risk assessments and are not assessed separately.	See below as for Facility Operations post-introduction of reservoir hydrocarbon.
Facility Operations (post-introduction of reservoir hydrocarbon – start-up and normal operations)	
Emissions and discharges	
Atmospheric emissions from power generation, flaring, venting and other offshore emission sources.	Yes
Light emissions from flaring	Yes
Light emissions from navigational lights on the facility and vessels	Yes
Routine discharges – subsea discharges during operations	Yes
Routine discharges – produced water	Yes
Routine discharges – seawater used for cooling	Yes
Routine discharges – ballast water (exposure based on residual	Yes

sodium hypochlorite (NaClO) as per seawater used for cooling)	
Routine discharges – seawater used in gas scrubbing	Yes
Routine discharges – sewage effluent, grey water and food wastes	Yes
Routine discharges – open drains and bilge discharges	Yes
Routine discharges – foam fire extinguishing (assessed with open drains discharge)	Yes
Routine discharges – brine from fresh / potable water systems	Yes
Waste management	
Inappropriate waste handling and disposal	Yes
Noise and vibration	
Operation of the facility and subsea infrastructure	No – A study into FPSO underwater noise emissions determined fifth percentile levels to be in the order of 188 dB re 1 µPa at 1 m (Erbe et al. 2013). Noise exposure with the potential to result in a permanent threshold shift (PTS) or temporary threshold shift (TTS) is not expected. This is because widely accepted noise impact thresholds, proposed by Southall et al. (2007) for cetaceans, suggest the onset of TTS at sound pressure levels of 224 dB re 1 µPa or sound exposure levels of 183 dB re 1 $\mu Pa^2 \cdot s$ and the onset of PTS at sound pressure levels of 230 dB re 1 µPa or sound exposure levels of 198 dB re 1 $\mu Pa^2 \cdot s$. As such, a change in ambient underwater noise levels is not expected to be significant enough to result in either PTS or TTS in marine fauna.
Loss of containment	
Loss of containment – accidental release overboard	Yes
Subsea condensate release due to integrity failure of the subsea production system	Yes

Biodiversity and conservation protection	
Introduction of IMP from high-risk ballast water and/or biofouling	Yes
IMR activities	
Emissions and discharges	
Subsea discharges during IMR activities	Yes
Discharge of filtered inhibited seawater during IMR activities	Yes
Seabed (land) disturbance	
Seabed intervention activities	Yes
Waste management	
Inappropriate waste handling and disposal from vessel activities	Yes
Noise and vibration	
Acoustic surveys during inspection of subsea infrastructure	No – Sidescan sonar and multibeam echo sounders are high-frequency, low-energy geophysical survey instruments, which are understood to be significantly less intrusive than high-energy seismic survey instruments. Source levels produced by these instruments typically range from 195–235 dB re 1 µPa at 1 m at dominant frequencies of 50 kHz–700 kHz (Department of the Environment, Heritage and Local Government, Ireland 2007; CSA International, Inc. 2013; Zykov 2013). The high operating frequencies of sidescan and multibeam instruments place the dominant sound frequencies above the auditory range of most marine fauna species, including turtles and fish; therefore, no impacts to these species groups are expected (Popper et al. 2014).
Vessel activities	
Emissions and discharges	
Atmospheric emissions from vessels	Yes

Change in light levels from vessels	Yes
Routine discharges of cooling water from vessels	Yes
Routine discharges of sewage effluent, grey water and food waste from vessels	Yes
Routine discharge of oily water (deck drainage, bilge and fire foam) from vessels	Yes
Routine discharges of desalination brine from vessels	Yes
Waste management	
Inappropriate waste handling and disposal from vessel activities	Yes
Noise and Vibration	
Vessel operation (engines)	No – Vessel engines and dynamic positioning (DP) thrusters are capable of generating sound at levels between 108 and 182 dB re 1 µPa at 1 m at dominant frequencies between 50 Hz and 7 kHz (Simmonds et al. 2004; McCauley 1998). Noise exposure with the potential to result in a PTS or TTS is not expected. This is because widely accepted noise impact thresholds proposed by Southall et al. (2007) for cetaceans suggest the onset of TTS at sound pressure levels of 224 dB re 1 µPa or sound exposure levels of 183 dB re 1 $µPa^2$·s, and the onset of PTS at sound pressure levels of 230 dB re 1 µPa or sound exposure levels of 198 dB re 1 $µPa^2$·s. A range of behavioural changes can occur in response to sound pressure levels as low as 120 dB re 1 µPa (Southall et al. 2007). Offloading tanker noise was modelled for the purpose of the Ichthys draft EIS (INPEX 2010). The model showed that the low-frequency noise generated would abate to 120 dB re 1 µPa within 8 km of the source location. The area receiving 130–140 dB re 1 µPa is very small, i.e. less than 1 km in radius.

Loss of containment	
Loss of containment – accidental release overboard	Yes
Loss of containment during a vessel collision	Yes
Biodiversity and conservation protection	
Introduction of IMP from ballast water discharge and biofouling (vessels)	Yes
Physical presence of vessels and interaction with marine fauna	Yes
Social and cultural heritage	
Physical presence of vessels resulting in disruption to other marine users	Yes
Oil spill response strategies	
Emissions and discharges	
Routine effluent discharges of sewage effluent, grey water and food waste from vessels	Yes
Vessel-based surface dispersant application	Yes
Waste management	
Shoreline clean-up	Yes
Inappropriate waste handling and disposal from vessel activities	Yes
Biodiversity and conservation protection	
Wildlife hazing	Yes
Post-contact wildlife response	Yes
Turtle nesting disturbance during shoreline responses	Yes
Quarantine during shoreline responses	Yes

For each aspect with a potential to result in impact and risk, the greatest consequence (or potential impact) of an activity, was then evaluated with no safeguards or control measures in place, thereby enabling the identification of a maximum foreseeable consequence of the scenario. Control measures associated with existing design safeguards were then identified to prevent or mitigate the threat and/or its consequence(s).

Where existing safeguards or controls were judged as inadequate to manage the identified hazards, additional safeguards or controls were proposed.

Additional engineering and management control measures were identified taking account of the principle of preferences illustrated in Figure 5-2. The options were then systematically evaluated in terms of risk reduction. Where the level of risk reduction achieved by their selection was determined to be grossly disproportionate to the “cost” of implementing the identified control measures the control measure has not been implemented, and the risk is considered ALARP. Cost may include financial cost, time or duration, effort, occupational health and safety risks, or environmental impacts associated with implementing the control.

Preference	Category	Sub-category	Description
Most Preferred	**Elimination**		Removal of the hazard or sensitive receptor
	Substitution		Replacement of highly hazardous materials / approaches with less hazardous materials / approaches
	Engineering	**Prevention**	Design measures that reduce the likelihood of a hazardous event occuring
		Detection	Design measures that facilitate early detection of a hazardous event
		Control	Design measures that limit the extent/escalation potential of a hazardous event
		Mitigation	Design measures that protect the environment should a hazardous event occur
		Response Equipment	Design measures or safeguards that enable clean-up / response following the realisation of a hazardous event
	Procedures & Administration		Management systems and work instructions used to prevent or mitigate environmental exposure to hazards
Least Preferred	**Sensitive Receptor Protection**		The lowest level in the hazard management hierarchy which should only be considered when all higher controls in the hierarchy have been exhausted e.g. physical barriers located at the sensitive receptor

Figure 5-2: ALARP options preference

The likelihood (or probability) of a consequence occurring was then determined, taking into account the control measures in place. The residual risk was then evaluated and ranked.

Potential environmental impacts and risks are only deemed acceptable once all reasonably practicable alternatives and additional measures have been taken to reduce the potential impacts and risks to ALARP. The potential environmental impacts and risks associated with implementing the activities described in the EP were determined to be acceptable if:

- the activities (and associated potential impacts and risks)
  - comply with relevant environmental legislation, industry standards/guidelines, and corporate policies, standards, and procedures specific to the operational environment,
  - take into consideration stakeholder feedback
- the level of environmental risk is assessed to be Low; or

- the level of environmental risk is assessed to be Moderate or High and the level of environmental risk is reduced to be ALARP.

A summary of the hazards and threats, identified control measures and residual risk rankings are shown in Table 5-2. To provide context further details on potential consequences from the hazards and threats are assessed in Appendix A with the corresponding reference included for each hazard and threat in Table 5-2.

Table 5-2: Summary of potential impacts and risks and associated control measures

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
Aspect – emissions and discharges				
Atmospheric emissions from power generation, flaring, venting and other offshore emission sources.	Atmospheric emissions produced from the facility and support vessels have the potential to result in localised changes in air quality and subsequent exposure of marine avifauna to air pollutants.	A1	• Energy efficiency and emissions reduction technologies on board the CPF and FPSO to be installed, functional and maintained, including: o OGR system (CPF and FPSO) o power interconnector cable between the FPSO and CPF o waste heat recovery units (FPSO) o nitrogen system (FPSO). • Marine diesel engines on board the CPF and FPSO (except diesel engines that are dedicated to the exploitation and associated offshore processing of hydrocarbons) will meet NO_X emission requirements and limits as set out by Marine Orders – Part 97, the POTS Act, and Regulation 13 of MARPOL 73/78, Annex VI (as applicable to vessel and engine size, type and class) and have an associated EIAPP Certificate and IAPP certificates. • Installation of equipment or systems on board the CPF, FPSO, ASVs and support vessels that contain ODS will be consistent with Marine Orders – Part 97, the POTS Act, and MARPOL 73/78, Annex VI, Regulation 12 (as appropriate to vessel size, type and class). • Implement a Flaring Management Plan with annual flaring targets. • In accordance with Marine Orders – Part 97, the POTS Act, the *Navigation Act 2012* and Annex VI of MARPOL 73/78 (as applicable to vessel and engine/propulsion size, type and class), the CPF, FPSO, ASVs and support vessels >400 GT will have the following certifications:	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
			o International Air Pollution Prevention (IAPP) o Engine International Air Pollution Prevention (EIAPP) for each marine diesel engine installed on board. • In accordance with Marine Orders – Part 97, the POTS Act and Regulation 14 of Annex VI of MARPOL 73/78, only low-sulfur fuel oil / marine diesel with 3.5% mass–for-mass (m/m) sulfur content will be used in vessel engines prior to 1 January 2020 (and 0.5% m/m sulfur content on and after 1 January 2020). • Waste prohibited for incineration by MARPOL 73/78, Annex VI, Regulation 16 will not be incinerated. • In accordance with Regulation 16 of MARPOL 73/78, personnel responsible for operating incinerators will have appropriate training in incinerator operation and appropriate waste for incineration. • The CPF, FPSO, ASVs and support vessels >400 GT shall maintain a list of equipment containing ODS and an ODS Record Book (or similar record) to record details of the supply, recharge, repair, maintenance, discharge, or disposal of ODS, consistent with Marine Orders – Part 97, the POTS Act and Regulation 12 of MARPOL 73/78, Annex VI (as applicable to vessel and engine size, type and class). • ODS or equipment containing ODS will be disposed of onshore at an appropriate waste reception facility when removed from ships, consistent with Marine Orders – Part 97, the POTS Act and MARPOL 73/78, Annex VI, Regulation 12 (as applicable to vessel and engine size, type and class). • ASVs and vessels >400 GT will have an International Energy Efficiency (IEE) certificate consistent with Marine Orders – Part 97, the POTS Act and MARPOL 73/78, Annex VI, Regulation 20, 21 and 22 (as applicable to vessel, engine/propulsion size, type and class).	

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
			• The ASVs and support vessels >400 GT will carry a Ship Energy Efficiency Management Plan consistent with Marine Orders – Part 97, the POTS Act and MARPOL 73/78, Annex VI, Regulation 22 (as applicable to vessel and engine/propulsion size, type and class).	
Change in light levels from flaring	Light emissions associated with flaring have the potential to expose light-sensitive marine fauna, to changes in ambient light levels that could lead to behavioural changes. Marine turtles and marine avifauna can be particularly sensitive to light emissions. Flares will be permanently lit with a limited amount of pilot gas on the CPF and FPSO, to retain the ability to release combustion and hydrocarbon gases. This is required given the potential safety implications and risks to life from the build-up of emissions that may occur during these times. During normal production, continuous operational flaring is not expected. However, there are some circumstances under which flaring is required in order to protect the integrity of the facility and to prevent harm to personnel, the environment and equipment. Three types of flaring events have been identified: • Pressure relief and emergency blowdown – to protect the integrity of the facility and prevent loss of containment. • Manual blowdown – to safely	A2	• Use of flaring abatement systems to prevent continuous intentional operational flaring. • Implement a Flaring Management Plan (FMP) with annual flaring targets.	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
	depressurise equipment prior to inspection and maintenance. • Process upset – an unplanned event, such as gas exceeding the necessary dewpoint specification for export, requiring it to be flared to protect the integrity of the GEP. Only during such events will flaring potentially result in light emissions that may be detectable at Browse Island, which is the nearest known aggregation area for marine turtles or marine avifauna.			
Change in light levels from navigational lights on the facility and vessels	Light emissions associated with facility and vessel lighting (for navigational and safe working condition requirements) have the potential to expose light-sensitive marine fauna, specifically marine turtles and seabirds and migratory birds, to changes in ambient light levels that could lead to behavioural changes. Low-intensity light spill will be generated from the offshore facility and support vessels as a consequence of providing safe illumination of work and accommodation areas. Additional lighting will be required periodically for the safe loading and unloading of support vessels and export tankers, to minimise the potential for safety and environmental hazards.	A3	• None identified	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
	Unless specifically required to support over-the-side activities (e.g. lifting or IMR activities) or for navigational purposes, lighting on the FPSO, CPF and support vessels is directed over the work area, which aids in limiting light spill to the marine environment. During IMR activities, underwater lighting may be generated over short periods of time while ROVs are in use.			
Routine discharges – subsea discharges during operations and IMR activities	Subsea discharges to the marine environment during operations and IMR activities may result in a change in ambient water quality potentially impacting transient, EPBC-listed species and benthic communities. Volumes of subsea control fluids released during operations are expected to be in the order of approximately 3 m^3 per week across all subsea infrastructure. The majority of subsea control fluids are based on fresh water with additives, such as MEG, lubricants, and surfactants. Some subsea discharges associated with IMR activities may contain trace amounts of hydrocarbons. Small quantities (<1 m^3 per activity) of weak acid (acetic acid/vinegar) may be used in marine growth / lime-scale removal. These discharges have the potential to expose marine fauna to changes in water quality	A4	• Design subsea system to use control fluids that present a low environmental hazard. • Subsea flow components will be purged with MEG, to remove residual hydrocarbons before being disconnected. • Subsea Integrity Monitoring and Management Plan and Inspection Management System.	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
	through changing ambient pH levels. During IMR activities, volumes of subsea control fluids discharged may range from approximately 7–10 m^3 during replacement of flow control modules to larger volumes of approximately 88 m^3 to 212 m^3 discharged, either subsea or topsides, during riser or flowline replacement. Up to 125 m^3 may be discharged during planned pigging of the GEP within WA-50-L through launching and recovering of the PLR. During this activity, a maximum of 75 m^3 of MEG would be released in any single 24-hour period. The PLR will be pre-filled with MEG (25 m^3) which will be lost to sea as the PLR is lowered to the seabed and installed (this activity is expected to take at least a day). During the PLR flushing activity up to 75 m^3 of MEG will be released to sea. Following completion of the pigging activity, expected to last at least 7 days, the PLR may be flushed with 25 m^3 of MEG (contingency flushing). The release of MEG is required to avoid introducing liquids in the GEP which would present a GEP integrity issue. FIS may also be discharged subsea during maintenance and repair activities from the pigging of subsea infrastructure, or during the dewatering of a flowlines, following			

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
	replacement. IMR subsea discharges are expected to be infrequent; in particular, the larger volumes associated with unplanned major repairs.			
Routine discharges – CPF cooling water	Cooling water discharge from the CPF has the potential to result in maximum continuous discharge volumes in the order of 20 000 m^3/h. The facility has been designed so that cooling water discharges do not exceed 45 °C. The CPF cooling water system is treated continuously with NaClO, generated through an electrolysis reaction in the biofouling control package. The CPF biofouling control package is designed to dose at a concentration of approximately 3.0 ppm, with shock dosing of approximately 5.0 ppm, for approximately 15 minutes every six hours. These dosing rates will result in an anticipated 24-hour rolling average concentration of 3.1 ppm to 3.5 ppm.	A5	• Monitoring of cooling water temperature. • Monitoring NaClO dosing levels (measured as chlorine equivalent).	Low
Routine discharges – CPF ballast water	Ballasting uses seawater supplied from the seawater cooling system dosed at the point of inlet with NaClO at a concentration of 3–3.5ppm, to inhibit biofouling with no further dosing of ballast tanks with biocide. During normal operating conditions no ballast water will be discharged; however, in the event that	A6	• Monitoring NaClO dosing levels (measured as chlorine equivalent).	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
	unplanned ballasting needs to occur on the CPF for stability reasons, return ballast will be discharged to sea via the seawater dump caisson on an as-required basis. Intermittent flows of ballast water may be discharged (575 m^3/h maximum pump capacity).			
Routine discharges – CPF desalination brine	The continuous discharge of desalination brine has the potential to cause changes in water salinity. Water makers on board the CPF have the capacity to make 100 m^3/day of potable water. At full capacity, this results in a maximum discharge rate of approximately 185 m^3 per day (~7.7 m^3/hour) of desalination brine water for the entire system. The salinity of the discharge is expected to be approximately 50 parts per thousand (ppt) in comparison to ambient seawater with a salinity of 35 ppt (INPEX, 2010). The brine is then mixed with return seawater from the cooling water system in the seawater dump caisson, this dilution results in the final discharge that enters the receiving environment having a salinity of approximately ambient conditions (i.e. 35 ppt). Therefore, the discharge of desalination brine from the CPF does not result in a discharge of increased salinity above ambient seawater.	A7	• Route desalination brine to mix with cooling water.	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
Routine discharges – CPF sewage, grey water and food waste	The intermittent discharge of sewage effluent, grey water and food waste has the potential to expose planktonic communities to changes in water quality from the introduction of nutrients. Such a decline in water quality has the potential to result in reduced ecosystem productivity or diversity. Sewage generated on the CPF will be macerated and combined/diluted with grey water and food waste before discharge via the sewage disposal caisson. Volumes of sewage effluent, grey water and food waste will vary over the 40-year life of the operation. For example, when the maximum number of personnel is required on board the CPF (i.e. 200 POB), up to 60 m^3/day of sewage effluent and grey water may be generated. The discharge from the facility is not continuous and is considered to be intermittent (or pulsing) in nature and principally occurs during two-hourly peak periods at shift changeover, with smaller volumes generated outside of these times. The maximum flow rate of sewage discharge is in the order of 24 m^3/h and has been used for this assessment to provide a worst-case scenario. As with sewage and grey water, the volumes of food waste will also vary over the life of the operation influenced by the number of	A8	• Installation and maintenance of sewage maceraters on board CPF.	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
	persons on board. Volumes of up to 0.36 m^3 per day are estimated at times when the maximum persons are on board. These volumes, however, are also expected to be smaller when less people are on board and will fluctuate during shift changeover and mealtimes. Food waste will be macerated (<25 mm) before discharge via the sewage dump caisson.			
Routine discharges – CPF open drains and bilge	Contaminated deck drainage and bilge discharges or failure to treat oily water to suitable OIW concentrations prior to discharge has the potential to expose marine fauna to changes in water quality and/or result in impacts through direct toxicity. CPF oily water discharges will be intermittent and will comply with the 15 ppm (v) requirement as specified for bilge water in MARPOL 73/78, Annex 1. The maximum capacity of the open-drains centrifuge to treat oily water on the CPF is 20 m^3 per hour. The CPF is equipped with firefighting foams and their availability on board is a safety-critical requirement. The foam systems supply 3% AR-AFFF and 3% FFFP foams which will be used in the event of an incident or (infrequent) testing. Therefore, foam discharges will not be routine, but may be	A9	• Oily water is treated by centrifuge, and discharges controlled through an OIW analyser, to ensure a maximum concentration of 15 ppm (v) prior to discharge as specified in MARPOL 73/78, Annex 1. • AMSA-issued International Oil Pollution Prevention (IOPP) certificate. • OIW analysers to be tested against a range of known concentrations of oil during factory acceptance testing (FAT). • Validate OIW analyser readings against offshore laboratory sampling results during start-up (two samples per day for a minimum of 28 days or until such time as the difference between the OIW analyser and samples is less than 10% for a 28-day consecutive period). • Weekly validation and corrective action (if required) of both OIW analysers using the offshore laboratory to ensure difference is maintained at <10%. • Monthly validation and corrective action (if required) of both OIW analysers using a third-party laboratory to ensure difference is maintained at <10%. • In the event of failure of both OIW analysers, INPEX will undertake sampling and analysis in the offshore laboratory, to confirm OIW	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
	discharged to sea via the open drains in the event that they are required.		concentrations. • Potential volumes of oily water generated can be minimised through the availability of spill kits on board and training of personnel in their use. • Select firefighting foam in accordance with the INPEX *chemical, assessment and approval procedure.*	
Routine discharges – FPSO produced water	Discharging PW to the marine environment has the potential to expose identified values and sensitivities to changes in water quality and sediment quality from liquid and particulate components of the PW discharge stream.	A10	• Use primary PW treatment system to reduce OIW concentrations. • Use MPPE as a secondary PW treatment system. • During normal operations, use of primary and secondary PW treatment systems to achieve OIW discharge, to meet ≤30 mg/L, on a rolling 24-hour average. • During the start-up period (12 months after first gas), use of primary and secondary PW treatment systems to achieve OIW discharge concentrations will be controlled to: o achieve OIW discharge concentrations of between 30 mg/L and 100 mg/L, based on a 24-hour rolling average, for ≤60 days o achieve OIW discharge concentrations of <30 mg/L, based on a 24-hour rolling average, for ≥120 days. • Following the initial 12 month start-up period (during normal operations), when a new well is brought online, use of primary and secondary PW treatment systems to achieve OIW discharge to meet <50 mg/L, on a 24-hour rolling average, for a period not exceeding three days. • OIW analysers to be tested against a range of known concentrations of oil during factory acceptance testing (FAT). • Validate OIW analyser readings against offshore laboratory sampling	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
			results during start-up and commissioning (two samples per day for a minimum of 28 days or until such time as the difference between the OIW analyser and samples is less than 10% for a 28-day consecutive period). • Weekly validation and corrective action (if required) of both OIW analysers using the offshore laboratory to ensure difference is maintained at <10%. • Monthly validation and corrective action (if required) of both OIW analysers using third-party laboratory to ensure difference is maintained at <10%. • In the event of failure of both OIW analysers, INPEX will undertake sampling and analysis in the offshore laboratory, to confirm OIW concentrations. • Production chemicals that are discharged to sea will be assessed to ensure chemicals with a low environmental hazard are preferentially selected.	
Routine discharges – FPSO cooling water	Cooling water discharge from the FPSO has the potential to result in maximum continuous discharge volumes in the order of 12 000 m^3/h. The facility has been designed so that cooling water discharges do not exceed 45 °C. The FPSO cooling water system is treated continuously with NaClO, generated through an electrolysis reaction in the biofouling control package. The FPSO biofouling control package is designed to dose at a concentration of approximately 3 ppm, with shock dosing of approximately 5.0 ppm,	A11	• Monitoring of cooling water temperature. • Monitoring NaClO dosing levels (measured as chlorine equivalent).	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
	for approximately 15 minutes every 6 hours. These dosing rates will result in an anticipated 24-hour rolling average concentration of 3.1 ppm to 3.5 ppm.			
Routine discharges – FPSO sewage, grey water and food waste	Discharging sewage effluent, grey water and food waste has the potential to expose planktonic communities to changes in water quality from the introduction of nutrients. Such a decline in water quality has the potential to result in reduced ecosystem productivity or diversity. Sewage generated on the FPSO will be macerated and combined/diluted with grey water and food waste before discharge via a dedicated hose in the discharge moonpool at a depth of approximately 30–35 m. Volumes of sewage effluent, grey water and food waste will vary over the 40-year life of the operation with no anticipated variation between installation, hook-up and commissioning (IHUC), and phases of operations (i.e. steady state). For example, when the maximum number of persons on board (POB) is required for the FPSO (i.e. 200), up to 60 m^3/day of sewage effluent and grey water may be generated. The discharge from the facility is not continuous and is considered to be intermittent (or pulsing) in nature, and	A12	• Installation and maintenance of food and sewage maceraters on board FPSO.	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
	principally occurs during two-hourly peak periods at shift changeover, with smaller volumes generated outside of these times. The maximum flow rate of sewage discharge is in the order of 24 m^3/h, and has been used for this assessment to provide a worst-case scenario. As with sewage and grey water, the volumes of food waste will also vary over the life of the operation influenced by the number of POB. Volumes of up to 0.36 m^3/day are estimated at times with maximum POB. These volumes, however, are also expected to be smaller when less people are on board and will fluctuate during shift changeover and mealtimes. Food waste will be also macerated (<25 mm) before discharge via a dedicated hose within the moonpool at a depth of approximately 30–35 m.			
Routine discharges – FPSO ballast water	Ballasting uses seawater pumped from the inlet moonpool and as per all other FPSO systems utilising seawater (e.g. the cooling water system) is dosed at the point of inlet with NaClO at a concentration of 3–3.5 ppm, to inhibit biofouling. Return ballast is discharged to sea via the moonpool on an as-required basis with no further dosing of ballast tanks with biocide. Intermittent flows	A13	• Monitoring NaClO dosing levels (measured as chlorine equivalent).	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
	of ballast water will be discharged (3400 m^3/h maximum capacity).			
Routine discharges – FPSO open drains and bilge	Contaminated deck drainage and bilge discharges, or failure to treat oily water to suitable OIW concentrations before discharge, has the potential to expose marine fauna to changes in water quality and/or result in impacts through direct toxicity. FPSO oily water discharges will comply with the 15 ppm (v) requirement as specified for bilge water in MARPOL 73/78, Annex 1. The maximum capacity of the open-drains centrifuge to treat oily water on the FPSO is 50 m^3 per hour. The oily water burden of the FPSO is greater than that of the CPF due to the requirement for tank cleaning and other cargo and process system-flushing operations. Therefore, upstream of the open-drains centrifuge package is a slops tank where bulk separation of oil and water occurs through gravity separation, with recovered oil recycled back through the process. The oily water is pumped to the open-drains centrifuge for treatment and then on to a downstream OIW monitor where, if it meets specification, i.e. ≤15 ppm (v), it is discharged to sea via the moonpool. If it is off-specification, the water is recycled to the slops tank.	A14	• Oily water is treated by centrifuge, and discharges controlled through an OIW analyser, to ensure a maximum concentration of 15 ppm (v) prior to discharge as specified in MARPOL 73/78, Annex 1. • AMSA-issued IOPP certificate. • OIW analysers to be tested against a range of known concentrations of oil during factory acceptance testing (FAT). • Validate OIW analyser readings against offshore laboratory sampling results during start-up (two samples per day for a minimum of 28 days or until such time as the difference between the OIW analyser and samples is less than 10% for a 28-day consecutive period). • Weekly validation and corrective action (if required) of both OIW analysers using the offshore laboratory to ensure difference is maintained at <10%. • Monthly validation and corrective action (if required) of both OIW analysers using a third-party laboratory to ensure difference is maintained at <10%. • In the event of failure of both OIW analysers, INPEX will undertake sampling and analysis in the offshore laboratory, to confirm OIW concentrations. • Potential volumes of oily water generated can be minimised through the availability of spill kits on board and training of personnel in their use. • Select firefighting foam in accordance with the INPEX *chemical, assessment and approval procedure.*	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
	The FPSO is equipped with firefighting foam and its availability on board is a safety-critical requirement. The foam system supplies 3% FFFP foam which will be used in the event of an incident or infrequent testing. Therefore, foam discharges will not be frequent or routine, but will be discharged to sea via the open drains in the event they are required.			
Routine discharges – FPSO scrubbing water	On the FPSO, the inert gas system will be used to generate inert gases for use as a blanket gas within hydrocarbon-containing tanks. Nitrogen will be used in preference; however, when nitrogen gas is unavailable, inert gas will be derived from the combustion of fuel gas (with diesel as a backup) for use as a blanket gas to prevent the ingress of oxygen. Seawater scrubbing is necessary to cool the inert gas before use, and the return seawater has the potential to result in an increase in ambient water temperature and will contain residual NaClO, as the seawater is dosed with NaClO at the inlet moonpool. The production of combustion residues is not expected and would only occur if combustion is not optimised, i.e. due to damaged or incorrectly fitted equipment, or when diesel is used, as diesel is more likely to result in soot generation compared to fuel gas. The scrubbing water discharge from the inert gas	A15	• Use nitrogen as a blanket gas. • Maintenance schedule will include the IGG and HCl scrubber.	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
	generator will be intermittent in nature and only in the event that nitrogen is unavailable. The maximum discharge rate is expected to be 528 m^3/h. Seawater is also used as a scrubbing media to remove HCl vapour or fumes from pH controller storage tanks and vent lines in the HCl gas scrubbers. The treated seawater to be discharged from the HCl gas scrubbers comprises residual NaClO and HCl at approximately 1900 mg/L and is directed to the moonpool for intermittent discharge at a maximum rate of 5 m^3/h, where it is then commingled before discharge to the receiving environment.			
Routine discharges – ASVs desalination brine	Discharging desalination brine has the potential to cause changes in water salinity. Each water maker on board the ASVs has the capacity to make 75 m^3/day of potable water. At full capacity, this results in a maximum discharge rate of approximately 500 m^3 per day (~21 m^3/hour) of desalination brine water for the entire system. The salinity of the discharge is expected to be approximately 45–50 parts per thousand (ppt) in comparison to ambient seawater with a salinity of 35 ppt (INPEX 2010).	A16	• None identified.	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
Routine discharges – ASVs sewage, grey water and food waste	Discharging sewage effluent, grey water and food waste has the potential to expose planktonic communities to changes in water quality from the introduction of nutrients. Such a decline in water quality has the potential to result in reduced ecosystem productivity or diversity. Discharges associated with the activity occur in Zone 1, which is in the open ocean in water depths of approximately 250 m and more than 12 nm from the nearest land. The accommodation support vessels (ASVs) will use approved (MARPOL 73/78) sewage treatment plants (STPs) which can bio-treat sewage before discharge, when connected to the CPF and FPSO. ASVs are expected to be in Zone 1 only during periods of intense maintenance activity including approximately 6–12 months when the EP is first activated. For intensive maintenance activities, they could return to the field and reconnect to the CPF and/or FPSO at a later date on a temporary basis. Peak load for an ASV (estimated to be approximately 132 m^3/day) has been calculated based on its maximum capacity of 440 POB. Discharges from the ASVs are generally intermittent (or pulsing) in nature and principally occur during two-hourly peak	A17	• ASVs will be equipped with onboard STPs compliant with MARPOL 73/78, IMO Resolution MEPC.2 (IV) or MEPC.159 (55), depending on the STP installation date. • ASVs will macerate food waste to a particle size of <25 mm before disposal.	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
	periods at shift changeover, with smaller volumes generated outside of these times.			
Routine discharges – ASVs oily water and bilge	Contaminated deck drainage and bilge discharges or failure to treat oily water to suitable OIW concentrations before discharge has the potential to expose marine fauna to changes in water quality and/or result in impacts through direct toxicity. ASVs oily water discharges will comply with the 15 ppm (v) requirement as specified for bilge water in MARPOL 73/78, Annex 1. The capacity of the OWS on the ASVs is reported at 1000 litres per hour (~1 m^3 per hour). ASVs are equipped with firefighting foams and their availability on board is a safety-critical requirement. The foam systems supply AFFF foam which will be used in the event of an incident and will be discharged to sea via the deck drainage. There will be no tests scheduled during the period of time when the ASVs will be present in Zone 1 and therefore no discharges to sea.	A18	• ASVs are equipped with oil–water separators (OWS). • Oily water is treated to a maximum concentration of 15 ppm prior to discharge, as specified in MARPOL 73/78, Annex 1. • Bilge water and waste that does not meet MARPOL 73/78 discharge requirements (15 ppm) will be retained onboard for controlled disposal at a port reception facility. • ‘White box’ oil-content detector to ensure concentrations of oil in water are ≤15 ppm • Vessel inspections confirm MARPOL 73/78 compliant OWS are operational and maintained on ASVs. • Spill kits will be available onboard ASVs.	Low
Routine discharges – ASVs cooling water	Cooling water discharge to the marine environment will result in a localised and temporary increase in the ambient water temperature. This may cause a variety of effects, including marine fauna behavioural	A19	• Engines and machinery adequately maintained to ensure efficient operation.	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
	changes and reduced ecosystem productivity or diversity through impacts to planktonic communities. The ASVs each have three CW systems: one each for the engines, accommodation, and thrusters. The maximum discharge rate from all three systems is estimated to be 1125 m^3 per hour. The temperature of the CW discharge will be approximately 32–36 °C, approximately 10°C above ambient seawater temperature (which ranges from 22 to 26 °C as described in Section 3). The cooling water on the ASVs is not planned to be dosed with biocide.			
Routine discharges – support vessel desalination brine	Discharging desalination brine has the potential to cause changes in water salinity. The estimated volume of brine discharge for vessels is estimated to be in the order of 150 m^3 per day with salinity in the order of 50 ppt, i.e. elevated in comparison to ambient seawater with a salinity of 35 ppt (INPEX 2010). Based on the assumption that there are two vessels present in Zone 1, the combined rate of discharge of brine is considered to be approximately 300 m^3 per day or 12.5 m^3 per hour.	A20	• None identified	Low
Routine discharges –	Discharging sewage effluent, grey water and food waste has the potential to expose	A21	• Support vessels may discharge sewage effluent, grey water and food waste within Zone 1 in accordance with MARPOL 73/78 which is	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
support vessel sewage, grey water and food waste	planktonic communities to changes in water quality from the introduction of nutrients. Such a decline in water quality has the potential to result in reduced ecosystem productivity or diversity. Discharges associated with the activity occur in Zone 1, which is located in the open ocean and more than 12 nm from the nearest land. The average volume of sewage and greywater expected from vessels (including domestic waste water) generated by a person per day is approximately 230 L (based on calculations in Hänninen & Sassi 2009). Therefore, based on the assumption that when there are two vessels present in Zone 1, each with 50 POB, the combined rate of discharge of sewage, grey water and food waste is conservatively considered to be approximately 25 m^3 per day (or 1.05 m^3 per hour).		implemented through the POTS Act . • Support vessels will manage food waste in accordance with the requirements of MARPOL 73/78.	
Routine discharges – support vessel oily water and bilge	Contaminated deck drainage and bilge discharges or failure to treat oily water to suitable OIW concentrations before discharge has the potential to expose marine fauna to changes in water quality and/or result in impacts through direct toxicity. Deck-drainage discharge volumes on support vessels are dependent on weather conditions and frequency of deck washing. Volumes of bilge water from engines and other mechanical	A22	• Vessels are equipped with oil–water separators (OWS) • Oily water is treated to a maximum concentration of 15 ppm (v) prior to discharge as specified in MARPOL 73/78, Annex 1. • Bilge water and waste that does not meet MARPOL 73/78 discharge requirements will be retained onboard for controlled disposal at a port reception facility. • Vessel inspections confirming MARPOL 73/78 compliant oil–water separators (OWS) are operational and maintained.	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
	sources found throughout the machinery spaces will also vary between vessels. In general, the capacities of OWS on vessels range from 100–1000 litres per hour. Therefore, conservatively based on the highest possible rate, each vessel present in Zone 1 could potentially discharge 1 m^3 per hour. So, assuming there are two vessels present in Zone 1, the combined rate of oily water discharge is considered approximately 48 m^3 per day.		• Spill kits will be available on board support vessels	
Routine discharges – support vessel cooling water	CW discharges to the marine environment will result in a localised and temporary increase in the ambient water temperature. Elevated discharge temperatures may cause a variety of effects, including marine fauna behavioural changes and reduced ecosystem productivity or diversity through impacts to planktonic communities. CW discharge rates vary largely depending on the vessel type. Maximum discharge rates based on equipment capacities and specifications range from approximately 20 000 m^3 per day for a PSV up to approximately 100 000 m^3 per day for an HLV. Based on the assumption that when there are two vessels present in Zone 1 (OSV and PSV), the combined rate of CW discharge is expected to be in the order of approximately 100 000 m^3 per day (or	A23	• Engines and machinery adequately maintained to ensure efficient operation.	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
	4167 m^3 per hour). The temperature of the cooling water discharge will be approximately 32–36 °C, or approximately 10 °C above the ambient seawater temperature (which ranges from 22 to 26 °C as described in Section 3). Due to its short residence time, the cooling water on vessels is not dosed with biocide.			
Routine discharges – cumulative impacts from liquid effluent discharges	A number of liquid effluent streams will be discharged to sea during the development and operation of the offshore facility, ranging from one-off or short-term temporary discharges, to long-term discharges such as PW containing production chemicals. Where possible, the previous assessments of liquid effluent discharges have been based on the known or predicted constituents using worst-case discharge flow rates in order to conservatively assess potential impacts. Predictive dispersion modelling of the worst-case constituents that drive the mixing zone, i.e. constituents requiring the greatest number of dilutions to reach guideline values or No Effect Concentrations from the FPSO and CPF during start-up and steady state has been undertaken to assess any cumulative or additive effects.	A24	• Implement a Liquid Effluent Management Plan at first introduction of reservoir hydrocarbons comprising of: o facility-based monitoring o receiving environment monitoring o adaptive monitoring within an adaptive monitoring framework .	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
Aspect – waste management				
Inappropriate waste handling and disposal	Unsecured or incorrectly stored waste may be windblown or displaced into the ocean where it has the potential to negatively affect marine ecosystems. Wastes can cause contamination of the ocean resulting in changes to water quality (through the leaching of chemicals from wastes, such as liquid mercury, mercury-contaminated adsorbent filters, spent catalysts, MPPE media, ash from incinerators, spilt chemicals, paints and solvents), which can cause changes to ecosystem productivity and diversity. Additionally, certain types of waste can cause injury to marine fauna through entanglement or may affect the health of marine species that ingest waste materials.	A25	• Appropriate storage of hydrocarbons and chemicals. • Spill containment and recovery equipment. • Offshore waste/garbage management plan • Waste management processes communicated to personnel.	Low
Aspect – loss of containment				

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
Loss of containment – accidental release overboard	Several loss of containment events were identified including minor spills on board (<1 m^3); loss of tote tank during cargo transfer (5.5 m^3); loss of hydrocarbon fuels (vessels and helicopters) during refuelling transfers (2.5 m^3 to 12 m^3); loss of condensate during offloading to tankers (110 m^3); and loss of Group II fuel (diesel) from topside fuel tanks onboard the CPF/FPSO (125 m^3). Even the largest and most persistent spill scenario (125 m^3 diesel spill) is not predicted to result in any contact with benthic habitats. The results of modelling of a 200 m^3 diesel spill (RPS APASA 2014a) predicted that hydrocarbon plumes would not exceed the surface, entrained/dissolved or shoreline contact thresholds at Browse Island or any other shoreline / benthic habitat location in any season. Therefore, an accidental release overboard resulting in a spill that reaches the marine environment has the potential to result in changes to water quality, resulting in impacts to marine fauna, but no impact on deeper water communities or benthic habitats. Based on the generally low volumes, impacts are expected to be localised to the point of release and any spills will rapidly disperse, as the hydrocarbons involved are predominantly Group I and Group II, which tend to be more volatile and less persistent in the environment.	A26	• Prevent on board spills through appropriate (training of personnel and) storage of hydrocarbons and chemicals including their associated waste constituents. • Reduce the volume of oil from on board spills reaching the marine environment by ensuring spill containment and recovery equipment, such as spill kits, is available for responding to minor spillage of hydrocarbons and chemicals on board. • Dry-break, breakaway couplings or similar technology will be installed and used during refuelling and offloading operations. • Emergency shutdown valve (ESDV) at the FPSO for offloading operations. • Bunkering and offloading procedures will be in place and followed during any bunkering and offloading operations involving hydrocarbons or chemicals, specifically: o visual monitoring of hoses, couplings and the sea surface will be undertaken during bunkering and offloading operations. o radio contact will be maintained between the CPF/FPSO and vessels during refuelling and offloading operations. • Marine vessels >400 tonne (t) will carry Shipboard Oil Pollution Emergency Plan (SOPEPs) approved under MARPOL 73/78 Annex 1, Regulation 37. • Company-approved (Facility) emergency response plans (ERPs) available on board the CPF, FPSO, and ASVs. • Implement the INPEX *Chemical Assessment And Approval Procedure.* • Lifting procedures implemented to reduce the risk of dropped objects. • Hydraulic equipment on board the CPF/FPSO and vessels will be subject to routine servicing and inspection to ensure it is fit for purpose.	Mode-rate

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
Loss of containment – vessel collision. Emergency condition.	Group I, Group II and Group IV oils that reach the marine environment have the potential to result in changes to water quality through surface, entrained, dissolved, and shoreline hydrocarbon exposure.	A27	• Ship collision detection and avoidance systems. • Navigational aids and communication systems in place. • Double-walled skin and outboard ballast tanks on the FPSO provide protection to inboard condensate storage and fuel tanks. • Implement the Field Management Plan. • A 500 m PSZ will be maintained around the CPF, FPSO, CRM and FFG transfer lines and the drill centres. • Develop an operational net environmental benefit analysis (NEBA) in accordance with the OPEP to confirm effectiveness of response strategies before their implementation. • Implement oil spill response controls • Response effectiveness will be monitored in accordance with the OPEP. • Response preparedness will be maintained by implementing the EP. • INPEX will provide all available support to AMSA in AMSA's performance of its combat (control) agency responsibilities for vessel-based spill events. • INPEX will provide all available support to WA DoT in its performance as control agency for a spill which reaches WA waters, resulting from a collision with the offshore facility.	Mode-rate

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
Loss of containment – subsea condensate release due to integrity failure of the subsea production system. Emergency condition.	A leak or spill of Group I hydrocarbons (gas condensate) has the potential to result in changes to water quality through surface, entrained/dissolved and shoreline accumulation hydrocarbon exposure. The loss of containment from a production well could result in prolonged exposure of a wide range of values and sensitivities to entrained/dissolved hydrocarbons above the hydrocarbon exposure thresholds. Surface hydrocarbons >10 g/m^2 are not predicted to occur anywhere except in the immediate vicinity of the spill location. Although a worst-case of 1.5 m^3 of shoreline accumulation was calculated by the model to occur at Browse Island, this is two orders of magnitude smaller than shoreline accumulation volumes when compared to the vessel collision scenarios.	A28	• All subsea infrastructure components have been subject to a series of inspections and testing such as factory-acceptance testing before load-out and/or hydrotesting following installation in the Ichthys Field. • Conduct inspections and testing of the subsea infrastructure during operations. • Perform tests and verification of well barriers. • Conduct inspections of the CPF/FPSO mooring system during operations. • Conduct maintenance of subsea infrastructure, based on outcomes of inspections, as specified in the Inspection Management System. • Prior to the introduction of hydrocarbons, perform leak test of the interconnected subsea production system. • Prior to introduction of hydrocarbons, validate the functionality of the SSSVs, XTVs, SSIVs and RESDVs and validate the automated alarms and automated shutdowns related to the subsea production system. • Prior to introduction of hydrocarbons, function test the subsea production system isolation valves (SSSVs, XTVs, SSIVs and RESDVs). • Verification of Competency (VOC) of CPF and FPSO CCR Operators. • The Field Management Plan will be implemented. • INPEX *Lifting Standard* • Australian Hydrographic Service (AHS) informed of subsea production system infrastructure locations prior to the activity commencing • Stakeholder consultation will be conducted and maintained. • Plan and control all pigging and IMR activities in the Ichthys Field. • A PSZ will be maintained around the CPF, FPSO, CRM and FFG lines and the drill centres.	Mode-rate
			• Develop an operational net environmental benefit analysis (NEBA) in accordance with the OPEP to confirm effectiveness of response strategies before their implementation. • Implement oil spill response controls • Response effectiveness will be monitored in accordance with the OPEP.	

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
Aspect – biodiversity protection and conservation				
Introduction of IMP from high risk ballast water and biofouling	The discharge of high-risk ballast water (DAWR 2016) and biofouling on external wet areas and in internal seawater systems has the potential to result in the introduction of invasive marine pests (IMPs). The introduction and establishment of IMPs into the marine environment may result in impacts to benthic communities.	A29	• Support vessels, ASVs, the FPSO and CPF will have an antifouling coating applied that is in accordance with the prescriptions of the International Convention on the Control of Harmful Anti-fouling systems on ships, 2001, and the *Protection of the Sea (Harmful Antifouling Systems) Act 2006* (Cwlth). • Support vessels mobilised from outside Australia to comply with the intent of the *Australian Ballast Water Requirements, Version 6* (DAWR 2016). • Support vessels, ASVs the CPF and FPSO mobilised from international waters to Zone 1 will complete a vessel and immersible equipment risk assessment and/or implement mitigation measures commensurate with the level of risk.	Low
Physical presence of vessels and interaction with marine fauna	The physical presence of vessels used to support the activity in Zone 1 has the potential to result in collision (vessel strike) with marine fauna.	A30	• Implementation of EPBC Regulations 2000 – Part 8 Division 8.1 (Regulation 8.05). • Implementation of the Whale Shark Code of Conduct (Whale Shark Wildlife Management Program no. 57).	Low
Aspect – social and cultural heritage				
Physical presence of vessels resulting in	The physical presence of vessels and the facility in Zone 1 has the potential to cause disruption to other marine users, including shipping operators and fisheries through the	A31	• Stakeholder engagement plan.	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
disruption to other marine users	reduction of space available to conduct shipping and fishing activities. The offshore infrastructure has a gazetted petroleum safety zone (PSZ) (Zone 1 at the sea surface) in place for safety purposes and specifically to prevent collisions. The PSZ is marked on the Australian Hydrographic Service (AHS) navigation charts.			
Aspect- seabed (land) disturbance				
Seabed intervention activities	Over the life of the EP, seabed intervention activities may be required for example, to stabilise and protect subsea infrastructure or enable access to subsea infrastructure for repairs within Zone 1 (i.e. within 500 m of installed infrastructure). Activities may include: • physical seabed intervention/excavation alongside infrastructure to adjust sand levels to gain access to, or enable repairs of, infrastructure • jetting or mass-flow excavation • installation of grout bags, concrete mattresses, rock placement, or other physical structures to stabilise and protect infrastructure on the seabed • temporary set down of ROV tooling,	A32	• Dynamic positioning (DP) vessels • Differential Global Positioning System (DGPS) • Engineering analysis/ environmental assessment of possible intervention techniques	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
	baskets and equipment on the seabed. Undertaking such seabed intervention activities has the potential to physically disturb the seabed close to the subsea infrastructure in Zone 1. A disturbance to benthic communities has the potential to result in reduced ecosystem productivity or diversity. The area of seabed disturbance is directly related to the nature of the repair or inspection being performed and therefore cannot be confirmed. However, a range of reasonably foreseeable activities such as ROV set downs may occur for a matter of hours and disturb an area approximately 2–4 m^2. Potential excavations may vary in length from a few metres to 100 m and may be in the order of 2–4 m wide. Installation of other physical structures such as grout bags or mattresses, or temporary items such as tooling baskets may vary from <1 m^2 up to approximately 50 m^2. In addition to physical disturbance, seabed intervention activities may also result in the localised generation of silt plumes could affect the surrounding benthic communities. Dropped objects may result in physical disturbance at the immediate location of the dropped object.			

Oil spill response strategies

Not all techniques are appropriate for every hydrocarbon spill. Different types of spilt hydrocarbon, spill locations and spill volumes require different techniques, or a combination of techniques, to implement an effective response.

INPEX has identified a set of primary and secondary response strategies to reduce the impacts and risks of hydrocarbon spills from offshore activities to ALARP. However, the deployment of response strategies has the potential to introduce further impacts and risks. Each response strategy has been evaluated in terms of its response capability, constraints, logistical issues and environmental benefits as presented in Table 5-3.

Primary response strategy

Operational monitoring and evaluation has been determined as the only appropriate primary (first strike) response measure for all hydrocarbon spills. This involves surveillance and reconnaissance, using vessels, aircraft, satellite imagery and satellite tracking buoys to monitor the size, trajectory, weathering and fate of the hydrocarbon spill.

The information obtained through the surveillance and reconnaissance program will inform spill modelling and the development of Incident Action Plans (IAPs), which will include consideration of the use of secondary response strategies.

Secondary response strategies

The following secondary response strategies have been determined as potentially applicable during the IAP development stage, (depending on hydrocarbon type).

- wildlife hazing
- pre-contact and/or post-contact wildlife response
- shoreline clean-up
- aerial and/or vessel-based dispersant application
- protect and deflect and/or contain and recover.

It should be noted that the risk assessment for implementation of oil spill response strategies has been based on a worst-case scenario. However, some of the strategies have been assessed as having insignificant environmental consequence including operational monitoring and evaluation and wildlife hazing (Appendix A).

Table 5-3: Oil spill response strategies

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
All aspects				
Primary and secondary response strategies: Operational monitoring and evaluation, wildlife hazing, pre-contact and/or post-contact wildlife response, shoreline clean-up, aerial and/or vessel-based dispersant application, protect and deflect and/or contain and recover.	Routine sewage effluent, grey water and food waste discharges from vessels used in oil spill response could result in the exposure of transient, EPBC-listed species to untreated/non-macerated discharges. Accidental release of waste as a result of inappropriate management leading to overboard releases may result in impacts to marine fauna through entanglement or ingestion of waste material, with the potential to result in injury. Inappropriate waste management also has the potential to expose marine flora and fauna to changes in water quality and may result in reduced ecosystem productivity or diversity. The physical presence of vessels used in the response strategy has the potential for vessel-to-vessel collisions. Poorly implemented wildlife response has the potential to cause stress or suffering to wildlife impacted by the spill. Reduced water quality and toxicity to marine flora and fauna from dispersant and dispersed hydrocarbons in the water column. Increased concentrations of entrained hydrocarbons within the water column,	A33 to A39	• Ship collision detection and avoidance systems. • Navigational aids and communication systems in place. • Due to the nature of call-off vessels that may be used during an oil spill response, not all vessels can be confirmed to be equipped with onboard sewage treatment plants compliant with MARPOL 73/78 (depending on the sewage treatment plant installation date) or an approved sewage comminuting and disinfecting system. However, all vessels will comply with the requirements of MARPOL 73/78, Annex IV for sewage discharges and Annex V for food scrap discharges during oil spill response activities. • The INPEX Operations PSVs and OSV will be equipped with dispersant application spray equipment. • A mobile dispersant spray system, which can be mobilised to support vessels, will be stored in Zone 1 at all times during IHUC and Operations. • 16 m^3 of dispersant stored in Zone 1 at all times during IHUC and Operations. • Implement the Field Management Plan. • Emergency response preparedness will be maintained in accordance with the EP and OPEP. • Develop an Operational NEBA in accordance with the OPEP to confirm the effectiveness of response strategies before their implementation. • Develop and implement IAPs using the processes described within the OPEP.	Mode-rate

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking

	potentially contacting submerged sensitive receptors.
	Capture, cleaning and rehabilitation of oiled wildlife has the potential to create additional stress to animals.
	The movement of equipment and personnel onto offshore islands has the potential to introduce terrestrial exotic pests, including rats.
	The movement of personnel and equipment on offshore islands has the potential to disturb turtle nests and turtle-nesting activities.
	Incorrect management of hydrocarbon-contaminated wastes generated during shoreline clean-up has the potential to create additional contamination of the shoreline.
	Incorrect management of hydrocarbon-contaminated wastes generated during protect and deflect / contain and recovery activities has the potential to create additional contamination of the shoreline or declines in water quality.
			• Vessel and/or aerial dispersant application on Group IV hydrocarbons will only occur in accordance with the IMT dispersant application decision matrix.
			• Dispersants with high efficacy for dispersal of Group IV hydrocarbons will be used.
			• Response effectiveness will be monitored in accordance with the OPEP.
			• Hard copies of the INPEX *Oil Spill and Dispersant Visual Observation Guide for Vessels and Aircraft* will be available:
			  o on the ASV/FPSO/PSV and OSV at the location that dispersant/dispersant spray equipment is located
			  o at the INPEX aviation contractor base in Broome.
			• Conduct AMOSC 'train-the-trainer' vessel-based dispersant application course.
			• Relevant personnel in Zone 1 and PSV/OSV personnel will be trained in vessel-based dispersant application.
			• A waste management plan will be prepared and implemented for any protect and deflect, contain and recover or shoreline clean-up response, in consultation with AMOSC and WA DoT.
			• Permits obtained, in consultation with relevant government agencies, before activities which may have an impact on wildlife begin.
			• Shoreline response activity HSE plan prepared and implemented which incorporates consideration of impacts to turtle nesting.
			• Visual inspections of helicopters and vessels as part of any shoreline response activity to prevent introduction of exotic rodents to offshore islands.	

6 MONITORING ENVIRONMENTAL PERFORMANCE

The INPEX health, safety, environment and quality management system (HSEQ-MS) includes standards and procedures from all business areas. It is based on the principle of a "plan, do, check, act" continual improvement cycle, and was developed in accordance with the following Australian standards:

- AS/NZS 4801:2001, *Occupational health and safety management systems—Specification with guidance for use*.
- AS/NZS ISO 14001:2004, *Environmental management systems—Requirements with guidance for use*.

It provides mandatory rules and processes for the systematic and consistent management of HSEQ risks, demonstration of compliance, and facilitation of continual improvement. In the context of the EP, the HSEQ-MS enables INPEX to ensure that:

- environmental risks of activities are identified and communicated
- organisational structures and resources are provided to ensure that control measures remain effective in reducing environmental risks to levels that are tolerable and ALARP
- performance outcomes and standards are being met
- continual improvement is achieved through application of lessons learned.

A summary of the elements associated with implementation of the EP and details on the arrangements for ongoing monitoring of environmental performance are provided in Table 6-1. The processes within the HSEQ-MS that specifically address how environmental performance is monitored and achieved are described in sections 6.1 to 6.5.

Table 6-1: Summary of INPEX HSEQ-MS elements

HSEQ-MS element	Description	Performance monitoring
Leadership and commitment	INPEX environmental performance is achieved through strong visible leadership, commitment and accountability at all levels of the organisation. Leadership includes defining performance targets and providing structures and resources to meet them.	Overall performance with respect to the implementation of the EP will be subject to an annual review by senior management. Formal review of the effectiveness and appropriateness of the INPEX HSEQ-MS is also performed by senior management on a periodic basis.
Capability and competence	INPEX appoints and maintains competent personnel to manage environmental risks, and provide assurance that the INPEX Environmental Policy, objectives and performance expectations will be achieved. This applies to both individual competencies and the overall capability of the organisation.	INPEX conducts training needs analysis for each of the key roles in relation to the EP to define minimum training requirements. The analysis is used to develop training plans for individuals that are then used to document, schedule and record completion of specific HSEQ training. Inductions are provided to all personnel (including INPEX representatives, contractors, subcontractors and visitors) before they start work at or visit any of the vessels described in the EP.

HSEQ-MS element	Description	Performance monitoring
		Inductions cover the health, safety and environment requirements under the INPEX HSEQ-MS, including information about the commitments contained in the EP.
Documentation, information and data	INPEX implements and maintains document and records management procedures and systems. These are in place to ensure that information required to support safe and reliable operation of the facility, and management of environmental risks, is identified, current, reliable and available to those who need it.	The EP and associated documentation are maintained within INPEX document management systems, with the current versions also available via the controlled document repository. Records to demonstrate implementation of the HSEQ-MS and compliance with legal and other obligations are identified and maintained for at least five years.
Risk management	Robust and structured processes are applied to identify hazards and ensure that risks arising from the operation of the facility are systematically identified, assessed, evaluated and controlled.	Impacts and risks associated with the EP are detailed in Table 5-2 and Appendix A. Additional risk assessments will be undertaken when triggered by any of the following circumstances: • when there is a proposed change to the design or method of facility or IMR activities, as identified by a INPEX Management of Change (MoC) request • when flagged as necessary following the investigation of an event • when additional information about environmental impacts becomes available (e.g. through better knowledge of the receptors present within the environment that may be affected) • during scheduled reviews of the documentation associated with the EP.
Operate and maintain	INPEX implements and maintains processes including the chemical assessment and approval process, to ensure that, while operating, records relevant to the implementation of the EP are maintained.	The INPEX HSEQ provides processes for the systematic and consistent management of HSEQ risks and demonstration of compliance during operations. Formal reviews of the effectiveness and appropriateness of the INPEX HSEQ-MS are performed by senior management on a periodic basis.
	Liquid effluent management plan	The LEMP will be reviewed annually, with a view to adapting the program using the multiple lines of evidence approach once monitoring data has been collected and there is a better understanding of the nature of the discharges and, in particular, PW coming

HSEQ-MS element	Description	Performance monitoring
		from the gas reservoirs. A review of the liquid discharge monitoring results will be provided in the annual compliance report to NOPSEMA.
	Flaring management plan	An annual review of the flaring management plan will be linked to the annual management review of the EP.
Management of Change (MoC)	Where a change to management of an activity is proposed, internal notification will be communicated via an MoC request. The request will identify the proposed change(s) along with the underlying reasons, and highlight potential areas of risk or impact.	Where change could affect the environment, in accordance with the INPEX business rules, it is mandatory to undertake an environmental risk assessment in every case. Formal reviews of the effectiveness and appropriateness of the INPEX HSEQ-MS are performed by senior management on a periodic basis.
Stakeholder engagement	Robust processes to ensure: • ongoing consultation with relevant stakeholders • communication with INPEX employees regarding legal and other requirements.	Ongoing consultation is undertaken with relevant stakeholders either annually or on an as required basis predominantly through the issue of an annual factsheet. Communication with INPEX employees may include: • daily toolbox meetings • use of notice boards, HSEQ alerts and newsflashes • internal and external project reporting.
Contractors and suppliers	Selection and management processes are in place to ensure that organisations working for, or on behalf, of INPEX are able and willing to meet the minimum business expectations of INPEX, including those related to HSEQ and risk management.	Contract compliance audits, and quality control and assurance checks are conducted throughout the life of the contract as appropriate to the scope of work and risks involved. Contractors are required to provide regular reports to communicate their HSEQ performance and compliance status and periodic checks and reviews are conducted by INPEX representatives.
Security and emergency management	INPEX implements and maintains security and emergency management processes to ensure: • capabilities and arrangements are in place to respond to an emergency • employees are trained and capable • response arrangements are	A review and update of security and emergency management processes including lessons learned from drills and response arrangement testing occurs at least twice yearly. Inductions covering security and emergency management processes are provided to all personnel before they start work. Emergency response capability is

HSEQ-MS element	Description	Performance monitoring
	tested.	maintained and updated on an annual basis.
Incident investigation and lessons learned	INPEX implements and maintains processes for ensuring environmental incidents are investigated and reported, and that corrective actions are implemented.	The assessment of conformance with HSEQ obligations and goals ensures HSEQ risks are effectively managed, investigated and reported to support continuous improvement. HSEQ performance is regularly reviewed by senior management.
Monitoring, auditing and reviewing	INPEX implements and maintains robust monitoring, auditing and reviewing processes to evaluate environmental performance and ensure continual improvement. Through a process of adaptive management, lessons from management outcomes will be used for continual improvement. Formal reviews of the effectiveness and appropriateness of the INPEX HSEQ-MS are performed by senior management on a periodic basis. Lessons learned from this process and iterative decision-making will then be used as feedback to improve future management.	INPEX's ongoing audit and inspection program including scheduled and unscheduled audits. Audit and inspection findings are reported and non-conformances, actions and improvement plans are managed in an action tracking system. Management reviews of the EP shall assess a number of aspects including the following: • control measures detailed in the EP are effective in reducing the environmental impacts and risks of the activity to ALARP and an acceptable level • implementation of the management of change (MoC) process has remained consistent with the commitment to ensuring impacts and risks are reduced to ALARP and are acceptable • the Operational and Scientific Monitoring Program (within the OPEP) remains fit for purpose • any changes in legislation, or matters relating to the EPBC Act , including policy statements and conservation management documentation, have occurred which affect or need to be taken into consideration in relation to the EP • lessons learned have been communicated and, where applicable, applied across all titleholder activities, as relevant.

6.1 Management system audit

An audit and inspection program will be developed and implemented in accordance with the INPEX business standard for auditing. The program will include:

- self-assessment HSEQ audits against the HSEQ-MS
- regular inspections of workplace equipment and activities
- reviews to evaluate compliance with legal and other requirements.

Unscheduled audits may be initiated by INPEX in the event of an incident, non-compliance or for other valid reasons. Audit teams will be appropriately qualified, experienced and competent in auditing techniques. They will include relevant technical expertise, as required, and the audit team structure will be commensurate with the scope of the audit. HSEQ audit and inspection findings will be summarised in a report. Non-compliances, actions and improvement plans resulting from audits will be managed in an actions tracking system.

6.2 Liquid effluent management plan

The LEMP has been designed to monitor for potential contaminants in the liquid effluent streams from the facility (CPF and FPSO). Monitoring will take place on the facility and in the receiving environment to enable cause and effect pathways to be confirmed. While the LEMP has been designed around CPF and FPSO discharges, it can be used as a surrogate for monitoring of liquid discharges from ASVs and support vessels. This is because the receiving environment monitoring will integrate discharges from all offshore discharge sources.

The objectives of the LEMP are:

1. To provide an indicator of potential impacts from liquid effluent discharges to the marine environment.
2. To confirm, with field-based monitoring of water and sediment quality, that the risk from liquid effluent discharges from the Ichthys offshore facility during start-up and ‘steady state’ operations is as predicted and acceptable.
3. To provide a framework to manage risk from liquid effluent discharges to the environment through adaptive management based on an integrated monitoring program so risks are managed to ALARP.

The LEMP is premised on an adaptive management framework that is integrated so that facility-based monitoring acts as an indicator to inform potential risks to the receiving environment along the risk to impact continuum (Figure 6-1). This framework is instrumental in effectively managing and mitigating environmental risks through the application of timely management responses should monitoring triggers be exceeded. This integrated monitoring program is an iterative process to ensure risks are managed to ALARP.

A range of monitoring and testing will be undertaken both on the facility (CPF and FPSO) and in the receiving environment on a routine basis. The routine monitoring is underpinned by the adaptive management framework in place which supports additional monitoring and testing, on an as determined, basis linked to triggers and the management response hierarchy.

A multiple lines of evidence approach will be used to assess and interpret results as recommended in *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ 2000) and the *Revision of the Sediment Quality Guidelines* (Simpson et al. 2013).

The LEMP will commence upon first introduction of reservoir hydrocarbons to begin the process of information gathering, used to support the impact assessment for liquid effluent discharges. Steady state operation may not be achieved until up to 12 months following start-up. Within this time period, valuable information can be obtained regarding the reservoir constituents and other factors that may influence the nature and behaviour of the liquid effluent discharge streams.

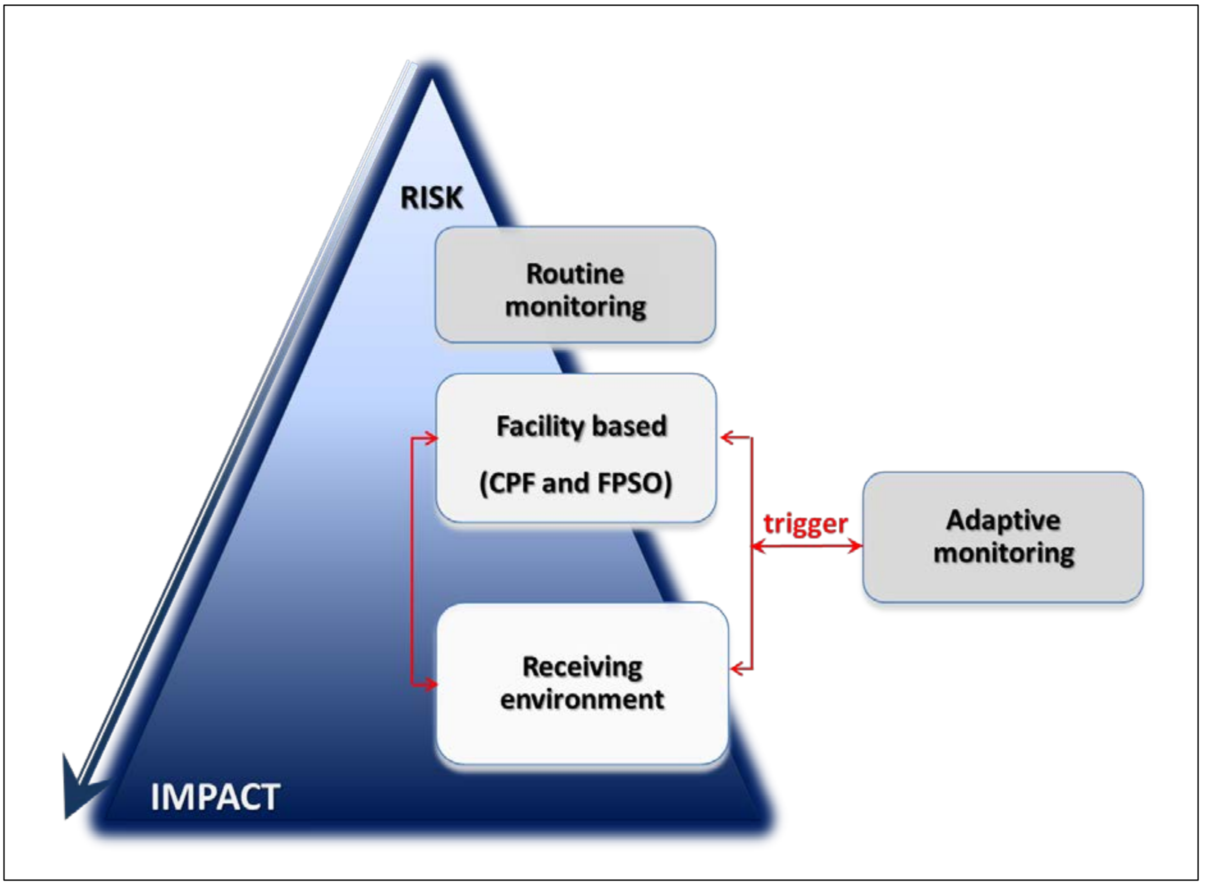

Figure 6-1: LEMP monitoring design

Monitoring will take place on the facility and in the receiving environment to enable cause and effect pathways to be confirmed. Therefore, decisions and actions can be taken based on a potential for risk, in advance of any actual detrimental impacts manifesting in the marine environment.

6.2.1 Facility-based monitoring

Facility-based monitoring on the FPSO and CPF is routinely conducted very early in the gas production process and targeted, to assess whether changing conditions may increase the potential for environmental harm. This may be related to either a change in the reservoir formation water production and/or changes in chemical injection and dosing, in response to gas processing demands.

Water cut monitoring will be undertaken daily to identify when formation water is detected. As only formation water is expected to contain increased levels of contaminants that may contribute to the overall toxicity of the discharge stream. An increase in formation water not only reflects a greater risk from the produced water in terms of volume, but also the greatest risk in toxicity.

Chemical injection rates are measured as they are dosed into the system and records retained in a database. Together with flow meters, this can be used to estimate the chemical dosing on the facility on all dosed streams on a daily basis. Chemical injection monitoring is a very early indication of risk only. Many of the chemicals are added specifically to remove components from the process waters and will be spent (e.g. scavengers), neutralised and decomposed with their risk to the environment decreasing at discharge.

Chemical characterisation of the liquid effluent discharge streams will routinely be conducted to verify that the discharge is as expected. It will provide information about the composition of the streams so that any changing conditions can be identified. Characterisation will be undertaken on a quarterly basis during start-up and then biannually once in steady state. In addition to the routine testing, further testing may be undertaken through a process of adaptive management in response to changes on an as determined basis linked to triggers and the management response hierarchy.

Chemical characterisation is complimented by ecotoxicity testing (referred to as direct toxicity testing as well as whole-of-effluent testing) of the liquid effluent stream (ANZECC/ARMCANZ 2000). Ecotoxicity testing provides a toxicity value for the discharge streams from the FPSO and CPF. Results can be used to verify that a safe dilution (using Predicted No Effect Concentrations/No Effect Concentrations) can be reached within the mixing zone. To reflect the uncertainty of performance of the reservoir, the frequency of routine sampling is greater during start-up than steady state. Ecotoxicity testing is proposed to be undertaken quarterly during start-up and biannually once steady state has been reached. In addition to the routine testing, ecotoxicity tests will also be conducted on FPSO topside streams for the first three drill centres of each reservoir. This is to reflect the greater level of uncertainty and potential for risk during the first few months of start-up (or when changing to the Plover Reservoir) and when bringing on new wells in different parts of the reservoir. The results of ecotoxicity testing will be used to re-determine the mixing zone for which future triggers/management response actions will apply.

6.2.2 Receiving environment monitoring

In addition to the facility-based monitoring, receiving environment monitoring will also be undertaken to monitor for any impacts in the marine environment.

Water quality monitoring is proposed to measure any potential changes in the receiving environment from exposure to the liquid effluent streams. Laboratory analysis will be performed on water samples collected in the receiving environment following a gradient design (dose/response) from the discharge point. Results will be compared to benchmark levels outside of the mixing zone. Benchmarks include water quality guidelines values as provided in ANZEC/ARCMANZ (2000), published literature, and/or other reference material, where applicable, in addition to available background data (i.e. baseline). The first water sampling event will occur as soon as practicable post start-up (within 12 months) with another sampling event scheduled for year 4.

Sediment sampling is proposed to monitor the potential for particulates, including PW precipitates or other particulates formed by flocculation or oxidation reactions upon discharge, to settle and accumulate on the seabed. Laboratory analysis will be performed on sediment samples collected in the receiving environment following a gradient design (dose/response) from the discharge point out to 10 km from the FPSO discharge point. To maximise comparison and provide multiple lines of evidence, sediment samples will be collected from the same locations as the water quality samples. Therefore, sediment sampling will be undertaken as soon as practicable post start-up (within 12 months) with another sampling event scheduled for year 4.

In addition to the routine testing, further receiving environment monitoring may be undertaken through a process of adaptive management in response to changes on an as determined basis linked to triggers and the management response hierarchy.

6.3 Flaring management

The flaring management plan (FMP) has been designed to ensure flaring levels on the CPF and FPSO are controlled against predetermined monthly triggers and annual targets set by INPEX. This is achieved through the continuous monitoring of flaring levels (as per National Greenhouse and Energy Reporting requirements) and an annual review of the FMP that will be linked to the annual management review of the EP.

6.4 Facility and vessel inspections

Inspections will be undertaken to ensure that the environmental performance outcomes and standards documented in the EP can be achieved. The inspections will be conducted:

- on support vessels (including ASVs) before mobilisation to complete a scope of work
- on the CPF and the FPSO before sail-away.

Findings during the inspections will be converted into actions that will be tracked within an actions tracking database until closed.

6.5 Performance reporting to regulator

For the purposes of regulatory reporting to NOPSEMA, an incident is classified as either “Reportable” or “Recordable” based upon the definitions contained in Regulation 4 of the OPGGS(E)R.

6.5.1 Reportable incidents

Based on the consequence assessments described in the EP, incidents identified as having the potential to be "reportable" incidents include:

- the introduction of IMPs
- a vessel collision resulting in a spill
- an integrity failure (production well loss of containment) resulting in a subsea condensate release.

6.5.2 Recordable incidents

In the event of a recordable incident (for example if one of the controls identified in Table 5-2 is not implemented) INPEX will report the occurrence to NOPSEMA as soon as practicable after the end of the calendar month in which it occurs, and in any case not later than 15 days after the end of the calendar month.

For the purposes of regulatory reporting to DoE, any significant impact to “matters of national environmental significance” (as classified using the INPEX Risk Matrix) will be reported to DoE.

6.5.3 Annual performance reporting

In accordance with Regulation 14(2) of the OPGGS (E) Regulations 2009, INPEX will undertake a review of its compliance with the environmental performance outcomes and standards set out in the EP, and will provide a written report of its findings for the reporting period January 1 to December 31, to NOPSEMA on an annual basis, as agreed with NOPSEMA.

7 OIL POLLUTION EMERGENCY PLAN

An OPEP has been developed specifically to respond to emergency conditions defined in the EP. The purpose of the OPEP is to:

- describe the oil spill emergency response arrangements and capabilities that are in place for the duration of Operations
- provide high-level guidance and process support for the INPEX Incident Management Team (IMT)
- demonstrate that the intent of Regulation 14(8) of the OPGGS (E) Regulations 2009 has been met.

INPEX adopts the emergency management principles of prevention, preparedness, response, recovery (PPRR). The aim of PPRR is to ensure that risks are identified and minimised; plans to respond are developed and practised; and recovery plans are in place.

Preparedness also includes ensuring that there are competent personnel available to respond to and manage emergency events and that their competence is maintained through regular training. INPEX achieves this through its adoption of competency-based training and annual 'crisis and emergency' exercise plans.

INPEX oil spill response arrangements shall be tested by the IMT:

- before the activity commences
- when the facility becomes operational (i.e. introduction of reservoir hydrocarbons)
- when the arrangements for an activity are significantly amended
- not later than 12 months following the most recent test.

Notification and call-out drills, that test communications channels and the ability to contact key individuals, shall be conducted at least annually.

The INPEX IMT will conduct a minimum of two dedicated oil spill drills per year to test:

- the structure and capability of the INPEX IMT
- communications between the IMT and vessel emergency response teams (ERT)
- onsite (facility and vessel) response capability (e.g. spill tracking buoys, dispersant spray capability)
- Vessel ERT and INPEX IMT understanding of AMSA / INPEX Control Agency responsibilities
- capability and logistical arrangements with external service providers such as aviation support, trained aerial observers, oil spill modelling and equipment registers.

An integral part of the OPEP is determining which spill response measures can be implemented for the identified events. Response measures were evaluated to identify the primary and secondary measures for surface and sub-surface hydrocarbon spills for multiple fuel types (i.e. Group I, Group II and Group IV).

7.1 Primary response measures

The outcomes of the evaluation, determined that the only appropriate primary response (first strike) measure for all fuel types and scenarios was Operational Monitoring and Evaluation. This involves the use of vessels, aircraft, satellite imagery and surface tracking buoys to monitor the size, trajectory, weathering and fate of the oil.

The arrangements and capabilities in place to implement this response measure are summarised in Table 7-1.

Table 7-1: Resources for operational monitoring and evaluation

Technique	Resource capability and availability	Minimum implementation time
Electronic surface tracking buoy(s)	INPEX has purchased several surface tracking buoys which it positions at high-risk locations, such as drilling rigs, the CPF, FPSO and other work activity sites, as deemed appropriate by INPEX. At least one tracking buoy will be maintained onshore (i.e. at Broome or Darwin) which can be deployed from an aircraft to any spill location (provided that CASA has granted permission to undertake this aerial deployment activity).	Immediately where available on the Facility or support vessels. 24–48 hours for aircraft deployment.
Oil spill trajectory modelling	INPEX maintain a contracted spill modelling service provider to provide 24-hour support.	2 hours
Aerial surveillance	Aerial surveillance with aircraft of opportunity using untrained observers (provided with INPEX's oil spill observation guide) will be available with a minimum implementation time of 5 hours*, and may involve using any of the following: • crew change helicopters that can be diverted with pilot and spotter • search and rescue helicopter • fixed-wing aircraft available in cyclone season (6 months of the year). Based on the position of the helicopters (flying in rotation between the Ichthys Field, Broome and Lombadina) at the time of the spill, a worst-case scenario could result in a maximum of 5 hours before aerial surveillance could commence. However, it is equally possible that depending on the location of the helicopters, immediate observations could be made. There is a dedicated full-time emergency helicopter, plus a minimum of four crew change helicopters available in Broome at all times. The crew change helicopters have access to the INPEX oil spill observation aid in Broome, ready for use during a spill observation event. Fixed-wing aircraft on call-off contracts for rapid mobilisation are only available during the cyclone-season. During the dry season, fixed-wing aircraft are utilised by the tourism industry, and therefore these fixed-wing service providers will not guarantee mobilisation within specified timeframes during the dry season. The response could be improved by having an additional dedicated fixed-wing aircraft available for the full 12 months of the year at $100,000 per month. The cost for this is considered to be grossly disproportionate based on	5* hours * All timings are based from the moment the relevant emergency response team (ERT) member is aware of the spill and initiates the response in daylight hours as visibility is critical for surveillance.

Technique	Resource capability and availability	Minimum implementation time
	the existing availability of alternative opportunistic aircraft. The addition of an extra aircraft will not reduce the time of response. Therefore, the “opportunistic” arrangement is considered appropriate, until such time that a trained aerial observer could be mobilised. The effectiveness of the response could also be improved through the use of trained aerial observers experienced and able to reliably detect, recognise and record oil pollution at sea; however, this would require a longer mobilisation time (24 hours). The higher quality of information provided is not expected to be improved to a level that would result in substantial environmental benefits, given the additional time it would take to mobilise a trained observer.	
Vessel surveillance	Other project vessels will be available for use as requested by INPEX or AMSA. Vessels of opportunity will also be available via call-off contracts.	48 hours Information from opportunistic vessels may be available sooner.
Satellite imagery analysis	Sourced via OSRL	48 hours

7.2 Secondary response measures

The following secondary response strategies have been determined as potentially applicable during the IAP development stage, (depending on hydrocarbon type).

- wildlife hazing
- pre-contact and/or post-contact wildlife response
- shoreline clean-up
- aerial and/or vessel-based dispersant application
- protect and deflect and/or contain and recover.

The arrangements and capability in place to implement these potential response measures are summarised in Table 7-2 to Table 7-6.

It should be noted that wildlife hazing and pre-contact/post-contact wildlife response are subject to regulatory approval. In addition, dispersant application may be subject to approval if its use may impact state waters.

Table 7-2: Arrangements and capabilities for wildlife hazing

Technique	Resource capability and availability	Minimum implementation time
Vessel-based wildlife hazing	Other project vessels will be available for use, as requested by INPEX or AMSA. Vessels of opportunity will also be available via call-off contracts.	48 hours Wildlife hazing using opportunistic vessels may be available sooner.

Table 7-3: Arrangements and capability for pre-contact and post-contact wildlife response

Technique	Resource capability and availability	Minimum implementation time
Oiled wildlife response (OWR) personnel	A WA DPaW 'oiled wildlife adviser' is available to the IMT (via WA DoT) under the (in draft) *West Australian Oiled Wildlife Response Plan* and *West Kimberley Oiled Wildlife Response Plan*. Approximately 20–30 oiled wildlife response personnel could be mobilised to Broome within 24 hours for mobilisation to support a Browse Island oiled wildlife response. Primary source of personnel: • At least one INPEX environmental person, trained in the WA DPAW oiled wildlife response course, will be available to assist with a wildlife response. • INPEX maintain service agreements with environmental service providers, to provide additional general field responders. Responders would receive on-the-job training, to assist, as required. AMOSC oil spill response (core-group) personnel are available via the INPEX membership of AMOSC to receive basic 'just-in-time training' and provide general response support, as directed by field management. WA DoT has state emergency response personnel that can receive basic 'just-in-time training' and provide general response support, as directed by field management. Secondary source of personnel: • Blue Planet Marine (WA, ACT) • Phillip Island Nature Park (QLD)	24 hours to mobilise personnel to Broome, board vessels and/or helicopters ready to deploy to wildlife response location.
Oiled wildlife response kit	Section 3 of the *West Kimberley Oiled Wildlife Response Plan* identifies a large number of oiled wildlife response kits, including those located in Broome, Exmouth and Dampier, which could be mobilised onto support vessels within 24–48 hours. AMOSC maintains an 'oiled wildlife response capability register' on behalf of industry to support an oiled wildlife response, which includes equipment and stockpile locations that could be mobilised onto support vessels within 6 hours	24 hours. Mobilisation times inclusive of the transit time to get the equipment from the warehouse in Broome to the spill location (approximately 18

Technique	Resource capability and availability	Minimum implementation time
	and present at the spill location within 24 hours (based on 18 hours transit time). Any reduction in this time is not warranted given that the response option is restricted by the availability of support vessels and trained personnel e.g. if AMOSC core-group are required to use the equipment.	hours away based on an average vessel speed of 14 knots), as well as the minimum time to mobilise equipment from the Broome stockpile to the wharf in Broome, ready for loading on to a vessel (6 hours).
Helicopters	The minimum requirements for a helicopter to support oil spill response activities at remote shoreline locations (such as Browse Island) are: • capacity to carry at least 6 personnel and their equipment, • fitted with cargo hooks for the ability to sling loads (i.e. equipment/waste) between the shoreline and nearby support vessels. • long-range fuel tanks due to the distance offshore • twin engines • life raft, satellite tracking and other safety systems. Small helicopters, such as BELL 206, AS350B and EC120, are capable of landing on remote islands with difficult access. However, they have single engines and were ruled out as they do not meet the criteria for safety, fuel range or have the ability to transport enough people/equipment to implement a response. Sikorsky S-92s, used for INPEX crew changes, meet some of the criteria, e.g. capacity, twin engines and long-range fuel tanks required to access remote areas. However, they do not have the capability to sling equipment, as they cannot be configured with cargo hooks. In addition, because of the size of the helicopter, the downwash generated is in excess of 125 km/h and landing on unprepared sites (like the concrete pad at Browse Island) can cause “brownout” conditions, which can restrict visibility due to the recirculation effect of the rotor downwash. Smaller helicopters, however, under aviation regulations are able to land at the Browse Island concrete pad (and possibly other shoreline locations) with extreme caution. However, aviation guidelines recommend that all aircraft operating under charter should have sufficient fuel to fly to an alternative aerodrome, which is not on a remote island. For example, for a response at Browse Island, the closest usable airport would be Lombadina. Based on the distance from Browse Island to Lombadina and the requirement for smaller helicopter types that can land at remote islands, the most suitable twin-engine helicopter types identified were the MBB Kawasaki BK-117 and the Airbus H-135 or H-145 (if fitted with a long-range fuel tank). Small helicopters, such as those listed above, are generally	7 days to mobilise utility helicopters via INPEX aviation call-off arrangements.

Technique	Resource capability and availability	Minimum implementation time
	working under contract with many configured in an air ambulance role or a surf rescue role. The market for surplus available aircraft is therefore limited and the response time cannot be guaranteed. The response implementation time could be improved to <7 days if a BK-117, H-135 or a long-range H-145 helicopter was positioned, on standby in Broome or Darwin on a permanent basis. The high cost (estimated at AUD1.5–2.0 million per year) of maintaining this capability, including the hire of the aircraft, pilots on standby, reoccurring training and maintenance of the aircraft, is considered to be grossly disproportionate to the environmental benefit gained. This is because a spill (and resulting impacts) would have already occurred with only clean-up taking place. It is not expected that a significant improvement for the environment would be achieved if clean-up commences within the first 7 days or whether it occurs from day 7 onwards. Other arrangements to get people and equipment onto remote shorelines to undertake oil spill response activities, without the use of a helicopter, have been considered. Vessel access to remote shorelines is weather-dependent and highly influenced by seasonality. There are significant safety risks associated with getting people on and off islands and beaches from small craft. This can only be done safely in calm weather and in the absence of swell. In addition, where islands have extensive surrounding reef platforms, such as at Browse Island, vessel access becomes restricted during periods of low tide, effectively stranding shoreline clean-up or wildlife response crews on the island and impacting the ability to medivac an injured or sick person for urgent medical attention. Smaller vessels (i.e. those <6 m), as a means to gain access to remote offshore islands, are generally towed to the location as a tender. Vessel speed limitations while towing a tender (10 knots) results in a transit time to the Ichthys Field from Broome of approximately 26 hours. Therefore, time to mobilise equipment, personnel, a vessel and a small tender (<6 m) in Broome and get to the location of the spill is estimated at approximately 3 days. Once at the spill clean-up location, the use of the smaller vessel may not be possible if weather conditions mean it is not safe to access the island. It is not expected that a significant improvement for the environment would be achieved if clean-up commences within the first 3 days or whether it occurs from day 7 onwards. The use of a light utility helicopter suitable for landing on Browse Island or similar remote shoreline for OWR, shoreline clean-up and protect and deflect / contain and recover activities is available under INPEX aviation call-off agreements within 7 days. Other alternatives have been considered to reduce the time to <7 days; however, the costs to maintain a utility helicopter are grossly disproportionate to the potentially negligible benefit gained. A vessel-based response using a small tender may be possible but presents potentially unacceptable health	

Technique	Resource capability and availability	Minimum implementation time
	and safety risks and cannot be guaranteed due to variability in weather conditions.	
Accomm-odation and logistics support vessels	<u>Support vessels – large (> 30 m) e.g. PSV</u> Larger vessels (>30 m) such as PSVs are used for a range of open ocean oil spill response activities, e.g. contain and recover. The minimum implementation time is affected by the location of specific PSVs at the time of the incident. As a worst-case, INPEX would mobilise any available larger PSV type support vessel from the Ichthys Field to Broome, load the vessel with equipment, supplies and personnel, and return to Ichthys Field or other similar distance spill location within 48 hours. This timeframe comprises transit time between the Ichthys Field and Broome which takes approximately 18 hours each way (based on an average speed of 14 knots), and up to 12 hours required for loading equipment in Broome). However, as INPEX operates two charter vessels from Broome, depending on their location at the time of the incident, this access time may be improved. Based on the distance from Broome to the Ichthys Field and limitations to wharf access, the only way to potentially improve the mobilisation time for a larger vessel would be to maintain a large PSV, on hire at anchor offshore of Broome, for the duration of the activity. This would incur standby costs of approximately AUD 20,000 per vessel, per day. However, a vessel would still need to wait for wharf space to become available, load the relevant response equipment, and then transit to the spill location. Therefore, the additional cost is considered to be grossly disproportionate given the limited environmental benefit gained by implementing the response approximately 12 to 24 hours faster.	48 hours
	<u>Support vessels – small (< 30 m) e.g. cray boat</u> Smaller vessels (< 30 m) can be used for supporting shallow-water response activities. While not capable of deploying large booms, these smaller vessels can support most other spill response activities, including wildlife hazing, protect and deflect, and shoreline response activities. Smaller response vessels are available in Broome. In an emergency, these smaller vessels, could be alongside a wharf to load supplies within 6 hours (i.e. Broome stockpile equipment transferred to the wharf and loaded onto vessel), then transit to the Ichthys Field, or other similarly distanced location, within 24 hours from the time they were activated, assuming an approximate transit time of 18 hours based on an average speed of 14 knots. Therefore, a small support vessel would be available on site within 24 hours. The only identified method to further improve the minimum implementation times for smaller vessel-based responses would be to have additional vessels on standby, or in the Ichthys Field, preloaded with spill response equipment and personnel trained to deploy the equipment. Spill response equipment requires regular maintenance, testing and	24 hours

Technique	Resource capability and availability	Minimum implementation time
	checking and, therefore cannot be permanently stored on board a vessel. In addition, there may be an operational requirement to have specific types of equipment from the stockpiles mobilised to different locations on different types of vessels, depending on the nature of the spill, receptors at risk and weather conditions at the time. It is not practicable to store and maintain all potentially useful types of equipment, and associated trained personnel to oversee the deployment of this equipment, offshore at all times.	

Table 7-4: Arrangements and capability for shoreline clean-up

Technique	Resource capability and availability	Minimum implementation time
Shoreline clean-up personnel	INPEX maintains contracts with short-term labour hire companies. Short-term labour can be made available at short notice to support shoreline clean-up. AMOSC oil spill response personnel, who can lead/manage the onsite shoreline response, are available via the INPEX membership of AMOSC. WA DoT would provide strategic advice to INPEX IMT for shoreline response activities. Under the WA DoT State Emergency Management Plan For Marine Oil Pollution (WestPlan MOP; WA DoT 2015), additional personnel to assist with direct clean-up activities may also be provided, if requested by the INPEX IMT. INPEX maintain a service agreement with environmental service providers, to provide additional general field responders, who would receive on-the-job training, to assist, as required.	24 hours to mobilise personnel to Broome to board vessels and/or helicopters ready to deploy to shoreline clean-up locations.
Shoreline clean-up equipment	Shoreline clean-up equipment can be mobilised from the Broome stockpile to the wharf in Broome within 6 hours and present at the spill location within 24 hours (based on 18 hours transit time).	24 hours. Mobilisation times inclusive of the transit time to get the equipment from the warehouse in Broome to the spill location (approximately 18 hours away based on an average vessel speed of 14 knots), as well as the minimum time to mobilise equipment from the Broome stockpile to the wharf in Broome, ready for loading

Technique	Resource capability and availability	Minimum implementation time
		on to a vessel (6 hours).
Helicopters	The minimum requirements for a helicopter to support oil spill response activities at remote shoreline locations (such as Browse Island) are: • capacity to carry at least 6 personnel and their equipment • fitted with cargo hooks for the ability to sling loads (i.e. equipment/waste) between the shoreline and nearby support vessels • long-range fuel tanks due to the distance offshore • twin engines • life raft, satellite tracking and other safety systems. Small helicopters, such as BELL 206, AS350B and EC120, are capable of landing on remote islands with difficult access. However, they have single engines and were ruled out as they do not meet the criteria for safety, fuel range or have the ability to transport enough people/equipment to implement a response. Sikorsky S-92s, used for INPEX crew changes, meet some of the criteria e.g. capacity, twin engines and long-range fuel tanks required to access remote areas. However, they do not have the capability to sling equipment as they cannot be configured with cargo hooks. In addition, because of the size of the helicopter the downwash generated is in excess of 125 km/h and landing on unprepared sites (like the concrete pad at Browse Island) can cause “brownout” conditions, which can restrict visibility due to the recirculation effect of the rotor downwash. Smaller helicopters, however, under aviation regulations are able to land at the Browse Island concrete pad (and possibly other shoreline locations) with extreme caution. However, aviation guidelines recommend that all aircraft operating under charter should have sufficient fuel to fly to an alternative aerodrome which is not on a remote island. For example, for a response at Browse Island, the closest usable airport would be Lombadina. Based on the distance of Browse Island to Lombadina and the requirement for smaller helicopter types that can land at remote islands, the most suitable twin-engine helicopter types identified were the MBB Kawasaki BK-117 and the Airbus H-135 or H-145 (if fitted with a long-range fuel tank). Small helicopters, such as those listed above, are generally working under contract with many configured in an air ambulance role or a surf rescue role. The market for surplus available aircraft is therefore limited and the response time cannot be guaranteed. The response implementation time could be improved to <7 days if a BK-117, H-135 or a long-range H-145 helicopter was positioned, on standby in Broome or Darwin on a permanent basis. The high cost (estimated at AUD 1.5–2.0 million per year) of maintaining this capability, including the hire of the aircraft, pilots on standby, reoccurring training and	7 days to mobilise utility helicopters via INPEX aviation call-off arrangements.

Technique	Resource capability and availability	Minimum implementation time
	maintenance of the aircraft, is considered to be grossly disproportionate to the environmental benefit gained. This is because the spill (and resulting impacts) would have already occurred with only clean-up taking place. It is not expected that a significant improvement for the environment would be achieved if clean-up commences within the first 7 days or whether it occurs from day 7 onwards. Other arrangements to get people and equipment onto remote shorelines to undertake oil spill response activities, without the use of a helicopter, have been considered. Vessel access to remote shorelines is weather-dependent and highly influenced by seasonality. There are significant safety risks associated with getting people on and off islands and beaches from small craft. This can only be done safely in calm weather and in the absence of swell. In addition, where islands have extensive surrounding reef platforms, such as at Browse Island, vessel access becomes restricted during periods of low tide, effectively stranding shoreline clean-up or wildlife response crews on the island and impacting the ability to medivac an injured or sick person for urgent medical attention. Smaller vessels (i.e. those <6 m), as a means to gain access to remote offshore islands, are generally towed to the location as a tender. Vessel speed limitations while towing a tender (10 knots) results in a transit time to the Ichthys Field from Broome of approximately 26 hours. Therefore, time to mobilise equipment, personnel, a vessel and a small tender (<6 m) in Broome and get to the location of the spill is estimated at approximately 3 days. Once at the spill clean-up location, the use of the smaller vessel may not be possible if weather conditions mean it is not safe to access the island. It is not expected that a significant improvement for the environment would be achieved if clean-up commences within the first 3 days or whether it occurs from day 7 onwards. The use of a light utility helicopter suitable for landing on Browse Island or similar remote shoreline for OWR, shoreline clean-up and protect and deflect / contain and recover activities is available under INPEX aviation call-off agreements within 7 days. Other alternatives have been considered to reduce the time to <7 days; however, the costs to maintain a utility helicopter are grossly disproportionate to the potentially negligible benefit gained. A vessel-based response using a small tender may be possible but presents potentially unacceptable health and safety risks and cannot be guaranteed due to variability in weather conditions.	
Accomm-odation and logistics support	Support vessels – large (> 30 m) e.g. PSV Larger vessels (>30 m) such as PSVs are used for a range of open-ocean oil spill response activities, e.g. contain and recover. The minimum implementation time is affected by the location of specific PSVs at the time of the incident. As a worst-case, INPEX would mobilise any available larger PSV type support vessel from the Ichthys Field to Broome, load the vessel with	48 hours

Technique	Resource capability and availability	Minimum implementation time
	equipment, supplies and personnel, and return to Ichthys Field or other similarly distanced spill location within 48 hours. This timeframe comprises transit time between the Ichthys Field and Broome which takes approximately 18 hours each way (based on an average speed of 14 knots), and up to 12 hours required for loading equipment in Broome). However, as INPEX operates two charter vessels from Broome, depending on their location at the time of the incident, this access time may be improved. Based on the distance from Broome to the Ichthys Field and limitations to wharf access, the only way to potentially improve the mobilisation time for a larger vessel would be to maintain a large PSV, on hire at anchor offshore of Broome, for the duration of the activity. This would incur standby costs of approximately AUD 20,000 per vessel, per day. However, a vessel would still need to wait for wharf space to become available, load the relevant response equipment, and then transit to the spill location. Therefore, the additional cost is considered to be grossly disproportionate given the limited environmental benefit gained by implementing the response approximately 12 to 24 hours faster.	
	Support vessels – small (< 30 m) e.g. cray boat Smaller vessels (<30 m) can be used for supporting shallow-water response activities. While not capable of deploying large booms, these smaller vessels can support most other spill response activities, including wildlife hazing, protect and deflect and shoreline response activities. Smaller response vessels are available in Broome. These smaller vessels, in an emergency, could be alongside a wharf to load supplies within 6 hours (i.e. Broome stockpile equipment transferred to the wharf and loaded onto vessel), and then transit to the Ichthys Field or other similarly distanced location within 24 hours from the time they were activated, assuming an approximate transit time of 18 hours based on an average speed of 14 knots. Therefore, a small support vessel would be available on site within 24 hours. The only identified method to further improve the minimum implementation times for smaller vessel-based responses would be to have additional vessels on standby, or in the Ichthys Field, preloaded with spill response equipment and personnel trained to deploy the equipment. Spill response equipment requires regular maintenance, testing and checking and therefore cannot be permanently stored on board a vessel. In addition, there may be an operational requirement to have specific types of equipment from the stockpiles mobilised to different locations on different types of vessels, depending on the nature of the spill, receptors at risk and weather conditions at the time. It is not practicable to store and maintain all potentially useful types of equipment, and associated trained personnel to oversee the deployment of this equipment, offshore at all times.	24 hours

Technique	Resource capability and availability	Minimum implementation time
Waste management	INPEX has a waste management contract in place for oil-contaminated waste to be received immediately for treatment or disposal. The outcome of predictive oil spill modelling indicates the worst-case estimate of oil accumulating on shorelines is 63 m^3 at Browse Island, resulting from a 5700 m^3 condensate vessel collision spill. Larger volumes of heavy fuel oil (HFO) may contact shorelines from an HFO tanker spill; however, AMSA will be the combat agency under these circumstances and INPEX will provide support to AMSA as required. Based on 63 m^3 of oil potentially contacting shorelines, approximately ten times more waste would be generated during a shoreline clean-up operation. Therefore, up to 630 m^3 of oil-contaminated waste may require disposal. This would require access to approximately 105 skips (assuming each standard skip has a capacity of 6 m^3). The INPEX waste management contract enables access to a sufficient number of skips and would be available in a timeframe to meet the first available vessel. It should be noted that vessels, such as an INPEX PSV, have sufficient deck space (approximately 600 m^2) and therefore would have capability to transport waste equipment (skips/tanks etc.) to an affected area.	Immediate

Table 7-5: Arrangements and capability for aerial and vessel based dispersant application

Technique	Resource capability and availability	Minimum implementation time
Ichthys Field dispersant stockpile	A stockpile of 16 m^3 of Slickgone NS dispersant is stored in the field management area.	If an available support vessel is in the field management area, mobilisation of dispersant to the support vessel could be achieved within 1 to 2 hours.
Fixed-Wing Aerial Dispersant (FWAD) stockpiles	Stockpiles that can be rapidly mobilised by air or road to the FWAD airbase are located in Darwin, Broome and Exmouth.	Stockpiles can be relocated via road or air to Mungalalu Truscott Airport within 24 hours.
Aerial-based dispersant application	Fixed-wing aerial-based dispersant application could be implemented within 24 hours. A key control and contractual requirement of the FWAD contract (AMSA 2015b) is the provision of an Air Attack Supervisor, to ensure dispersant is correctly applied to the spill. Incorrect air attack supervision could potentially result in dispersant contamination of the ocean, without any effect on the spill. AMOSC has confirmed that Air Attack Supervisors are	24 hours* * All timings are based from the moment the relevant emergency response team

Technique	Resource capability and availability	Minimum implementation time
	government-appointed personnel, generally sourced from the various fire departments throughout Australia. This select group of personnel maintain their skill-set through ongoing real-life air attack activities (e.g. bushfire water-bombing operations). There are no industry trained Air Attack Supervisors because of the limited opportunities for personnel to be trained and maintain this skill-set and it is therefore appropriate that government-trained personnel are used and sourced by AMSA/AMOSC during an oil spill incident in support of FWAD operations. As Air Attack Supervisors are located throughout Australia, it is expected that it would take a minimum of 24 hours to mobilise one Air Attack Supervisor to the FWAD-nominated airfield (i.e. Mungalalu Truscott Airport) and be ready to implement an aerial-based dispersant application. Therefore, due to the costs and impracticalities (especially Air Attack Supervisors) decreasing mobilisation timeframes is not considered practicable.	(ERT) member is aware of the spill and initiates the response in daylight hours as visibility is critical for this response.
Vessel-based dispersant application	In WA-50-L, a stockpile of 16 m^3 of Slickgone NS dispersant and a mobile spray system will be maintained. INPEX will operate support vessels, all equipped with their own dispersant spray systems fixed, onboard. These vessels will maintain their own teams of personnel on board at all times, who are trained in the use of their vessel-specific dispersant spray system. In the event of a spill which is amenable to dispersant application, and there is a support vessel in the Ichthys Field, dispersant and a mobile spray system (if required) could be transferred (i.e. crane-lifted from FPSO or ASV) to the support vessel within 3 hours. Set-up on board, i.e. decant dispersant and configure spray booms, would take 2 hours. Therefore, vessel-based dispersant application would be able to occur within 5 hours.	5 hours * * All timings are based from the moment the relevant emergency response team (ERT) member is aware of the spill and initiates the response in daylight hours as visibility is critical for this response.
Vessel-based dispersant trained personnel	Personnel working at the location where the dispersant stockpile and mobile spray systems are stored, and personnel on the PSVs/OSV, will be trained in vessel-based dispersant application.	Trained personnel will always be available on the PSVs/OSV during Operations. Trained personnel will always be available, located in Zone 1, who can mobilise the dispersant spray system to an available support vessel.
Aerial surveillance	Aerial surveillance with aircraft of opportunity with untrained observers (provided with INPEX's oil spill observation guide) will be available with a minimum implementation time of 5 hours*, and may involve using any of the following:	5 hours * All timings are based from the moment the

Technique	Resource capability and availability	Minimum implementation time
	• crew change helicopters that can be diverted with pilot and spotter • search and rescue helicopter • fixed-wing aircraft available in cyclone season (6 months of the year). Personnel who have completed the AMOSC air observer course could be used, to increase the quality of aerial observer data received by the IMT during the initial stages of a spill response. However, the quality of data that would be received by the IMT, from personnel, such as helicopter co-pilots, using the INPEX oil spill observation aid, and data from other operational and monitoring evaluation techniques, will provide adequate information for the INPEX IMT to conduct its role. It should be noted that the crew-change helicopter pilots are familiar with observing the natural colours and shades of the ocean in the Browse Basin / Timor Sea area and, therefore, are less likely to misinterpret natural phenomenon, such as cloud-shadow or algal bloom for oil slicks. In order to implement aerial surveillance in under 48 hours, using trained aerial observers, would require trained observers on a standby contract, located in Broome on a permanent basis. However, this additional standby cost is considered grossly disproportionate given INPEX has crew-change helicopter pilots available in Broome, equipped with the INPEX oil spill observation aid.	relevant emergency response team (ERT) member is aware of the spill and initiates the response in daylight hours as visibility is critical for surveillance.

Table 7-6: Arrangements and capabilities – protect and deflect / contain and recover

Technique	Resource capability and availability	Minimum implementation time
Protect and deflect / contain and recover personnel	AMOSC core group personnel, who can lead/manage a protect and deflect / contain and recover activity, are available via the INPEX membership of AMOSC. WA DoT would provide strategic advice to INPEX IMT for any protect and deflect activities at WA shorelines. Under the WA DoT State Emergency Management Plan For Marine Oil Pollution (WestPlan MOP; WA DoT 2015), additional personnel to assist with protect and deflect activities may also be provided, if requested by the INPEX IMT. INPEX has the ability to contract additional general field responders under short-term labour hire contracts.	24 hours to mobilise personnel to Broome to board vessels and/or helicopters ready to deploy to protect and deflect / contain and recover locations.
Protect and deflect / contain and recover equipment	Level 1 protect and deflect / contain and recover equipment can be mobilised from the Broome stockpile to the wharf in Broome within 6 hours and present at the spill location within 24 hours (based on 18 hours transit time).	24 hours Mobilisation times inclusive of the transit time to get the equipment from the warehouse in Broome to the spill

Technique	Resource capability and availability	Minimum implementation time
		location (approximately 18 hours away based on an average vessel speed of 14 knots), as well as the minimum time to mobilise equipment from the Broome stockpile to the wharf in Broome, ready for loading onto a vessel (6 hours).
Helicopters	The minimum requirements for a helicopter to support oil spill response activities at remote shoreline locations (such as Browse Island) are: • capacity to carry at least 6 personnel and their equipment, • fitted with cargo hooks for the ability to sling loads (i.e. equipment/waste) between the shoreline and nearby support vessels. • long-range fuel tanks due to the distance offshore • twin engines • life raft, satellite tracking and other safety systems. Small helicopters, such as BELL 206, AS350B and EC120, are capable of landing on remote islands with difficult access. However, they have single engines and were ruled out as they do not meet the criteria for safety, fuel range or have the ability to transport enough people/equipment to implement a response. Sikorsky S-92s, used for INPEX crew changes, meet some of the criteria e.g. capacity, twin engines and long-range fuel tanks required to access remote areas. However, they do not have the capability to sling equipment as they cannot be configured with cargo hooks. In addition, because of the size of the helicopter the downwash generated is in excess of 125 km/h and landing on unprepared sites (like the concrete pad at Browse Island) can cause "brownout" conditions which can restrict visibility due to the recirculation effect of the rotor downwash. Smaller helicopters, however, under aviation regulations are able to land at the Browse Island concrete pad (and possibly other shoreline locations) with extreme caution. However, aviation guidelines recommend that all aircraft operating under charter should have sufficient fuel to fly to an alternative aerodrome, which is not on a remote island. For example, for a response at Browse Island, the closest usable airport would be Lombadina. Based on the distance of Browse Island to Lombadina and the requirement for smaller helicopter types that can land at remote islands, the most suitable twin-engine helicopter types identified were the MBB Kawasaki BK-117 and the Airbus H-135 or H-145 (if fitted	7 days to mobilise utility helicopters via INPEX aviation call-off arrangements.

Technique	Resource capability and availability	Minimum implementation time
	with a long-range fuel tank). Small helicopters, such as those listed above, are generally working under contract with many configured in an air ambulance role or a surf rescue role. The market for surplus available aircraft is therefore limited and the response time cannot be guaranteed. The response implementation time could be improved to <7 days if a BK-117, H-135 or a long-range H-145 helicopter was positioned, on standby in Broome or Darwin on a permanent basis. The high cost (estimated at AUD1.5–2.0 million per year) of maintaining this capability, including the hire of the aircraft, pilots on standby, reoccurring training and maintenance of the aircraft, is considered to be grossly disproportionate to the environmental benefit gained. This is because the spill (and resulting impacts) would have already occurred with only clean-up taking place. It is not expected that a significant improvement for the environment would be achieved if clean-up commences within the first 7 days or whether it occurs from day 7 onwards. Other arrangements to get people and equipment onto remote shorelines to undertake oil spill response activities, without the use of a helicopter, have been considered. Vessel access to remote shorelines is weather-dependent and highly influenced by seasonality. There are significant safety risks associated with getting people on and off islands and beaches from small craft. This can only be done safely in calm weather and in the absence of swell. In addition, where islands have extensive surrounding reef platforms, such as at Browse Island, vessel access becomes restricted during periods of low tide, effectively stranding shoreline clean-up or wildlife response crews on the island and impacting the ability to medivac an injured or sick person for urgent medical attention. Smaller vessels (i.e. those <6 m), as a means to gain access to remote offshore islands, are generally towed to the location as a tender. Vessel speed limitations while towing a tender (10 knots) results in a transit time to the Ichthys Field from Broome of approximately 26 hours. Therefore, time to mobilise equipment, personnel, a vessel and a small tender (<6 m) in Broome and get to the location of the spill is estimated at approximately 3 days. Once at the spill clean-up location, the use of the smaller vessel may not be possible if weather conditions mean it is not safe to access the island. It is not expected that a significant improvement for the environment would be achieved if clean-up commences within the first 3 days or whether it occurs from day 7 onwards. The use of a light utility helicopter suitable for landing on Browse Island or similar remote shoreline for OWR, shoreline clean-up and protect and deflect / contain and recover activities is available under INPEX aviation call-off agreements within 7 days. Other alternatives have been considered to reduce the time to <7 days; however, the costs to maintain a utility helicopter are grossly disproportionate to the potentially	

Technique	Resource capability and availability	Minimum implementation time
	negligible benefit gained. A vessel-based response using a small tender may be possible but presents potentially unacceptable health and safety risks and cannot be guaranteed due to variability in weather conditions.	
Accomm-odation and logistics support	<u>Support vessels – large (> 30 m) e.g. PSV</u> Larger vessels (>30 m) such as PSVs are used for a range of open ocean oil spill response activities e.g. contain and recover. The minimum implementation time is affected by the location of specific PSVs at the time of the incident. As a worst-case, INPEX would mobilise any available larger PSV type support vessel from the Ichthys Field to Broome, load the vessel with equipment, supplies and personnel, and return to Ichthys Field or other similar distance spill location within 48 hours. This timeframe comprises transit time between the Ichthys Field and Broome which takes approximately 18 hours each way (based on an average speed of 14 knots), and up to 12 hours required for loading equipment in Broome). However, as INPEX operates two charter vessels from Broome, depending on their location at the time of the incident, this access time may be improved. Based on the distance from Broome to the Ichthys Field and limitations to wharf access, the only way to potentially improve the mobilisation time for a larger vessel would be to maintain a large PSV, on hire at anchor offshore of Broome, for the duration of the activity. This would incur standby costs of approximately AUD 20,000 per vessel, per day. However, a vessel would still need to wait for wharf space to become available, load the relevant response equipment, and then transit to the spill location. Therefore, the additional cost is considered to be grossly disproportionate given the limited environmental benefit gained by implementing the response approximately 12 to 24 hours faster.	48 hours
	<u>Support vessels – small (< 30 m) e.g. cray boat</u> Smaller vessels (< 30 m) can be used for supporting shallow-water response activities. While not capable of deploying large booms, these smaller vessels can support most other spill response activities, including wildlife hazing, protect and deflect and shoreline response activities. Smaller response vessels are available in Broome. These smaller vessels, in an emergency, could be alongside a wharf to load supplies within 6 hours (i.e. Broome stockpile equipment transferred to the wharf and loaded onto vessel), and then transit to the Ichthys Field or other similarly distanced location within 24 hours from the time they were activated, assuming an approximate transit time of 18 hours based on an average speed of 14 knots. Therefore, a small support vessel would be available on site within 24 hours. The only identified method to further improve the minimum implementation times for smaller vessel-based responses would be to have additional vessels on standby, or in the Ichthys Field, preloaded with spill response equipment and	24 hours

Technique	Resource capability and availability	Minimum implementation time
	personnel trained to deploy the equipment. Spill response equipment requires regular maintenance, testing and checking and therefore cannot be permanently stored on board a vessel. In addition, there may be an operational requirement to have specific types of equipment from the stockpiles mobilised to different locations on different types of vessels, depending on the nature of the spill, receptors at risk and weather conditions at the time. It is not practicable to store and maintain all potentially useful types of equipment, and associated trained personnel to oversee the deployment of this equipment, offshore at all times.	
Waste management	INPEX has a waste management contract in place for oil-contaminated waste to be received immediately for treatment or disposal.	Immediate

7.3 Operational and scientific monitoring plans

In 2011, an Operational and Scientific Monitoring Program (OSMP) was developed by the Environment Group Browse Basin (of which INPEX is a member). The program encompasses a number of individual Operational Monitoring (OM) and Scientific Monitoring (SM) plans to guide a spill response, assess potential environmental impacts and inform any remediation activities. The OSMP has been reviewed and refined for the various emergency conditions (and fuel types) as described in the EP.

Operational monitoring is to commence as soon as a spill occurs and aims to characterise the nature and scale of the spill for the duration of the spill. Monitoring is designed to collect information on the predicted spread of the oil and the locations it may impact and, in turn, the OM informs and supports a secondary oil spill response, such as wildlife hazing and dispersant application, as well as the scientific monitoring.

Scientific monitoring is the investigation component which assesses the overall impact and recovery of the ecosystems which have been exposed to hydrocarbons and response activities, as informed by the OM program.

Each monitoring plan will be tailored, activated and terminated as appropriate to the characteristics, nature and scale of the spill under the supervision of the INPEX IMT Leader, in consultation with:

- the INPEX IMT environmental adviser
- AMOSC
- environmental service providers
- environmental science coordinator (WA DoT) for spills entering WA state waters.

INPEX will organise and implement the OSMP for spills for which INPEX is the control agency (e.g. facility based spills).

AMSA is responsible for monitoring (OSMP implementation) in instances where AMSA is the control agency (e.g. vessel-based spills). INPEX will provide support to AMSA, in accordance with a Memorandum of Understanding between AMSA and INPEX.

Consultation with relevant regulatory authorities, regarding progress and outcomes of the OSMP, will occur as part of ongoing notifications and reporting during an emergency (spill) response.

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APPENDIX A: CONSEQUENCE ASSESSMENT

A1:

Source of risk or impact	**Potential consequence**
Atmospheric emissions from power generation, flaring, venting and other offshore emission sources.	The particular values and sensitivities identified as having the potential to be impacted by atmospheric emissions are: • presence of a listed migratory species (marine avifauna). There are no known marine avifauna BIAs within 100 km of the operational area; however, marine avifauna breed at Browse Island and a number of migratory marine avifauna species may transit near Zone 1 during their migration via the East Asian–Australasian Flyway (EAA Flyway) (see Section 3). In the absence of air quality standards or guidelines specifically for marine avifauna, a review of human health air quality standards and guidelines was undertaken to be used as a proxy for the assessment of atmospheric emissions from the CPF and FPSO and potential impacts to marine avifauna. The review identified thresholds for NO_2 set by the World Health Organization (WHO) to protect human and animal health based on a 1-hour mean exposure (200 µg/m^3) and an annual mean exposure (40 µg/m^3) (WHO 2005). These thresholds were compared to Australian ambient air quality standards set by National Environmental Protection Measures (NEPM), reported as 226 µg/m^3 (1-hour exposure) and 56 µg/m^3 (annual mean exposure), respectively. Emissions dispersion modelling was undertaken by APASA (2014) to predict the potential extent of pollutant concentrations using the more conservative World Health Organization thresholds for NO_2. Modelling examined the conversion of NO_X emissions to NO_2 and elemental mercury as the key constituents of concern. Therefore, a threshold of 0.01 µg/m^3 was adopted for the modelling based on the Texas Commission of Environmental Quality standard (TCEQ cited in APASA 2014) for forms of mercury in air. This is a more conservative threshold standard when compared to the Worksafe Australia maximum exposure concentration of 5 µg/m^3 for elemental mercury, although this is not specifically for atmospheric exposure alone (Qld Health 2002). The modelling study concluded that NO_2 concentrations may typically exceed long-term (annual average) within a few kilometres of the emissions source, i.e. 2–3 km. Short-term (1-hour average) exposure levels may also be exceeded within a few hundred metres, i.e. 200–400 m of the emission source (APASA 2014). Modelling results also reported mercury concentrations of concern were not detected beyond the CPF and FPSO themselves (APASA 2014). Therefore, modelling indicates that changes in air quality are expected to be localised. Changes in air quality resulting from vessel and equipment emissions are also predicted to be highly localised given the nature of those emissions is less than those from the facility. The thresholds referenced in the APASA (2014) modelling study are time-averaged standards which take into account continuous, long-term exposures and chronic health impacts. If marine avifauna are exposed at all, they are only expected to be exposed to changes in air quality for short periods as they pass close to emissions sources. Chronic exposures are not considered plausible given that marine avifauna would move away, i.e. continue migration, or foraging activities elsewhere. Therefore, the ambient air quality standards do not accurately represent thresholds that may potentially result in acute, short-term physiological or toxicological effects to transient marine avifauna that may be exposed for very short periods of time. Acute exposure thresholds are not available for the key atmospheric emission constituents predicted to occur from the offshore facility and vessels. However, it is reasonable to expect that pollutant concentrations would need to be significantly higher than thresholds (for human health) to result in any discernible acute physiological or

Source of risk or impact	Potential consequence
	toxicological effects to marine avifauna, and such concentrations are expected to be highly localised and in the immediate vicinity of exhaust stacks and vents. A review of the human health and environmental effects of the various air pollutants, as described in the National Pollutant Inventory, indicates that short-term exposures to significant concentrations of pollutants such as CO, NO_X, SO_2, VOCs, and fine particles, could cause symptoms such as irritation to eyes and respiratory tissues, breathing difficulties, and nausea. As a worst case, it is conservatively assumed that a small number of individual marine avifauna may develop some short-term symptoms if they remain in the immediate vicinity of an emissions source where the pollutants are most concentrated, with rapid recovery after individuals move away from the source. However, such exposures and symptoms are not expected to occur. Temporary increases in combustion emissions may occur during flaring during start-up, maintenance, process upsets or emergency conditions; however, this is not expected to result in a significant increase in exposure to marine avifauna as they are expected to avoid the immediate area surrounding the flare. Atmospheric venting from the FPSO may also occur infrequently during process upsets and could result in short-term increases in process gas emissions and H_2S concentrations. However, these will rapidly disperse following release from the vents in the open marine environment and the potential for exposure remains limited to the immediate vicinity of the vents. Overall, the consequences of localised changes in air quality may result in short-term, sublethal effects to a small number of transient marine avifauna individuals, and are therefore considered insignificant.

A2:

Source of risk or impact	Potential consequence
Change in light levels from flaring	The particular values and sensitivities identified as having the potential to be impacted by light emissions from flaring are: • marine turtles (including the green turtle BIA at Browse Island) • marine avifauna. Shell (2009) estimated that light from flaring activities can be detected as far as 51 km from the source. Similarly, an assessment by Woodside (2014) for the Browse FLNG development reported that the maximum distance at which flaring under routine operational conditions was detectable was 47.7 km. However, in the event of emergency flaring, Woodside's assessment reported that light may be visible up to ten kilometres further than during normal operating conditions but that any such emergency flaring would be of a short-term duration. Behavioural changes reported in marine turtles exposed to increases in artificial lighting can include disorientation and interference during nesting (Pendoley 2005). Disorientation of adult marine turtles or hatchlings has been known to result in risks to the survival of some individuals through excess energy expenditure or increased likelihood of predation (Witherington & Martin 2000; Limpus et al. 2003). Previous investigations on the effects of light from flaring on marine turtles in Western Australia found that the effects of disorientation on turtles caused by flaring only occurred around the new moon, with the impact reducing with distance from the source and as the moon phase progressed towards full moon (Pendoley 2000). The potential effect of direct light from the flare tip or glow from deck facilities is mitigated by the reduction in intensity of light, which diminishes with the square of the distance (i.e. light is reduced to one-hundredth of the initial intensity after 10 m, one ten-thousandth after 100 m, etc.) and by the spectral

Source of risk or impact	Potential consequence
	range of the emitted light. Gas flares emit measurable light energy over the whole range of visible and near-infrared wavelengths, with peak intensities in the spectral range from 750 to 900 nm (Hick 1995) while the most disruptive wavelengths to turtles are in the range of 300 to 500 nm (Tuxbury & Salmon 2005; Witherington 1992). Therefore, the glow that may be visible at Browse Island is considered to be too low and primarily of the wrong spectral range to cause any disturbance to turtles. It should also be noted that while turtle hatchlings primarily use light cues to orient to water, once in the water they rely on sea-wave and magnetic cues for orientation (Witherington & Martin 1996; DEE 2016), therefore further limiting any potential impacts of light from flaring once turtles have reached the ocean. It should also be noted that an operational lighthouse is present on Browse Island for navigation purposes. There are no known important foraging areas for turtles near to the offshore facility, with the closest known turtle nesting BIA being at Browse Island, over 33 km from the offshore facility. Although light emissions from flaring may be visible at Browse Island, significant exposure or changes in ambient light levels are not expected to affect the behaviour of the marine turtle population at this area. This assessment was confirmed by the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC 2008) through the formal environmental assessment process, indicating that the risk of light spill adversely impacting any listed threatened species is low. The offshore light source created by the flare is not expected to have a discernible effect on adult turtles' or hatchlings' abilities to orientate to water at Browse Island and the potential for light from flaring to attract marine turtles once they are at sea is expected to be temporary with an inconsequential ecological significance. While it is not considered a regionally significant habitat for marine avifauna, with previous surveys finding a lack of diversity of seabirds breeding there (Clarke 2010), Browse Island has been recognised, through stakeholder consultation with WA DPaW as an important location for marine avifauna. Marine avifauna are highly, visually orientated. Impacts on large flocks of birds, including fatalities, have previously been documented on oil platforms. Injuries may occur through direct collisions, with the rate of collisions (as inferred from literature) related to weather conditions, the cross-sectional area of the obstacle, the amount of light and number of birds travelling through an area at the time. Where bird collision incidents have been reported, low visibility weather conditions (cloudy, overcast and foggy nights) are usually implicated as the major contributing factor and there are seldom collision incidents on clear nights (Wiese et al. 2001). Conditions in Zone 1 are not conducive to fog formation with most rainfall associated with the monsoon season between December and March (Section 3) which is outside the periods of bird migration (southward migration is from August to November, and northward migration from March to May) (Bamford et al. 2008). The environmental consequence attributable to light emissions from intermittent flaring from the CPF and FPSO is expected to be temporary with an inconsequential ecological significance.

A3:

Source of risk or impact	Potential consequence
Change in light levels from navigational lights on the	The particular values and sensitivities identified as having the potential to be impacted are: • marine turtles (including the green turtle BIA at Browse Island)

Source of risk or impact	Potential consequence
facility and vessels	• marine avifauna. Behavioural changes reported in marine turtles exposed to increases in artificial lighting can include disorientation and interference during nesting (Pendoley 2005). Browse Island is the closest turtle-nesting area which is located approximately 33 km from the offshore facility. This area is used by green turtles as a nesting area and is listed as a C-class reserve for this reason. Once turtle hatchlings have reached the ocean, hatchlings normally maintain seaward headings by using wave propagation direction as an orientation cue. Because waves and swells generally reliably move towards shore in shallow coastal areas, swimming into waves usually results in movement towards the open sea (Lohmann & Fittinghoff-Lohmann 1992). While there is a slight chance that hatchlings and adult turtles could be attracted towards the facility and support vessel lighting, this is considered highly unlikely given the distance of 33 km. The offshore facility and support vessels are located within the EAA Flyway, an internationally recognised migratory bird pathway that covers the whole of Australia and its surrounding waters. There are 54 species of migratory shorebirds that are known to specifically follow migration paths within the EAA Flyway (Bamford et al. 2008). The migration of birds through the EAA Flyway generally occurs at two times of year, northward between March and May and southward between August and November (Bamford et al. 2008). Therefore, impact of light from the offshore facility may be slightly elevated for six months of the year. While not an identified BIA, the closest habitat for seabirds from the offshore facility is Browse Island. Browse Island is not a regionally significant habitat for seabirds, with previous surveys finding a lack of diversity of seabirds breeding there (Clarke 2010). However, Browse Island has been recognised, through stakeholder consultation with WA DPaW, as an important location for seabirds. Lighting from offshore platforms and the vessels that service them has also been found to attract seabirds, particularly those that are nocturnally active (BirdLife International 2012). Nocturnal birds are at much higher risk of impact (Weise et al. 2001); however, there are no threatened nocturnal migratory seabirds that use the EEA Flyway (DEWHA 2010). A study by Poot et al. (2008) of offshore oil platforms in the North Sea, found that large flocks of migrating seabirds can be attracted to the lights of offshore oil platforms, particularly on cloudy nights and between the hours of midnight and dawn. Poot 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 only small additional fat reserves than required for the transit (e.g. twelve hours of fat reserves for a ten-hour flight). Any delay (e.g. resting on a facility or circling around them) may decrease the bird's resilience and potential survival. Studies conducted in the North Sea indicate that migratory birds may be attracted to offshore lights when travelling within a radius of 3 to 5 km from the light source. Outside this area their migratory paths are likely to be unaffected (Marquenie et al. 2008). Significant effects of lighting associated with oil and gas infrastructure on populations of migratory birds have been found previously in the northern hemisphere as described above (Weise et al. 2001); however, there is no published literature of these impacts occurring on the NW Shelf of Western Australia. Migratory shorebirds travelling the EAA Flyway may fly through Zone 1, before moving on to the mainland (south) in the spring or Indonesia (north) in the autumn. It is possible that migratory birds may use ships and facilities in order to rest. However, the possibility of this occurring on the FPSO and CPF is low due to the presence of alternative habitat for resting and foraging (marine avifauna BIAs) in relatively close proximity (Browse Island approximately 33

Source of risk or impact	Potential consequence
	km away). If any birds were attracted to the facility for resting, due to the proximity of BIAs, it would only present a minimal deviation from migratory pathways. Therefore, impacts to seabirds and migratory birds potentially attracted to light on the CPF, FPSO or vessels in Zone 1, leading to a diversion from migratory behaviours, is not expected. The environmental consequence attributable to light emissions from the facility and support vessels is considered to be a minor and temporary (in the case of vessels, which will be transient) impact to a small proportion of a protected species.

A4:

Source of risk or impact	Potential consequence
Routine discharges – subsea discharges during operations and IMR activities	The particular values and sensitivities identified as having the potential to be impacted by changes to water quality from discharges of subsea control fluids are: • transient, EPBC-listed species • benthic communities. The operational area (Zone 1) is a disturbed site that has been subject to construction activity since 2014. Zone 1 has a water depth of approximately 250 m, is located in a high current environment, subject to oceanographic processes. Small volume, regular and intermittent discharges are expected to experience rapid dilution and dispersion in highly localised areas at the discharge point. Seabed surveys in the Project location indicate benthic habitats are limited to flat and featureless soft substrate areas, typical of deep continental shelf seabed and are widely distributed in the deeper parts of the Browse Basin (RPS 2007). Potential exposure of transient, EPBC-listed species to subsea and topside discharges of subsea control fluids and weak acetic acid from marine growth/lime-scale removal is expected to be localised to the point of release, in Zone 1, and will disperse through natural physical oceanic processes, such as currents, tides and waves. In the absence of any known BIAs for marine fauna in Zone 1, any individuals present are likely to be transiting the area for a short duration. The subsea hydraulic fluid selected has been formulated for use in subsea production control systems and contains a biodegradable red dye. MEG is considered to pose little or no risk to the environment (PLONOR) by OSPAR (2012). Although routine operational discharges will be relatively small in volume and localised at the point of release, they will occur regularly over the life of production operations (40 years). Larger volumes of MEG that may be discharged during IMR activities, such as pigging of subsea infrastructure or discharges associated with major repairs will be released to the marine environment. However, given the low toxicity ratings, the dispersive receiving environment, widely represented benthic habitats and lack of BIAs for transient, EPBC-listed species, it is considered that the most plausible consequence would be ranked as insignificant. In the event of an IMR activity, such as replacement of a flowline, the new flowline would require to be recommissioned as per the initial installation and commissioning of flowlines during the construction phase of the Project. Any volumes of FIS used and discharged, during repair activities, will be of a similar quantity, chemical composition, and concentration used during the initial

Source of risk or impact	Potential consequence
	installation and commissioning of flowlines as described in the NOPSEMA-accepted *Umbilical, Riser and Flowline (URF) Installation Environment Plan* (E075-AH-PLN-10000). In a flowline replacement scenario, FIS could remain within flowlines for up to 1–2 years before being discharged to sea. Discharged FIS will have depleted oxygen concentrations due to the presence of oxygen scavenger and will contain residual biocide and a non-toxic fluorescein dye used for leak detection. The active chemical components of the oxygen scavenger and biocide are sodium bisulfite (45%) and glutaraldehyde (24%), respectively. Sodium bisulfate is rated as PLONOR by OSPAR (2012) and glutaraldehyde and fluorescein both have a CHARM rating of Gold. In reacting with oxygen in pipe, sodium bisulfite converts to sodium bisulfate, a weak acid. This will cause a reduction in pH of the FIS by approximately 0.5 to 1 unit, resulting in a pH of approximately 7.4. The stability of glutaraldehyde is known to be enhanced in neutral or acidic conditions; however, degradation of glutaraldehyde will continue to occur in the presence of sodium bisulfate. The purpose of adding oxygen scavenger (sodium bisulfite) is to cause anaerobic conditions to develop in the flowline and hence limit microbial growth. Anaerobic metabolism of glutaraldehyde will result in its biodegradation and, as concentrations decrease, the toxicity will also decrease over time, especially given the potential residence time of up to 1–2 years within the flowline. Biodegradation of glutaraldehyde in anaerobic conditions is expected to occur relatively quickly with approximately 70% degraded in 100 days (McIlwaine 2002) and will result primarily in the formation of 1,5-pentanediol which is non-toxic (Leung 2000). Therefore, the toxicity of the FIS at the time of discharge is expected to be negligible due to the oxygen scavenger having been consumed and the formation of 1,5-pentanediol from the degradation of glutaraldehyde. FIS discharged to sea is expected to be highly influenced by natural dispersion and dilution processes associated with the currents experienced in the offshore environment enabling reoxygenation. Potential impacts on benthic habitats from the discharge of FIS are primarily focused on oxygen depletion and the competition for oxygen as a resource by benthic communities (Ferguson et al. 2013). In conjunction with the reported limited benthic community abundance and diversity in Zone 1 (RPS 2007), and infrequent nature and low toxicity of the discharge (i.e. only in the event of a significant IMR activity), the consequence of the exposure of benthic communities to plumes of deoxygenated FIS would be at a local scale with a temporary impact, and is therefore ranked as insignificant. The discharge of a significantly larger volume of FIS, the full contents of the GEP (710 000 m^3), is described in the NOPSEMA-accepted *INPEX GEP Precommissioning Environment Plan* (C050-AH-PLN-10001) and was assessed as minor consequence. Given that the worst-case potential volume discharged during IMR activities, such as a flowline replacement, is 4280 m^3, i.e. several orders of magnitude lower than the GEP discharge, the consequence is ranked as insignificant to reflect the temporary and localised nature and scale of this discharge.

A5:

Source of risk or impact	Potential consequence
Routine discharges – CPF cooling water	Particular values and sensitivities with the potential to be impacted are: • transient, EPBC-listed species • planktonic communities.

Source of risk or impact	Potential consequence
	The CPF cooling water system is treated continuously with sodium hypochlorite (NaClO), generated through an electrolysis reaction in the biofouling control package. The biocidal effectiveness of seawater chlorination attributed to NaClO residuals is due to the generation of chlorine-produced oxidants such as hypobromous acid (HOBr). HOBr reacts with the natural organic material (NOM) in seawater to form chlorination by-products (CBP), the primary one of which is bromoform. The fundamental consequence of HOBr in reacting with a range of NOM is that the toxicity of the initial reactant is either neutralised or diluted across a range of by-products. The highest expected concentration of bromoform, is calculated to be 0.032 ppm, which is well below its most conservative LC_{50} value (for fish) of 12 ppm, (PAN 2016). Hence, no dilution once entering the marine environment would be required to reach a safe concentration (LC_{50}). This is further supported by a study by Taylor (2006) that summarised the effects of chlorination on the marine environment. The study was based on a review of applications using hypochlorite as an antifoulant for the seawater cooling circuits, and highlighted that: • the chlorination procedure itself does cause the mortality of a proportion of planktonic organisms and the smaller organisms entrained through a cooling water system; however, only in very rare instances, where dilution and dispersion were constrained, were there any impacts beyond the point of discharge • long term exposure to chlorination residues on fish species did not impose any apparent ecotoxicological stress • studies of the impact of CBP on marine communities, population, physiological, metabolic and genetic levels, indicate that the practice of low-level chlorination on coastal receiving water is minor in ecotoxicological terms. These findings indicate that the toxicity of the cooling water is negligible at discharge and unlikely to require further dilution. However, thermal effects may present an issue and therefore these have been considered further. The outcome of the modelling indicated that near-field processes should limit the temperature of the discharge plume to no more than 1.6 °C above ambient temperature at 100 m from the discharge point for the worst-case scenario, which is in alignment with IFC guidelines (2015) that recommends discharges should not result in a temperature increase of more than 3 °C at the edge of the mixing zone. It should also be noted that surface waters of the region are tropical year-round, with surface temperatures of ~26 °C in summer and ~22 °C in winter (DSEWPaC 2012) and baseline monitoring in the offshore development area recorded surface water temperatures of ~30 °C in summer (March) and ~26–27 °C in winter (July) (INPEX 2010). Therefore, over the seasons, seawater temperatures naturally vary by around 3 to 4 °C. Effects of elevation in seawater temperature cause a range of behavioural responses in transient, EPBC-listed species including attraction and avoidance behaviour. There are no known BIAs or aggregation areas that would result in sedentary behaviour in this area, and EPBC-listed species with the potential to be present in Zone 1 are considered to be transient in nature (DoE 2015). The facility is situated in an open-ocean location in a water depth of approximately 250 m in a high current environment; therefore, potential consequences on transient, EPBC-listed species are potentially localised avoidance of thermally elevated water temperatures with an inconsequential ecological significance to protected species. Elevated seawater temperatures are known to cause alterations to the physiological (especially enzyme-mediated) processes of exposed biota (Wolanski 1994). These alterations may cause a variety of effects and potentially even mortality of plankton in cases of prolonged exposure. In view

Source of risk or impact	Potential consequence
	of the high level of natural mortality and the rapid replacement rate of many plankton species, UNEP (1985) indicates that there is no evidence to suggest that lethal effects to plankton from thermal discharges are ecologically significant. The potential consequence on planktonic communities is a localised impact on plankton abundance in the vicinity of the point of discharge with inconsequential ecological significance.

A6:

Source of risk or impact	Potential consequence
Routine discharges –CPF ballast water	Particular values and sensitivities with the potential to be impacted are: • planktonic communities. Based on the assessment made for CPF cooling water discharges above, the toxicity of the ballast water fed from the cooling water stream, is considered to be negligible at discharge. Furthermore, due to the long residence time of seawater within the ballast tanks, the NaClO and chlorination by-products (CBPs) will have been subjected to additional degradation over time. Therefore, potential impacts to planktonic communities are considered to be insignificant.

A7:

Source of risk or impact	Potential consequence
Routine discharges –CPF desalination brine	Particular values and sensitivities with the potential to be impacted are: • planktonic communities. The discharge of desalination brine from the CPF does not result in a discharge of increased salinity above ambient seawater. However, in the event that dilution of the brine water was not possible, i.e. during maintenance of the cooling water system, undiluted brine may be discharged. Plankton may be directly affected by increased salinity at the immediate point of discharge prior to dispersion and dilution occurring. However, the effects of a temporary and highly localised increase in salinity are not expected to result in any significant ecological impacts to planktonic communities. Therefore, the consequence is considered to be insignificant.

A8:

Source of risk or impact	Potential consequence
Routine discharges – CPF sewage, grey water and food waste	Particular values and sensitivities with the potential to be impacted are: • planktonic communities. A study undertaken to assess the effects of nutrient enrichment from discharge of sewage in the ocean found that the influence of nutrients in open marine areas is much less significant than that experienced in enclosed, poorly mixed water bodies. The study also found that zooplankton composition and distribution in areas associated with sewage dumping grounds were not affected (McIntyre & Johnston 1975). When sewage effluent, grey water and food waste is discharged there is the

Source of risk or impact	Potential consequence
	potential for localised and temporary, changes in water quality within Zone 1. The potential consequence on planktonic communities is a localised impact on plankton abundance in the vicinity of the point of discharge. Given the deepwater (approximately 250 m) location, oceanic currents will result in the rapid dilution and dispersion of these discharges. Therefore, the consequence is considered to be of inconsequential ecological significance.

A9:

Source of risk or impact	Potential consequence
Routine discharges – CPF open drains and bilge	Particular values and sensitivities with the potential to be impacted are: • transient, EPBC-listed species • planktonic communities Discharges of oily water will be treated to <15 ppm (v) in accordance with MARPOL 73/78 requirements. This could introduce hazardous substances (mixture of water, oily fluids, lubricants, cleaning fluids, etc.) into the water column, albeit in low concentrations. This could potentially result in a reduction in water quality, and impacts to transient, EPBC-listed species and plankton. Given the highly mobile and transient nature of marine fauna and the absence of known BIAs in Zone 1, the potential exposure is likely to be limited to individuals close to the discharge point at the time of the discharge. Worst-case impacts may include direct toxic effects, such as damage to lungs and airways, and eye and skin lesions from exposure to oil at the sea surface (AMSA 2015a). Considering the low concentrations of oil and the location of the discharges in the dispersive open environment, a surface expression is not anticipated; therefore, impacts are considered to be of inconsequential ecological significance to transient, EPBC-listed species and are, therefore, considered insignificant. There is the potential for planktonic communities within Zone 1 to be affected if exposed to oily water. Such exposure may result in lethal effects to plankton. The potential consequence on planktonic communities is a localised impact on plankton abundance in the vicinity of the point of discharge with inconsequential ecological significance. Firefighting foams such as AR-AFFF and FFFP contain organic and fluorinated surfactants, which can deplete dissolved oxygen in water (Schaefer 2013; ANSUL 2007; IFSEC Global 2014). However, in their diluted form (as applied in the event of a fire or test), these foams are generally considered to have a relatively low toxicity to aquatic species (Schaefer 2013; IFSEC Global 2014) and further dilution of the foam mixtures in dispersive aquatic environments may then occur before there is any substantial demand for dissolved oxygen (ANSUL 2007). Toxicological effects from these types of foams is typically only associated with prolonged or frequent exposures, such as on land and in watercourses near firefighting training areas (McDonald et al. 1996; Moody and Field 2000). The AR-AFFF and FFFP type foams identified for the CPF are biodegradable and do not bioaccumulate (Mercury Firesafety 2013; Dafo Fomtec AB 2013). In the event that firefighting foam is required (in the event of an emergency or for infrequent testing), the foam systems mix the foam concentrates (3%) with water (97%) prior to application and then further dilution and dispersion following discharge to the open-water environment around the facility is expected to occur before any significant demand for dissolved oxygen or toxicological effects can occur.

Source of risk or impact	Potential consequence
	As toxicological effects from foams proposed to be used are associated with frequent or prolonged exposures, and discharges are expected to be very infrequent and rapidly disperse, it is not expected that any impacts will occur to transient, EPBC-listed species. It is also expected that effects on planktonic communities, if any, would be localised and of a short-term nature and insignificant. Additionally, the potential consequences are also considered to be countered by the net environmental benefit that would be achieved through mitigating the potential for a fire resulting in harm to people and the environment.

A10:

Source of risk or impact	Potential consequence
Routine discharges – FPSO produced water	Worst-case concentrations identified by well-stream fluids analysis and published literature sources have been used to provide a conservative indication of the number of dilutions required for discharged PW components to reach adjusted no effect concentrations (NECs) / predicted NECs (PNECs), following moonpool commingling (note that the PW system cannot operate without the cooling water system; therefore, commingling of PW with the cooling water stream will always occur). The size of the mixing zone for the discharge plume is driven by the presence of H_2S scavenger, a production chemical in the PW discharge stream. H_2S scavenger required the greatest number of dilutions to reach the adjusted NEC, requiring 579 dilutions during start-up and 347 dilutions during steady state. This equates to a maximum distance from the discharge point, of 2550 m (start-up) and 1514 m (steady state), that could be impacted by the PW discharge plume. Scale inhibitor and THPS process biocide were the next two highest values with a requirement of 92 and 86 dilutions, respectively, to reach adjusted NEC, equating to maximum distances of 342 m and 309 m from the discharge point, respectively, during start-up. However, during steady state, the number of dilutions to reach adjusted NEC for scale inhibitor and THPS process biocide were lower (69 and 57 dilutions, respectively, resulting in distances of 189 m and 143 m, respectively. The particular values and sensitivities with the potential to be impacted are: • transient, EPBC-listed species (marine fauna) • planktonic communities. Within the PW discharge zone, there are no known BIAs; however, due to the open-ocean location in Zone 1, there is the potential for threatened and migratory species to pass through the plume. Given that NECs are based upon smaller organisms and early life stages, with higher sensitivity to changes in water quality, transient, EPBC-listed species would need to be exposed to the PW plume for a relatively long period for toxic exposure to occur. As they are generally transiting the area, exposure times are likely to be much lower than the 96-hour chronic exposure periods usually applied in tests to assess toxicity. Furthermore, the plume will generally be diluting exponentially from the source, so the area where toxicity is high will be localised to the source of the discharge, thereby limiting exposure to transient, EPBC-listed species. In the absence of any known BIAs, or key aggregation or feeding habitats within the discharge zone for PW, any exposure is expected to be incidental and not result in any long-term behavioural or physical effects. In the event that transient, EPBC-listed species are exposed to higher concentrations of PW constituents through 'at-source' exposure, there is the potential for limited

Source of risk or impact	Potential consequence
	effects; however, these would only be expected at an individual, and not population, level. Planktonic communities present in the surface waters of Zone 1 may be exposed to PW discharges above threshold concentrations if they directly encounter the discharge plume as it vertically and horizontally disperses with the prevailing currents. Any potential for acute or chronic toxicity to planktonic communities would be expected to be limited to within 2550 m or 1514 m from the discharge source (95th percentile) (APASA 2016) for start-up and steady state, respectively. It should be noted that NEC values are typically based on 96-hour exposure data; whereas, the likely residence time for organisms drifting into the impact area is approximately anywhere between 20 and 80 minutes, depending on the speed of the current. Nevertheless, plankton in the vicinity of the discharge point could be exposed to the PW plume for a sufficient enough time to elicit a toxic response. The potential consequence on planktonic communities is a localised impact on plankton abundance at the point of discharge with inconsequential ecological significance.

A11:

Source of risk or impact	Potential consequence
Routine discharges – FPSO cooling water	Particular values and sensitivities with the potential to be impacted are: • transient, EPBC-listed species • planktonic communities. The outcome of the modelling indicated that near-field processes should limit the temperature of the discharge plume to no more than 1.6 °C above ambient at 100 m from the discharge point for the worst-case scenario, which is in alignment with IFC guidelines (2015) which recommend discharges should not result in a temperature increase of more than 3 °C at the edge of the mixing zone. It should also be noted that surface waters of the region are tropical year-round, with surface temperatures of ~26 °C in summer and ~22 °C in winter (DSEWPaC 2012), and that baseline monitoring in the offshore development area recorded surface water temperatures of ~30 °C in summer (March) and ~26–27 °C in winter (July) (INPEX 2010). Therefore, over the seasons, seawater temperatures naturally vary by around 3–4 °C. Effects of elevation in seawater temperature cause a range of behavioural responses in transient, EPBC-listed species, including attraction and avoidance behaviour. There are no known BIAs or aggregation areas that would result in sedentary behaviour in this area, and EPBC-listed species with the potential to be present in Zone 1 are considered to be transient in nature (DoE 2015). The facility is situated in an open-ocean location in a water depth of approximately 250 m in a high-current environment; therefore, potential consequences on transient, EPBC-listed species are potentially localised avoidance of thermally elevated water temperatures with an inconsequential ecological significance to protected species. Elevated seawater temperatures are known to cause alterations to the physiological (especially enzyme-mediated) processes of exposed biota (Wolanski 1994). These alterations may cause a variety of effects and potentially even mortality of plankton in cases of prolonged exposure. In view of the high level of natural mortality and the rapid replacement rate of many plankton species, UNEP (1985) indicates that there is no evidence to suggest that lethal effects to plankton from thermal discharges are ecologically significant. The potential consequence on planktonic communities is a localised impact on plankton abundance in the vicinity of the point of discharge with

Source of risk or impact	Potential consequence
	inconsequential ecological significance.

A12:

Source of risk or impact	Potential consequence
Routine discharges – FPSO sewage, grey water and food waste	Particular values and sensitivities with the potential to be impacted are: • planktonic communities. A study undertaken to assess the effects of nutrient enrichment from discharge of sewage in the ocean found that the influence of nutrients in open marine areas is much less significant than that experienced in enclosed, poorly mixed water bodies. The study also found that zooplankton composition and distribution in areas associated with sewage dumping grounds were not affected (McIntyre & Johnston 1975). When sewage effluent, grey water and food waste is discharged, there is the potential for localised and temporary changes in water quality within Zone 1. The potential consequence on planktonic communities is a localised impact on plankton abundance in the vicinity of the point of discharge. Given the deep water (approximately 250 m) location, oceanic currents will result in the rapid dilution and dispersion of these discharges. Therefore, the consequence is considered to be of inconsequential ecological significance.

A13:

Source of risk or impact	Potential consequence
Routine discharges -FPSO ballast water	Particular values and sensitivities with the potential to be impacted are: • planktonic communities. Based on the assessment made for CPF cooling water discharges above, the toxicity of the ballast water fed from the cooling water stream, is considered to be negligible at discharge. Furthermore, due to the long residence time of seawater within the ballast tanks, the NaClO and CBPs will have been subjected to additional degradation over time. Therefore, potential impacts to planktonic communities are considered to be insignificant.

A14:

Source of risk or impact	Potential consequence
Routine discharges – FPSO open drains and bilge	Particular values and sensitivities with the potential to be impacted are: • transient, EPBC-listed species • planktonic communities. Discharges of oily water will be treated to ≤15 ppm (v) in accordance with MARPOL 73/78 requirements. This could introduce hazardous substances (mixture of water, oily fluids, lubricants, cleaning fluids, etc.) into the water column albeit in low concentrations. This could potentially result in a reduction in water quality, and impacts to transient, EPBC-listed species and planktonic communities.

Source of risk or impact	Potential consequence
	Given the highly mobile and transient nature of marine fauna and the absence of known BIAs in Zone 1, the potential exposure is likely to be limited to individuals close to the discharge point at the time of the discharge. Worst-case impacts may include direct toxic effects, such as damage to lungs and airways, and eye and skin lesions from exposure to oil at the sea surface (AMSA 2015a). Considering the low concentrations of oil and the location of the discharges in the dispersive open environment, a surface expression is not anticipated; therefore, impacts are considered to be of inconsequential ecological significance to transient, EPBC-listed species and are therefore considered insignificant. There is the potential for planktonic communities within Zone 1 to be affected if exposed to oily water. Such exposure may result in lethal effects to plankton. The potential consequence on planktonic communities is a localised impact on plankton abundance in the vicinity of the point of discharge with inconsequential ecological significance. Firefighting foams, such as FFFP, contain organic and fluorinated surfactants which can deplete dissolved oxygen in water (Schaefer 2013; ANSUL 2007; IFSEC Global 2014). However, as described for the CPF, this type of foam is considered to have a relatively low toxicity to aquatic species used in its diluted form (Schaefer 2013; IFSEC Global 2014) and further dilution of the foam mixtures in dispersive aquatic environments may then occur before there is any substantial demand for dissolved oxygen (ANSUL 2007). The FFFP type foam identified for the FPSO is biodegradable and does not bioaccumulate (Dafo Fomtec AB 2013). In the event that firefighting foam is required (in the event of an emergency or for infrequent testing), the foam systems mix the foam concentrates (3%) with water (97%) prior to application and then further dilution and dispersion following discharge to the open-water environment around the facility is expected to occur before any significant demand for dissolved oxygen or toxicological effects can occur. As toxicological effects from the foam proposed to be used are associated with frequent or prolonged exposures, and discharges are expected to be very infrequent and rapidly disperse, it is not expected that any impacts will occur to transient, EPBC-listed species. It is also expected that effects on planktonic communities, if any, would be localised and of a short-term nature and insignificant. Additionally, the potential consequences are also considered to be countered by the net environmental benefit that would be achieved through mitigating the potential for a fire resulting in harm to people and the environment.

A15:

Source of risk or impact	Potential consequence
Routine discharges - FPSO scrubbing water	Particular values and sensitivities with the potential to be impacted are: • planktonic communities • benthic communities. Potential impacts to identified values and sensitivities from discharges with elevated temperatures above ambient levels are described in the cooling water discharge assessments. Given that the scrubbing water is intermittent and a significantly smaller discharge volume, it is not expected to have any effect on the commingled moonpool discharge which includes the larger return seawater

Source of risk or impact	Potential consequence
	cooling water discharge. The gas scrubbing process within the inert gas system is undertaken to remove sulfur and combustion residues. There is limited reported data on wash-water analyses from inert gas scrubbers, but it is generally accepted that, given the required volumes of seawater to sufficiently cool the gas, the concentrations of scrubbed components, predominantly particulates such as soot, are very low (Kjølholt et al. 2012) and are only expected to be present if the combustion process is not optimised. Changes in ambient TSS levels due to combustion residues, such as sooty particles, may result in a decline in water quality. Increased water turbidity decreases the passage of light through water and can slow photosynthesis by phytoplankton species and reduce primary productivity (Davies-Colley et al. 1992). Given the small volumes discharged, water depths and the dispersive open-ocean environment, it is not expected that gas scrubbing water particulates will result in water quality impacts due to elevated TSS levels. Therefore, no direct effects on plankton abundance due to TSS levels are expected. Any impacts that could occur would not result in an ecological impact based on the naturally high spatial and temporal variability in plankton distribution in Australian tropical waters. Seabed topography in Zone 1 is relatively flat, with no seafloor features, such as boulders, reef pinnacles or outcropping hard layers. Due to the strong bottom currents and mobile sediments (RPS 2007), these characteristics do not favour the development of diverse epibenthic communities. Surveys of the seabed near Zone 1 have identified only very limited numbers of epibenthic fauna. Infaunal assemblages within marine sediments in the area are dominated by polychaete worms and crustaceans which contribute around 70% of the animal species. Discharges of combustion residues into the water column have a potential to impact sediment quality, with the potential to harm benthic communities through smothering and bioaccumulation. It is reported that particles released into the water column will be subject to natural dispersion through oceanographic processes. The size of the combustion residues (sooty particulates) associated with the gas scrubbing water discharges are not expected to settle out due to their small size and, given the low ecological diversity of the benthic community in Zone 1, impacts to benthic communities are not expected. Hydrogen chloride (HCl) is highly soluble and will rapidly dissociate when discharged to sea, with potential effects resulting from a change in pH rather than through direct effects associated with exposure to hydrogen chloride/hydrochloric acid. Due to the disassociation into water and chloride ions, no accumulation of hydrogen chloride in living organisms is expected (OECD SIDS 2002). Based on the low intermittent maximum discharge rate (5 m^3 per hour), the predicted concentration of HCl within the moonpool, once commingled with other discharge streams, is expected to be approximately 1 mg/L. Acute toxicity from changes in pH for aquatic organisms is known to be highly variable and can be explained by the variation in buffer capacity of the receiving environment. For example, LC50 values of acute fish toxicity tests varied from 4.92 to 282 mg/L (OECD SIDS 2002) and the Material Safety Data Sheet (MSDS) reports an ecotoxicity value of 282 mg/L. The effect of scrubbing water discharges, containing hydrochloric acid, from the FPSO moonpool on local plankton abundance will be influenced by the buffering capacity of the seawater at the point of discharge which may affect the ionisation and neutralisation of the discharge. It is not considered useful to calculate a PNEC for hydrochloric acid, as factors such as the buffering capacity, the natural pH and the fluctuation of the pH are very specific for individual

Source of risk or impact	Potential consequence
	ecosystems (OECD SIDS, 2002). A significant decrease of the pH of the receiving water is not expected, and changes in pH of the receiving water should stay within the natural range of the pH as the scrubbing water comprises a very small component of the total liquid effluent discharge from the moonpool. HCl will likely be rapidly neutralised due to the very large buffering capacity of seawater outside of the moonpool. Nevertheless, plankton in the vicinity of the discharge point could be exposed to decreased pH levels for a sufficient enough time to elicit a toxic response if exposed to undiluted HCl discharges (no comingling with CW). The potential consequence on planktonic communities is a localised impact on plankton abundance at the point of discharge with inconsequential ecological significance.

A16:

Source of risk or impact	Potential consequence
Routine discharges – ASVs desalination brine	Particular values and sensitivities with the potential to be impacted are: • planktonic communities. Discharging desalination brine from the ASVs results in an increased level of salinity within the water column at the point of discharge. Exposure to increased levels of salinity has the potential to result in impacts to planktonic communities. Azis et al. (2003) indicate that effects on planktonic communities in areas of high mixing and dispersion, such as those found in Zone 1, are generally limited to the point of discharge only. A WA EPA report on the Southern Seawater Desalination Project (WA EPA 2008) reported that during operation of the desalination plant, the discharge of 418 ML of brine per day into the ocean with a salinity of up to 65 ppt would be diluted to meet a dilution criteria of <1 ppt salinity increase for 95% of the time within a mixing zone of 30 m from the discharge point. It further states that it has been identified that the salinity limit that can be tolerated by sensitive fauna before physical impacts begin to occur is 38 ppt. Therefore, plankton may be directly affected by increased salinity at the point of discharge prior to dispersion and dilution occurring. Given the water depths in Zone 1 and the dynamic marine environment (i.e. tides and currents) it is expected that the brine discharge would rapidly disperse relatively close to the point of discharge, i.e. based on the WA EPA study it is expected to be <30 m based on a significantly reduced discharge rate (approximately 500 m^3 per day, versus 418 ML (418 000 m^3) per day) and a reduced salinity content of approximately 45–50 ppt, versus 65 ppt. The effects of a temporary and highly localised increase in salinity from ASV desalination brine discharges are not expected to result in any significant ecological impacts to planktonic communities. Therefore, the consequence is considered to be insignificant.

A17:

Source of risk or impact	Potential consequence
Routine discharges –	Particular values and sensitivities with the potential to be impacted are: • planktonic communities.

Source of risk or impact	Potential consequence
ASVs sewage, grey water and food waste	A study undertaken to assess the effects of nutrient enrichment from discharge of sewage in the ocean found that the influence of nutrients in open marine areas is much less significant than that experienced in enclosed, poorly mixed water bodies. The study also found that zooplankton composition and distribution in areas associated with sewage dumping grounds were not affected (McIntyre & Johnston 1975). When sewage effluent, grey water and food waste is discharged, there is the potential for localised and temporary changes in water quality within Zone 1. The potential consequence on planktonic communities is a localised impact on plankton abundance in the vicinity of the point of discharge. Given the deep water (approximately 250 m) location, oceanic currents will result in the rapid dilution and dispersion of these discharges. Therefore, the consequence is considered to be of inconsequential ecological significance.

A18:

Source of risk or impact	Potential consequence
Routine discharges –ASVs oily water and bilge	Particular values and sensitivities with the potential to be impacted are: • transient, EPBC-listed species • planktonic communities. Discharges of oily water will be treated to <15 ppm (v) in accordance with MARPOL requirements. This could introduce hazardous substances (mixture of water, oily fluids, lubricants, cleaning fluids, etc.) into the water column, albeit in low concentrations. This could result in a reduction in water quality, and impacts to transient, EPBC-listed species and plankton. Given the highly mobile and transient nature of marine fauna and the absence of known BIAs in Zone 1, the potential exposure is likely to be limited to individuals close to the discharge point at the time of the discharge. Worst-case impacts may include direct toxic effects, such as damage to lungs and airways, and eye and skin lesions from exposure to oil at the sea surface (AMSA 2015a). Considering the low concentrations of oil and the location of the discharges in the dispersive open environment, a surface expression is not anticipated; therefore, impacts are considered to be of inconsequential ecological significance to transient, EPBC-listed species and are therefore considered insignificant. There is the potential for planktonic communities within Zone 1 to be affected if exposed to oily water. Such exposure may result in lethal effects to plankton. The potential consequence on planktonic communities is a localised impact on plankton abundance in the vicinity of the point of discharge with inconsequential ecological significance. Firefighting foams such as AFFF contain organic and fluorinated surfactants, which can deplete dissolved oxygen in water (Schaefer 2013; ANSUL 2007; IFSEC Global 2014). However, as described for the CPF and FPSO, this type of foam is considered to have a relatively low toxicity to aquatic species in its diluted (as used) form (Schaefer 2013; IFSEC Global 2014). Further dilution of the foam mixtures in dispersive aquatic environments may then occur before there is any substantial demand for dissolved oxygen (ANSUL 2007) and are expected to biodegrade. In the unlikely event that firefighting foam is required (in the event of an emergency), the foam systems on board the ASVs will mix the foam concentrates (1–3% depending on the ASV and its system) with water (97–99%) prior to application. Further dilution and dispersion will take place following discharge to the open-water environment around the facility which is

Source of risk or impact	Potential consequence
	expected to occur before any significant demand for dissolved oxygen or toxicological effects can occur. Therefore, the potential for impacts to transient EPBC-listed species and planktonic communities is expected to be short-term and highly localised around the point and time of discharge, and the consequence is therefore considered to be insignificant. The potential consequences are also considered to be countered by the net environmental benefit that would be achieved through mitigating the potential for a fire resulting in harm to people and the environment.

A19:

Source of risk or impact	Potential consequence
Routine discharges – ASVs cooling water	Particular values and sensitivities with the potential to be impacted are: • transient, EPBC-listed species • planktonic communities. Effects of elevation in seawater temperature cause a range of behavioural responses in transient, EPBC-listed species including attraction and avoidance behaviour. There are no known BIAs or aggregation areas that would result in sedentary behaviour in this area, and EPBC-listed species with the potential to be present in Zone 1 are considered to be transient in nature (DoE 2015). The ASVs will be situated in an open-ocean location in a water depth of approximately 250 m in a high current environment; therefore, potential consequences on transient, EPBC-listed species are potentially localised avoidance of thermally elevated water temperatures with an inconsequential ecological significance to protected species. Elevated seawater temperatures are known to cause alterations to the physiological (especially enzyme-mediated) processes of exposed biota (Wolanski 1994). These alterations may cause a variety of effects and potentially even mortality of plankton in cases of prolonged exposure. In view of the high level of natural mortality and the rapid replacement rate of many plankton species, UNEP (1985) indicates that there is no evidence to suggest that lethal effects to plankton from thermal discharges are ecologically significant. The potential consequence on planktonic communities is a localised impact on plankton abundance in the vicinity of the point of discharge with inconsequential ecological significance.

A20:

Source of risk or impact	Potential consequence
Routine discharges – support vessel desalination brine	Particular values and sensitivities with the potential to be impacted are: • planktonic communities. Discharging desalination brine from support vessels has the potential to result in increased salinity within the receiving environment. Exposure to increased levels of salinity has the potential to result in impacts to planktonic communities. Azis et al. (2003) indicate that effects on planktonic communities in areas of high mixing and dispersion, such as those found in Zone 1, are generally limited to the point of discharge only. A WA EPA report on the Southern Seawater Desalination Project (WA EPA 2008) reported that during operation of the desalination plant, the discharge of 418

Source of risk or impact	Potential consequence
	ML of brine per day into the ocean with a salinity of up to 65 ppt would be diluted to meet a dilution criteria of <1 ppt salinity increase for 95% of the time within a mixing zone of 30 m from the discharge point. It further states that it has been identified that the salinity limit which can be tolerated by sensitive fauna before physical impacts begin to occur is 38 ppt. Given the water depths in Zone 1 and the dynamic marine environment (i.e. tides and currents) it is expected that the brine discharge would rapidly disperse relatively close to the point of discharge, i.e. based on the WA EPA study it is expected to be <30 m based on a significantly reduced discharge rate (approximately 300 m^3 per day, versus 418 ML (418 000 m^3) per day) and a reduced salinity content of approximately 45–50 ppt, versus 65 ppt. The effects of a temporary and highly localised increase in salinity from support vessel desalination brine discharges are not expected to result in any significant ecological impacts to planktonic communities. Therefore, the consequence is considered to be insignificant.

A21:

Source of risk or impact	Potential consequence
Routine discharges – support vessel sewage, grey water and food waste	Particular values and sensitivities with the potential to be impacted are: • planktonic communities. A study undertaken to assess the effects of nutrient enrichment from discharge of sewage in the ocean found that the influence of nutrients in open marine areas is much less significant than that experienced in enclosed, poorly mixed water bodies. The study also found that zooplankton composition and distribution in areas associated with sewage dumping grounds were not affected (McIntyre & Johnston 1975). When sewage effluent, grey water and food waste is discharged there is the potential for localised and temporary, changes in water quality within Zone 1. The potential consequence on planktonic communities is a localised impact on plankton abundance in the vicinity of the point of discharge. Given the deep water (approximately 250 m) location, oceanic currents will result in the rapid dilution and dispersion of these discharges. Therefore, the consequence is considered to be of inconsequential ecological significance.

A22:

Source of risk or impact	Potential consequence
Routine discharges – support vessel oily water and bilge	Particular values and sensitivities with the potential to be impacted are: • transient, EPBC-listed species • planktonic communities. Discharges of oily water will be treated to <15 ppm (v) in accordance with MARPOL requirements. This could introduce hazardous substances (mixture of water, oily fluids, lubricants, cleaning fluids, etc.) into the water column, albeit in low concentrations. This could result in a reduction in water quality, and impacts to transient, EPBC-listed species and plankton. Given the highly mobile and transient nature of marine fauna and the absence of known BIAs in Zone 1, the potential exposure is likely to be limited to

Source of risk or impact	Potential consequence
	individuals close to the discharge point at the time of the discharge. Worst-case impacts may include direct toxic effects, such as damage to lungs and airways, and eye and skin lesions from exposure to oil at the sea surface (AMSA 2015a). Considering the low concentrations of oil and the location of the discharges in the dispersive open environment, a surface expression is not anticipated; therefore; impacts are considered to be of inconsequential ecological significance to transient, EPBC-listed species and are therefore considered insignificant. There is the potential for planktonic communities within Zone 1 to be affected if exposed to oily water. Such exposure may result in lethal effects to plankton. The potential consequence on planktonic communities is a localised impact on plankton abundance in the vicinity of the point of discharge with inconsequential ecological significance.

A23:

Source of risk or impact	Potential consequence
Routine discharges – support vessel cooling water	Particular values and sensitivities with the potential to be impacted are: • transient, EPBC-listed species • planktonic communities. Effects of elevation in seawater temperature cause a range of behavioural responses in transient, EPBC-listed species including attraction and avoidance behaviour. There are no known BIAs or aggregation areas that would result in sedentary behaviour in this area, and EPBC-listed species with the potential to be present in Zone 1 are considered to be transient in nature (DoE 2015). The support vessels will be operating in an open-ocean location in a water depth of approximately 250 m in a high current environment; therefore, potential consequences on transient, EPBC-listed species are potentially localised avoidance of thermally elevated water temperatures with an inconsequential ecological significance to protected species. Elevated seawater temperatures are known to cause alterations to the physiological (especially enzyme-mediated) processes of exposed biota (Wolanski 1994). These alterations may cause a variety of effects and potentially even mortality of plankton in cases of prolonged exposure. In view of the high level of natural mortality and the rapid replacement rate of many plankton species, UNEP (1985) indicates that there is no evidence to suggest that lethal effects to plankton from thermal discharges are ecologically significant. The potential consequence on planktonic communities is a localised impact on plankton abundance in the vicinity of the point of discharge with inconsequential ecological significance.

A24:

Source of risk or impact	Potential consequence
Routine discharges – cumulative impacts from liquid effluent	Particular values and sensitivities with the potential to be impacted are: • transient EPBC-listed species • planktonic communities • benthic communities

Source of risk or impact	Potential consequence
discharges	• demersal fish communities and fisheries. Several routine discharges will occur, not only from the CPF and FPSO, but also from associated vessels (including ASVs) and subsea infrastructure. Environmental impacts from the routine discharges are now assessed to consider potential additive effects or cumulative impacts to the values and sensitivities identified for each liquid effluent discharge stream. Routine operational subsea discharges have not been assessed further, given that the small volume discharges will occur at, or near, the seabed. The predominant discharge from subsea infrastructure is MEG, which has a higher density than seawater and, therefore, will not rise in the water column and combine with discharges released at, or near, the sea surface, particularly given the approximate 250 m water depth. In addition, based on the distances between drill centres and the distance from the CPF and FPSO, interactions with the larger liquid effluent discharge plumes from the facility are not considered plausible. The effect of multiple liquid effluent discharges may increase turbidity in the receiving environment potentially resulting in a range of impacts, from light reduction, to impairment of feeding in marine flora and fauna. Turbidity is generally not thought of as a cumulative stressor (Gaylard 2009). Changes in ambient TSS levels may arise from multiple liquid discharges. Increased water turbidity decreases the passage of light through water and can slow photosynthesis by phytoplankton species and reduce primary productivity (Davies-Colley et al. 1992). In coastal waters with poor dispersion, evidence suggests that there are occasions where highly turbid waters can remain entrained in the water column for many days, resulting in a reduction in light penetration, impacting sensitive components of the benthos, such as seagrass, making the impact of turbidity potentially cumulative (Gaylard 2009). Predictive modelling indicated that the discharge plumes from the FPSO and CPF do not overlap; therefore, increases in turbidity due to the discharge of multiple streams is not expected with limited potential for cumulative impacts. Given the dispersive nature of the open-ocean environment in Zone 1, no cumulative impacts from liquid discharges associated with turbidity are expected. This is further supported by the expected TSS of the FPSO moonpool discharge, which is an order of magnitude lower than ambient concentrations due the high ratio of mixing obtained with the cooling water. Impacts to transient, EPBC-listed species and planktonic communities are not expected due to slight increases in turbidity. Additionally, given the distance from shore in an open-ocean environment, the water depth of approximately 250 m, in conjunction with rapid dilution and dispersion, seabed habitats and benthic communities are unlikely to receive organic matter fallout from plumes released at, or near, the sea surface. The interaction of multiple liquid effluent streams may result in a decrease in dissolved oxygen (DO) concentrations mainly through elevations in water temperature, such as from cooling water discharges, and from increased biological oxygen demand due to the presence of organic materials and nutrients in the receiving environment from sewage, grey water and food waste discharges. Concentrations of DO are known to be highly dependent on temperature, salinity, biological activity (microbial, primary production) and rate of transfer from the atmosphere (Johnson et al. 2008) and, under natural conditions, DO will change, sometimes considerably, over a daily (or diurnal) period. The lethal and sublethal effects of reduced levels of DO are related to the concentration of DO and period of exposure of the reduced oxygen levels. A number of animals have behavioural strategies to survive periodic events of reduced DO which include avoidance by mobile animals, such as fish and macrocrustaceans, shell closure and reduced metabolic rate in bivalve molluscs, and either decreased burrowing depth or emergence from burrows for sediment

Source of risk or impact	Potential consequence
	dwelling crustaceans, molluscs and annelids (Cole et al. 1999). Given the water depth (approximately 250 m) and discharge depths (10–35 m) for the liquid effluent streams, benthic communities are not expected to encounter reduced DO levels as a result of multiple liquid effluent discharge streams from the CPF, FPSO or vessels. Stiff et al. (1992) and Nixon et al. (1995) identified crustaceans and fish as the most sensitive organisms to reduced DO levels, with the early life stages of fish particularly sensitive. In freshwater, a concentration of 5 ppm DO is recommended for optimum fish health and sensitivity to low levels of DO is species-specific. Generally, most species of fish become distressed when DO levels fall to 2–4 ppm and mortality is reported to occur at concentrations less than 2 ppm (Francis-Floyd 2014). Background levels of DO at the Ichthys Field are reported to mirror water temperatures, with constant levels of 6–6.5 ppm recorded at or above the thermocline in both summer and winter (INPEX 2010). Saltwater fish have a higher tolerance for low DO concentrations, as saltwater species generally have lower oxygen requirements than freshwater species (CoRIS 2016). Those species of fish found near coral reefs may require higher levels of DO; however, there are no coral reefs in Zone 1 or within the field of effect of the discharges (mixing zone <2550 m based on 579 dilutions). Concentrations of DO available for pelagic fish in the vicinity of the facility and the demersal fish community (KEF) situated approximately 12 km from Zone 1, are not expected to be impacted by cumulative liquid effluent discharges. This is based on the oceanic currents and mixing expected in the open-ocean environment of Zone 1 enabling re-oxygenation. Therefore, liquid effluent discharges are not expected to reduce DO concentrations to levels significantly below background ambient conditions and not to levels where fish mortality is possible. Given the limited spatial extent of multiple liquid effluent discharge plumes within the wider marine region, which do not overlap between the CPF and FPSO, the drifting nature of plankton, and highly mobile nature of fish and other transient marine fauna (transient, EPBC-listed species) with the ability to avoid plumes within the water column (approximately 250 m water depth), any impacts are expected to be short-term and minor. Potential cumulative or additive effects from liquid effluent discharges, above those already described previously for potential interactions between discharge streams, are not expected to occur and the consequence of any potential impact is considered to be short-term and minor.

A25:

Source of risk or impact	Potential consequence
Waste management - inappropriate waste handling and disposal	In the event of an accidental release of waste overboard, the particular values and sensitivities identified as having the potential to be impacted are: • transient, EPBC-listed species (marine fauna) • planktonic communities. Marine fauna can become entangled in waste plastics, which can also be ingested when mistaken as prey (Ryan et al. 1988), potentially leading to injury or death. For example, due to indiscriminate foraging behaviour, turtles have been known to mistake plastic for jellyfish (Mrosovsky et al. 2009). Items, such as discarded rope, have been found to entangle fauna, such as birds and marine mammals. The release of waste may result in injury or even death to individual transient, EPBC-listed species but is not expected to result in a threat to population viability of protected species.

Source of risk or impact	Potential consequence
	A change to water quality has the potential to impact planktonic communities found at the sea surface. Seabirds forage on planktonic organisms, generally at, or near, the surface of the water column. Any release of such hazardous waste materials will be limited to the immediate area surrounding the release, and any potential impacts are likely to be reduced, due to the dispersive open-ocean offshore environment. While plankton abundance in close proximity to the localised accidental release, or leaching from waste items, may be reduced, this will be of insignificant ecological consequence.

A26:

Source of risk or impact	Potential consequence
Loss of containment - accidental release overboard	In the event of a loss of containment event, the particular values and sensitivities identified as having the potential to be impacted are: • fisheries (commercial, recreational and traditional) • transient, EPBC-listed species (marine fauna) • planktonic communities. Potential accidental releases from loss of containment events may result in the exposure of marine fauna, including commercial fish species, transient EPBC-listed species and plankton, to a range of chemicals and Group I and Group II hydrocarbons. Foreseeable loss of chemicals to the marine environment could be of small volumes, and in combination with the INPEX *Chemical Assessment and Approval Procedure*; impacts would generally be of lower consequence. Therefore, the focus of this assessment is based on the largest spill volume associated with a loss of hydrocarbons. The values and sensitivities associated with commercial, traditional and recreational fisheries (seafood quality and employment) could be impacted due to entrained/dissolved/dispersed oil. Exclusion zones may impede access to fishing areas for a short-term to medium-term (ITOPF 2011). Commercial fisheries that transect the EMBA predominantly operate in the shallower waters of Zone 2 with generally low levels of fishing activity reported (AFMA 2012). Therefore, impacts of this type of spill on commercial fishing are expected to be highly localised and of short duration. Generally, there is little recreational fishing that occurs within Zone 1 because of its distance from land, lack of features of interest and the deep waters. Recreational day-fishing is concentrated around the population centres of Broome, Derby and Wyndham, as well as other readily accessible coastal settlements, which are generally at the edge or outside of Zone 2. Therefore, recreational fishing would not be impacted by this type of spill. Traditional fishing, which occurs at Browse Island and along the Kimberley coast, would not be impacted by this type of spill. Therefore, the socioeconomic impacts on commercial, traditional and recreational fisheries are expected to be short-term to medium-term and, therefore, the consequence is considered to be insignificant. Given the anticipated volumes (worst-case 125 m^3 of diesel), potential exposure is expected to be localised (in the vicinity of Zone 1 because any topsides spill is expected to be at least partially captured within the open-drains system) with some lower concentration expressions extending into Zone 2; however, not contacting any sensitive benthic receptors (RPS APASA 2014a). Hydrocarbons will disperse through natural physical oceanic processes, such as currents, tides and waves, and photochemical and biological degradation. A release of condensate at the sea surface would immediately start to weather, with the volatile constituent compounds rapidly evaporating at ambient temperatures. Condensate (Group I) is much lighter and less persistent than

Source of risk or impact	Potential consequence
	Group II hydrocarbons, such as MGO and diesel. Therefore, a surface expression is expected to weather and dissipate in a relatively short time, thereby providing limited potential for exposure to surfacing marine fauna. In the absence of any known BIAs for marine fauna in Zone 1, any individuals present are likely to be transiting the area for a short duration. As such, there is the potential that transient, EPBC-listed species could be exposed to these events if they are present in the immediate vicinity at the time of the release. However, given the limited duration of exposure due to expected weathering and dispersion in an open-ocean environment, and the lack of known BIAs within the area potentially affected, the level of consequence is expected to present a minor and temporary impact on a small proportion of a protected species. As a consequence of their presence close to the water surface, plankton may be exposed to entrained/dissolved hydrocarbon plumes, especially in high-energy seas where the vertical mixing of oil through the water column would be enhanced. The effects of oil on plankton have been well studied in controlled laboratory and field situations. The different life stages of a species often show widely different tolerances and reactions to oil pollution. Usually, eggs, larval and juvenile stages will be more susceptible than adults (Harrison 1999). Post-spill studies on plankton populations are few, but those that have been conducted, typically show either no effects or temporary minor effects (Kunhold 1978). Given the high temporal and spatial variability in plankton community, and small size of impact area resulting from accidental releases, the potential consequence in regards to plankton is considered to be insignificant.

A27:

Source of risk or impact	Potential consequence
Loss of containment – vessel collision. Emergency condition.	Oil spill modelling overview: AMSA guidance (AMSA 2013) was used to inform maximum credible volumes of hydrocarbons potentially spilled to the marine environment in the event of a vessel collision. The guidance states that the maximum credible spill volume for a vessel collision should be based on the volume of the largest fuel tank. Both condensate and HFO vessel collision spill scenarios were modelled based on a 2 hour release at the sea surface with stochastic modelling running for a further 49 and 70 days respectively. After which time, the original spill volumes would have either evaporated or decayed and the modelled duration is considered to be appropriate to inform the impact and risk evaluation.
	Surface hydrocarbons
	The values and sensitivities with the potential to be affected by surface hydrocarbon exposures are: • commercial, traditional and recreational fisheries • emergent benthic primary producer habitats (intertidal corals, mangroves, macroalgae and seagrasses, including those associated with the Ashmore Reef Ramsar wetland) • marine mammal BIAs • whale shark foraging BIAs • turtle BIAs • marine avifauna BIAs

Source of risk or impact	Potential consequence
	• transient, EPBC-listed species • planktonic communities. The values and sensitivities associated with commercial, traditional and recreational fisheries (seafood quality and employment) could be impacted due to a surface spill from a vessel collision. Implementing an exclusion zone during response may impede access to fishing areas for a short-to-medium term, and nets and lines could become oiled (ITOPF 2011). Generally, there is little recreational fishing that occurs within Zone 1 because of its distance from land, lack of features of interest and the deep waters. Recreational day-fishing is concentrated around the population centres of Broome, Derby and Wyndham, as well as other readily accessible coastal settlements which are generally at the edge of, or outside Zone 2, and therefore unlikely to be impacted by this type of spill. Commercial fisheries that transect the EMBA predominantly operate in the shallower waters of Zone 2 with generally low levels of fishing activity reported (AFMA 2012). Traditional fishing, particularly at Browse Island and along the Kimberley coast, including on the intertidal reef platforms, could be affected by impacts to fish and benthic habitats (discussed below and in the following subsections). Therefore, the socioeconomic impacts on commercial, traditional and recreational fisheries are expected to be short-to-medium term, and therefore the consequence is considered to be moderate. Emergent benthic communities, such as coral reefs at Browse Island, Scott Reef, Ashmore Reef, Cartier Island and the outer islands of the Kimberley coastline, may be impacted by exposure to surface hydrocarbons. Shallow-water communities are at a greater risk of exposure than deep-water communities (NRC 1985). Physical oiling of coral tissue can cause a decline in metabolic rate and may cause varying degrees of tissue decomposition which can lead to death (Negri & Heyward 2000). Additional impacts from entrained/dissolved hydrocarbons on corals are discussed in the subsection below. Mangrove communities within Zone 2, present along the Kimberley coastlines are also susceptible to surface oiling, with potential impacts including defoliation and mortality (Burns et al. 1993; Duke et al. 2000). Mangrove recovery from disturbance would be expected over the short-to-medium term. Seagrasses and macroalgae are generally not emergent, and therefore impacts and risks are discussed in the entrained/dissolved subsection below. Based on the above impact assessment, the consequence from a large surface spill into emergent benthic primary producer habitats is considered to be moderate. There are no marine mammal BIAs located in areas predicted to be exposed to surface expressions above the 10 g/m^2 moderate exposure threshold; however, marine mammals may still be present in areas potentially affected by a surface expression. As air-breathers, marine mammals, if they surface, are vulnerable to exposure to hydrocarbon spill impacts through the inhalation of evaporated volatiles. Effects include toxic effects, such as damage to lungs and airways, and eye and skin lesions from exposure to oil (AMSA 2015a). For the short time that the volatile components of the hydrocarbons are present, vapours from the spill are considered the most significant risk to cetacean health, as their exposure can be significant. Vapours, if inhaled, have the potential to damage the mucous membranes of the airways and the eyes. Inhaled volatile hydrocarbons are transferred rapidly to the bloodstream and may accumulate in tissues, such as in the brain and liver, resulting in neurological disorders and liver damage (AMSA 2015a; Gubbay & Earll 2000). Although there are potentially large volumes of surface oil and large physical extents of a surface expression associated with the worst-credible spill scenarios, due to the very rapid evaporation of volatile components (i.e. within 24 hours), the impacts

Source of risk or impact	Potential consequence
	associated with the inhalation of evaporated volatile hydrocarbons is expected to be localised near the spill event. Blue whales and humpback whales (baleen whales), that may filter-feed near the surface, would be more likely to ingest oil than gulp-feeders, or toothed-whales and dolphins. Spilled hydrocarbons may also foul the baleen fibres of baleen whales, thereby impairing food-gathering efficiency, or resulting in the ingestion of hydrocarbons, or prey that has been contaminated with hydrocarbons (AMSA 2015a). Weathered oil residues, particularly from a Group IV spill event, may persist for long periods, causing a potential risk to the feeding systems of baleen whales. Due to natural weathering processes, the duration of a surface expression is expected to be relatively short; although it is recognised that a Group IV spill will be more persistent in the marine environment than a Group I or II spill. Based on this impact analyses, impacts are expected to be on a local scale, with short-to-medium term impacts; however, with no threat to overall population viability. Therefore, the consequence is considered to be moderate. There are several turtle BIAs within areas that could potentially be impacted by a surface expression >10 g/m^2, with areas of higher probability of contact including Browse Island, Scott Reef, Ashmore Reef and Cartier Island. Turtles can be exposed to hydrocarbons if they surface within the spill, resulting in direct contact with the skin, eyes, and other membranes, as well as the inhalation of vapours or ingestion (Milton et al. 2003). Other aspects of turtle behaviour, including a lack of avoidance behaviour, indiscriminate feeding in convergence zones, and large, pre-dive inhalations, make them vulnerable (AMSA 2015a). In addition, hatchlings spend more time on the surface than older turtles, thus increasing the potential for contact with oil slicks (Milton et al. 2003). Therefore, there is the potential for local-to-medium scale, medium-term impacts to marine turtles in the event of a spill from a vessel collision. However, no threat to overall population viability is expected due to surface expression. Therefore, the consequence is considered to be moderate. Marine avifauna, have the potential to directly interact with oil on the sea surface, in the course of normal foraging activities. Direct contact with surface hydrocarbons may result in dehydration, drowning and starvation and is likely to foul feathers, which may result in hypothermia (AMSA 2015a). Birds resting at the sea surface and surface-plunging birds are considered particularly vulnerable to surface hydrocarbons. Impacts may include damage to external tissues, including skin and eyes, and internal tissue irritation in lungs and stomachs (Clark 1984). Toxic effects may also result where hydrocarbons are ingested, as birds attempt to preen their feathers (Jenssen 1994). Weathering of hydrocarbons on the sea surface will reduce the levels of toxicity that seabirds may be exposed to and, over time, the hydrocarbons on the surface will become patchy rather than continuous. Due to the potential size and persistence of a surface expression from a large HFO spill, there is the potential for short-to-medium term, local-to-medium scale impacts to marine avifauna; however, no threat to overall population viability is expected. Therefore, the consequence is considered to be moderate. Plankton would potentially be exposed to oil on the ocean surface. However, the majority of impacts would be from entrained/dissolved hydrocarbons; therefore, the impact evaluation regarding plankton is provided in the subsection below. In summary, the potential extent of surface hydrocarbon with a concentration >10 g/m^2 may result in widespread exposure to marine fauna (including transient EPBC-listed species, such as marine mammals, turtles and seabirds) and emergent benthic habitats, such as coral reefs and mangroves. There would likely also be cumulative impacts as a result of interactions between surface, entrained/dissolved and shoreline hydrocarbon impacts on the food web and through bioaccumulation up the food chain. On this basis, the

Source of risk or impact	Potential consequence
	potential consequence associated with surface expression of hydrocarbon from the identified spill events is considered to be significant.
	Entrained/dissolved hydrocarbons
	Weathering/fate modelling of the Group IV spill indicated that these oil types will be highly resistant to entrainment into the water column, even under strong wind conditions (RPS APASA 2014c). Therefore, no values and sensitivities are predicted to be exposed to the entrained/dissolved hydrocarbons from a Group IV spill. However, if dispersant is applied, impacts from dispersed Group IV oils could occur in the shallow/surface layers of the water column. Monitoring during the Montara spill (where dispersant was applied to surface spills) identified that entrained/dispersed hydrocarbons were limited to the top 25 m of the water column (AMSA 2010). The distribution of Group I (condensate) and Group II (MGO) spills in the water column and on the water surface is a dynamic process, resulting from changes in wind velocities over time. As the wind speed increases above 12 knots, the wind-generated waves increase the entrainment rates increasing the volume of oil in the water column and decreasing the volume of floating oil. The depth of entrained oil is generally restricted to the top 30 m of the water column, with the highest percentage of entrained oil in the top 10 m of the water column. As the wind decreases to lower values, the mixing forces cease and entrained oil droplets resurface, increasing the proportion of oil floating on the surface and decreasing that of oil in the water. When oil gets exposed to the atmosphere, higher evaporation takes place (RPS APASA 2014b). Therefore, effects on benthic habitats are only expected to occur in shallow-water areas. Consequently, the particular values and sensitivities with the potential to be exposed to entrained/dissolved hydrocarbons are: • commercial, recreational and traditional fishing • benthic primary producer habitats / benthic habitats shallower than –30 m LAT (corals, mangroves, macroalgae and seagrasses, including those associated with the Ashmore Reef Ramsar wetland) • KEFs (shallower than –30 m LAT) • planktonic communities • whale shark foraging BIAs • turtle foraging BIAs • marine mammal BIAs • sawfish BIAs • transient, EPBC-listed species. The values and sensitivities associated with commercial, traditional and recreational fisheries (seafood quality and employment) could be impacted due to entrained/dissolved/dispersed oil. Exclusion zones may impede access to fishing areas for a short-to-medium term (ITOPF 2011). Generally, there is little recreational fishing that occurs within Zone 1 because of its distance from land, lack of features of interest and the deep waters. Recreational day-fishing is concentrated around the population centres of Broome, Derby and Wyndham, as well as other readily accessible coastal settlements which are generally at the edge of, or outside, Zone 2, and therefore unlikely to be impacted by this type of spill. Commercial fisheries that transect the EMBA predominantly operate in the shallower waters of Zone 2 with generally low levels of fishing activity reported (AFMA 2012). Traditional fishing, particularly at Browse Island and along the Kimberley coast, including on intertidal reef platforms, could be affected by impacts to fish and benthic habitats from entrained oil, discussed below. Therefore, the socioeconomic impacts on commercial, traditional and

Source of risk or impact	Potential consequence
	recreational fisheries are expected to be short-to-medium term, and therefore the consequence is considered to be moderate. Benthic communities, particularly the coral reefs, would be exposed to entrained/dissolved hydrocarbons. Shallow-water communities are generally at greater risk of exposure than deep-water communities (NRC 1985). Wave-induced turbulence associated with waves breaking over coral reef crests may increase the entrainment of hydrocarbons into the water column. Exposure of entrained and dissolved hydrocarbons to shallow subtidal corals has the potential to result in lethal or sublethal toxic effects, resulting in acute impacts or death at moderate-to-high exposure thresholds (Loya & Rinkevich 1980; Shigenaka 2001), including increased mucus production, decreased growth rates, changes in feeding behaviours and expulsion of zooxanthellae (Peters et al. 1981; Knap et al. 1985). Adult coral colonies, injured by oil, may also be more susceptible to colonisation and overgrowth by algae or to epidemic diseases (Jackson et al. 1989). Lethal and sublethal effects of entrained and dissolved oils have been reported for coral gametes at much lesser concentrations than predicted for adult colonies (Heyward et al. 1994; Harrison 1999; Epstein, Bak & Rinkevich 2000). Goodbody-Gringley et al. (2013) found that exposure of coral larvae to oil and dispersants negatively impacted coral settlement and survival, thereby affecting reef resilience. However, an oil spill that occurs outside of a coral-spawning period would not affect coral planktonic stages. Browse Island, the closest receptor to Zone 1, was predicted to receive worst-case concentrations of entrained/dissolved hydrocarbons, of ~35 000 ppb (70 times the 500 ppb threshold), and other coral reefs at locations such as Echuca Shoal, Cartier Island and Heyward Shoal may be subject to exposure of up to 10 000 ppb. However, generally the likelihood of exceeding the 500 ppb threshold at the majority of receptors is <10%. Therefore, due to the potentially large physical extent and high concentrations received, potential impacts to coral reefs are considered to be significant. Entrained and dissolved hydrocarbons have the potential to affect seagrasses and macroalgae, through toxicity impacts. The hydrophobic nature of oil molecules allows them to concentrate in membranes of aquatic plants. Hence the thylakoid membrane (an integral component of the photosynthetic apparatus) is susceptible to oil accumulation, potentially resulting in reduced photosynthetic activity (Runcie & Riddle 2006). However, a layer of mucilage present on most species of seagrass prevents the penetration of toxic aromatic fractions (AMSA 2015a). Although seagrass and macroalgae may be subject to lethal or sublethal toxic effects, including mortality, reduced growth rates, and impacts to seagrass flowering, several studies have indicated rapid recovery rates may occur even in cases of heavy oil contamination (Connell, Miller & Farrington 1981; Burns et al. 1993; Dean et al. 1998; Runcie & Riddle 2006). For algae, this could be attributed to new growth being produced from near the base of the plant while the distal parts (which would be exposed to the oil contamination) are lost. For seagrasses this may be because 50–80% of their biomass is in their rhizomes, which are buried in sediments, thus less likely to be adversely impacted by hydrocarbons (Zieman et al. 1984). The seagrass locations are distant from Zone 1 (i.e. Ashmore Reef and the Kimberley coastline); therefore, the probability of contact with entrained/dissolved plumes is lower and, therefore, the associated received concentrations will be lower; however, still potentially above the threshold that could cause impacts. Therefore, based on the above impact assessment, the consequence is considered to be minor. Mangrove communities within Zone 2, present along the Kimberley coastline are also susceptible to entrained oil exposure, with potential impacts, including defoliation and mortality. However, as the use of dispersant on surface spills (resulting in entrainment of oils) shows a positive benefit to mangroves, the

Source of risk or impact	Potential consequence
	impacts of entrained/dissolved oil on mangroves is expected to be less than the impacts predicted from surface oiling (Burns et al. 1993; Duke et al. 2000). In addition, the inner Kimberley coastline, where mangroves are present within Zone 2, is very unlikely to receive entrained/dissolved plumes as it is lower and, therefore, the associated received concentrations will be lower; however, still potentially above the threshold that could cause impacts. Therefore, potential impacts are considered to be minor. As a consequence of their presence close to the water surface, plankton may be exposed to entrained/dissolved hydrocarbon plumes, especially in high-energy seas where the vertical mixing of oil through the water column would be enhanced. The effects of oil on plankton have been well studied in controlled laboratory and field situations. The different life stages of a species often show widely different tolerances and reactions to oil pollution. Usually, eggs, larval and juvenile stages will be more susceptible than adults (Harrison 1999). Post-spill studies on plankton populations are few, but those that have been conducted typically show either no effects, or temporary minor effects (Kunhold 1978). The lack of observed effects may be accounted for by the fact that many marine species produce very large numbers of eggs, and therefore larvae, to overcome natural losses (such as through predation by other animals; adverse hydrographical and climatic conditions; or failure to find a suitable habitat and adequate food). A possible exception to this would be if a shallow entrained/dissolved hydrocarbon plume were to intercept a mass, synchronous spawning event. Recently spawned gametes and larvae would be particularly vulnerable to oil spill effects, since they are generally positively buoyant and would be exposed to surface spills. Therefore, under most circumstances, impacts on plankton from surface spills is expected to be localised, with short-term impacts; however, if an entrained/dissolved surface expression reached a coral-spawning location, such as Browse Island or Scott Reef, during a spawning event, localised short-to-medium term impacts could occur. Therefore, the consequence is considered to be minor. Fish and sharks have the potential for exposure to entrained and dissolved hydrocarbons. Chronic impacts to juvenile fish, larvae, and planktonic organisms may occur if exposed to entrained/dissolved hydrocarbon plumes. Juvenile fish and larvae may experience increased toxicity if exposed to entrained/dissolved hydrocarbon plumes because of the sensitivity of these life stages. Adult fish exposed to low entrained hydrocarbon thresholds are likely to metabolise the hydrocarbons and excrete the derivatives, with studies showing that fish have the ability to metabolise petroleum hydrocarbons. These accumulated hydrocarbons are then released from tissues when fish are returned to hydrocarbon-free seawater (Reiersen & Fugelli 1987). Several fish communities present in Zone 1 and Zone 2, (such as the continental slope demersal fish community KEF and the 125 m ancient coastline KEF) are demersal and, therefore, the fish are more prevalent at the seabed in deep water (such as the continental slope demersal fish community KEF), where concentrations of entrained hydrocarbons will be absent, or far lower than those predicted at, or near, the sea surface. Pelagic fish may be at risk if transiting the immediate vicinity of a spill, but are unlikely to be significantly affected in other areas of a surface expression, as they typically swim at depth (Burns et al. 2011). Given the highly mobile nature of pelagic fish, they are not expected to remain within entrained hydrocarbon plumes for extended periods, and limited acute impacts or risks associated with entrained hydrocarbons are expected. Fish communities located at receptors shallower than –30 m LAT, such as Browse Island, Echuca Shoal, Heyward Shoal, Ashmore Reef and Cartier Island, have the potential to be exposed to entrained/dissolved hydrocarbons at concentrations well above the impact threshold, resulting in local-to-medium scale impacts over the medium term. Probabilities for exposures above the impact threshold at these locations is also >50% for most

Source of risk or impact	Potential consequence
	seasons. The sawfish BIAs are located on the very edge of the EMBA, and therefore limited impacts are expected to sawfish communities. Therefore, the consequence of entrained/dissolved hydrocarbons on fish and shark populations at these shallow water locations is considered to be moderate. Whale sharks have the potential for exposure to entrained and dissolved hydrocarbons. Potential effects include damage to the liver and lining of the stomach and intestines, as well as toxic effects on embryos (Lee 2011). As whale sharks are filter-feeders they are expected to be highly vulnerable to entrained hydrocarbons (Campagna et al. 2011). In the event that an oil spill from a vessel collision occurred during whale shark foraging activities, there is the potential for a small proportion of the population to be affected; however, as there are no whale shark aggregations (such as the Ningaloo Reef aggregation) in the region, the overall population viability is not expected to be threatened. Therefore, the consequence is considered to be minor. In summary, the potential extent of entrained/dissolved hydrocarbon with a concentration >500 ppb may result in widespread exposure to marine fauna (including transient, EPBC-listed species, such as marine mammals, turtles and seabirds) and benthic habitats, such as coral reefs, seagrass and mangroves. There would likely also be cumulative impacts as a result of interactions between surface, entrained/dissolved and shoreline hydrocarbon impacts on the food web and through bioaccumulation up the food chain. On this basis, the potential consequence associated with entrained/dissolved plumes from the identified spill events is considered to be significant.
	Shoreline hydrocarbons
	The following shorelines were predicted to receive shoreline accumulation in excess of the 100 g/m^2 threshold for vessel collision scenarios: • Browse Island • Scott Reef • Ashmore Reef • Cartier Island • Cassini Island • Islands within the Kimberley CMR • Shorelines within the proposed North Kimberley Marine Park. The minimum reported time to shoreline contact for all seasons was 27 hours at Browse Island. All other shoreline contact times were >72 hours. Given this time to reach shorelines, the spill is expected to have weathered due to several physical and biological processes, such as photo-oxidation and biodegradation. Intertidal habitats and marine fauna known to use shorelines are most at risk from shoreline accumulation, due to smothering of intertidal habitats (such as emergent coral reefs) and coating of marine fauna. Consequently, the particular values and sensitivities with the potential to be exposed to shoreline accumulated hydrocarbons are: • benthic primary producer habitats (intertidal only) • turtle BIAs • marine avifauna BIAs. Benthic primary producer habitats exposed at spring low tides, such as the coral reef platform of Browse Island, are the most vulnerable to smothering. However, as spills disperse, intertidal communities are expected to recover (Dean et al. 1998). Direct contact of hydrocarbons to emergent corals can cause smothering, resulting in a decline in metabolic rate and may cause

Source of risk or impact	Potential consequence
	varying degrees of tissue decomposition and death. A range of impacts may also result from toxicity, including partial mortality of colonies, reduced growth rates, bleaching, and reduced photosynthesis (Negri & Heyward 2000; Shigenaka 2001). The rate of recovery of coral reefs depends on the level or intensity of the disturbance, with recovery rates ranging from 1 or 2 years, to decades (Fucik et al. 1984, French-McCay 2009). Mangrove communities within Zone 2, present along the Kimberley coastline, could potentially be exposed to shoreline oil accumulation, with potential impacts, including defoliation and mortality (Burns et al. 1993; Duke et al. 2000). The recovery of mangroves from shoreline oil accumulation can be a slow process, due to the long-term persistence of oil trapped in anoxic sediments and subsequent release into the water column. (Burns et al. 1993). However, the inner Kimberley coastline, where mangroves are present within Zone 2, is very unlikely to receive significant shoreline oil accumulation (most shoreline oil accumulation would occur on the outer islands). Lighter oils are reported to penetrate more deeply into mangrove forests than heavier and more weathered oils (Hoff & Michel 2014); therefore, in the time taken for a spill to reach mangroves on the Kimberley coastline, it is considered that the hydrocarbons will have weathered and generally be less toxic in nature. Given the potential for volumes of oil to accumulate onshore there is the potential for local-to-medium scale, short-to-medium term impacts to benthic primary producer habitats. Therefore, the consequence is considered to be moderate. Turtles can be exposed to hydrocarbons externally, through contact; or internally, by ingesting oil, consuming prey containing oil, or inhaling volatile compounds (Milton et al. 2003). Shoreline hydrocarbons can impact turtles at nesting beaches when they come ashore, with exposure to skin and cavities, such as eyes, nostrils, and mouths. Eggs may also be exposed during incubation, potentially resulting in increased egg mortality and detrimental effects on hatchlings. Hatchlings may be particularly vulnerable to toxicity and smothering, as they emerge from the nests and make their way over the intertidal area to the water (AMSA 2015a; Milton et al. 2003). As there are a number of BIAs for, hawksbill, flatback and green turtles with the potential to be exposed to shoreline accumulation, there is the potential for impacts on nesting populations, which has the potential to affect species recruitment at a local population level. Given the predicted time for shoreline contact to occur (27 hours for Browse Island) and predicted volumes of oil accumulating onshore at Browse Island, there is the potential for local-to-medium-scale impacts with medium-term effects on nesting populations of turtles at individual nesting beaches/locations. At locations with longer times for shoreline contact, there is a high potential for hydrocarbons to become weathered. Weathered oil has been shown to have little impact on turtle egg survival, while fresh oil may have a significant impact (Milton et al. 2003). Therefore, given the time to reach shoreline contact and potential for weathering, the potential consequence is considered to be moderate. Birds coated in hydrocarbons can suffer from damage to external tissues including skin and eyes, as well as internal tissue irritation in their lungs and stomachs (AMSA 2015a). Toxic effects may also result where the product is ingested, either through birds' attempts to preen their feathers (Jenssen 1994) or ingested as weathered waxy flakes/residues present on shorelines. However, waxy residues are generally considered to be of lower toxicity (Woodside 2014). Shorebirds foraging and feeding in intertidal zones are at potential risk of exposure to shoreline hydrocarbons, potentially causing acute effects to numerous marine avifauna BIAs. It is also possible that birds exposed to MGO from a surface expression may be displaced (i.e. fly away) and use nearby shorelines to recover, thereby, potentially increasing their exposure to shoreline

Source of risk or impact	Potential consequence
	hydrocarbons. In the event of a spill, there is the potential for short–to-medium-term impacts on the environment while local populations recover; however, given the presence of other marine reserves within the region, it is not expected that the overall population viability for any protected species would be threatened. Therefore, the potential consequence associated with shoreline hydrocarbon exposure is considered to be moderate. In summary, the potential extent of shoreline accumulation may result in exposure to marine fauna (including transient, EPBC-listed species, such as turtles and seabirds) and intertidal benthic habitats, such as coral reefs and mangroves. There would likely also be cumulative impacts as a result of interactions between surface, entrained/dissolved and shoreline hydrocarbon impacts on the food web and through bioaccumulation up the food chain. On this basis, the potential consequence associated with shoreline accumulation from the identified spill events is considered to be significant.

A28:

Source of risk or impact	Potential consequence
Loss of containment - subsea condensate release due to integrity failure of the subsea production system. Emergency condition.	Oil spill modelling overview: The worst-case scenario for loss of containment from the subsea infrastructure is a loss of containment from a production well resulting in an 80-day subsea release of gas condensate (Group I). The model was run for a duration of 94 days to reflect the 80 day release (based on duration to complete a relief well/ well-kill operation) and additional time to account for the fate of hydrocarbons after the production well has been contained.
	Entrained/dissolved hydrocarbons
	Impacts and risks associated with surface oil and shoreline accumulation from a production well loss of containment or other subsea integrity failure scenario will be less than those presented for the vessel collision scenario. Therefore, the potential consequence assessment below focuses only on the entrained/dissolved components of the production well loss of containment scenario. The particular values and sensitivities with the potential to be exposed to entrained/dissolved hydrocarbons may include: • commercial, recreational and traditional fishing • benthic primary producer habitats / benthic habitats shallower than –30 m LAT (corals, macroalgae, mangroves and seagrasses, including those associated with Ashmore Reef Ramsar wetland) • fish communities (KEFs) • planktonic communities • marine avifauna BIAs • whale shark foraging BIAs • turtle foraging BIAs • marine mammal BIAs • transient, EPBC-listed species • benthic communities.

Source of risk or impact	Potential consequence
	The values and sensitivities associated with commercial, traditional and recreational fisheries (seafood quality and employment) could be impacted due to entrained/dissolved/dispersed oil. Exclusion zones may impede access to fishing areas for a short-to-medium term (ITOPF 2011). Generally, there is little recreational fishing that occurs within Zone 1 because of its distance from land, lack of features of interest and the deep waters. Recreational day-fishing is concentrated around the population centres of Broome, Derby and Wyndham, as well as other readily accessible coastal settlements which are generally at the edge of, or outside, Zone 2, and therefore unlikely to be impacted by this type of spill. Commercial fisheries that transect the EMBA predominantly operate in the shallower waters of Zone 2 with generally low levels of fishing activity reported (AFMA 2012). Traditional fishing, particularly at Browse Island and along the Kimberley coast, including on intertidal reef platforms, could be affected by impacts to fish and benthic habitats from entrained oil, discussed below. Therefore, the socioeconomic impacts on commercial, traditional and recreational fisheries are expected to be short-to-medium term, and therefore the consequence is considered to be moderate. Benthic communities, including benthic primary producers, such as coral reefs, seagrass and mangroves, and deeper water filter-feeding communities, would be exposed to entrained/dissolved hydrocarbons. Studies undertaken on benthic communities have found a wide range of variation in their associated toxicity threshold levels (Tsvetnenko 1998; NRC 2005). This is to be expected, as benthic communities are made up of a large variety of different organisms. In some cases, little to no impact is observed on benthic communities. For example, in the case of the Montara oil spill, where impacts were assessed at locations such as Ashmore Reef, Cartier Island, Barracouta Shoal and Vulcan Shoal, there was no observed impact on benthic communities (Heyward et al. 2010a; 2010b; 2011a; 2013). Exposure of entrained and dissolved hydrocarbons to corals has the potential to result in lethal or sublethal toxic effects, resulting in acute impacts or death at moderate-to-high exposure thresholds (Loya & Rinkevich 1980; Shigenaka 2001), including increased mucus production, decreased growth rates, changes in feeding behaviours and expulsion of zooxanthellae (Peters et al. 1981; Knap et al. 1985). Adult coral colonies, injured by oil, may also be more susceptible to colonisation and overgrowth by algae or to epidemic diseases (Jackson et al. 1989). Lethal and sublethal effects of entrained and dissolved oils have been reported for coral gametes at much lesser concentrations than predicted for adult colonies (Heyward et al. 1994; Harrison 1999; Epstein, Bak & Rinkevich 2000). Goodbody-Gringley et al. (2013) found that exposure of coral larvae to oil and dispersants negatively impacted coral settlement and survival, thereby affecting reef resilience. However, a spill that occurs outside of a coral-spawning period would not affect coral planktonic stages. Browse Island and Echuca Shoal, the closest receptors to Zone 1, were predicted to receive worst-case concentrations of entrained/dissolved hydrocarbons, of ~6500 ppb (65 times the 100 ppb threshold), and several other receptors were predicted to receive above the 100 ppb threshold, with likelihoods above 50%. Therefore, due to the potentially large physical extent and high concentrations received, and the potential for extended duration of exposure, the potential impacts to coral reefs are considered to be significant. Due to the proximity of some deepwater filter-feeding communities, such as the 125 m ancient coastline KEF, Echuca Shoal and Heyward Shoal, and the prolonged exposure above 100 ppb that may be received at these locations, the potential consequence for these filter-feeding communities is considered to be significant. Entrained and dissolved hydrocarbons have the potential to affect seagrasses and macroalgae, through toxicity impacts. The hydrophobic nature of oil

Source of risk or impact	Potential consequence
	molecules allows them to concentrate in membranes of aquatic plants. Hence, the thylakoid membrane (an integral component of the photosynthetic apparatus) is susceptible to oil accumulation, potentially resulting in reduced photosynthetic activity (Runcie & Riddle 2006). However, a layer of mucilage present on most species of seagrass prevents the penetration of toxic aromatic fractions (AMSA 2015a). Although seagrass and macroalgae may be subject to lethal or sublethal toxic effects, including mortality, reduced growth rates, and impacts to seagrass flowering, several studies have indicated rapid recovery rates may occur, even in cases of heavy oil contamination (Connell, Miller & Farrington 1981; Burns et al. 1993; Dean et al. 1998; Runcie & Riddle 2006). For algae, this could be attributed to new growth being produced from near the base of the plant while the distal parts (which would be exposed to the oil contamination) are lost. For seagrasses, this may be because a 50–80% of their biomass is in their rhizomes, which are buried in sediments, thus less likely to be adversely impacted by hydrocarbons (Zieman et al. 1984). The seagrass locations are distant from Zone 1 (i.e. Ashmore Reef and the Kimberley coastline); therefore, the probability of contact with entrained/dissolved plumes is lower and, therefore, the associated received concentrations will be lower; however, still potentially above thresholds that could cause impacts. Based on the above impact assessment, the consequence is considered to be minor. Mangrove communities within Zone 2, present along the Kimberley coastlines, are also susceptible to entrained oil exposure, with potential impacts, including defoliation and mortality. However, as the use of dispersant on surface expressions (resulting in entrainment of oils) shows a positive benefit to mangroves, the impacts of entrained/dissolved oil on mangroves is expected to be less than the impacts predicted from surface oiling (Burns et al. 1993; Duke et al. 2000). In addition, the inner Kimberley coastline, where mangroves are present within Zone 2, is very unlikely to receive entrained/dissolved plumes and is lower; therefore, the associated received concentrations will be lower; however, still potentially above the threshold that could cause impacts. Therefore, potential impacts are considered to be minor. The effects of oil on plankton have been well studied in controlled laboratory and field situations. The different life stages of a species often show widely different tolerances and reactions to oil pollution. Usually, eggs, larval and juvenile stages will be more susceptible than adults (Harrison 1999). Post-spill studies on plankton populations are few, but those that have been conducted, typically show either no effects, or temporary minor effects (Kunhold 1978). The lack of observed effects may be accounted for by the fact that many marine species produce very large numbers of eggs, and therefore larvae, to overcome natural losses (such as through predation by other animals; adverse hydrographical and climatic conditions; or failure to find a suitable habitat and adequate food). A possible exception to this would be if a shallow entrained/dissolved hydrocarbon plume were to intercept a mass, synchronous spawning event. Recently spawned gametes and larvae would be particularly vulnerable to oil spill effects, since they are generally positively buoyant and would be exposed to surface expressions. Therefore, under most circumstances, impacts on plankton from entrained/dissolved oil is expected to be localised, with short-term impacts; however, if an entrained/dissolved spill reached a coral-spawning location, such as Browse Island or Scott Reef during a spawning event, localised short-to-medium term impacts could occur. Therefore, the consequence is considered to be minor. Due to the potential for entrained/dissolved hydrocarbons from a production well loss of containment to be present at all depths of the water column, all fish and sharks within Zone 2, including pelagic fish, demersal fish communities (such as the continental slope demersal fish community KEF and the 125 m

Source of risk or impact	Potential consequence
	ancient coastline KEF), and site-attached fish on coral reefs, such as Echuca Shoal and Browse Island, have the potential to be exposed to entrained/dissolved hydrocarbons above the 100 ppb threshold. Chronic impacts to juvenile fish, larvae, and planktonic organisms may occur if exposed to entrained/dissolved hydrocarbon plumes. Juvenile fish and larvae may experience increased toxicity if exposed to entrained/dissolved hydrocarbon plumes because of the sensitivity of these life stages. Adult fish exposed to low entrained hydrocarbon thresholds are likely to metabolise the hydrocarbons and excrete the derivatives, with studies showing that fish have the ability to metabolise petroleum hydrocarbons. These accumulated hydrocarbons are then released from tissues when fish are returned to hydrocarbon-free seawater (Reiersen & Fugelli 1987). Given the highly mobile nature of pelagic fish, they are not expected to remain within entrained hydrocarbon plumes for extended periods, and limited acute impacts or risks associated with entrained hydrocarbons are expected. However, more site-attached fish, such as reef fish at Browse Island and Echuca Shoal may be exposed above the hydrocarbon exposure threshold for a more extended duration. Exposure, above the 100 ppb threshold, is predicted with high probability at several nearby receptors, including Browse Island, Echuca Shoal and Heyward Shoal. KEFs such as the continental slope demersal fish community KEF and 125 m ancient coastline KEF are also likely to receive concentrations exceeding 100 ppb. Therefore, medium-to-large scale, medium-term impacts could occur to fish and sharks. The sawfish BIAs are located on the very edge of the EMBA, and therefore limited impacts are expected to sawfish communities. As such, the consequence of entrained/dissolved hydrocarbons on fish and shark populations is considered to be significant. Whale sharks have the potential for exposure to entrained and dissolved hydrocarbons. Potential effects include damage to the liver and lining of the stomach and intestines, as well as toxic effects on embryos (Lee 2011). As whale sharks are filter-feeders they are expected to be highly vulnerable to entrained hydrocarbons (Campagna et al. 2011). In the event that a loss of containment of a production well occurred during whale shark foraging activities, there is the potential for a small proportion of the population to be affected; however, as there are no whale shark aggregations (such as the Ningaloo Reef aggregation) in the region, the overall population viability is not expected to be threatened. Therefore, the consequence is considered to be minor. Marine mammals, marine reptiles and marine avifauna could also be impacted through entrained hydrocarbons, primarily through ingestion, including through foraging activities (AMSA 1998). Therefore, due to the potential for medium-scale contamination of food sources, the impact to marine megafauna, including transient, EPBC-listed species is considered to be moderate. In summary, the potential extent of entrained/dissolved hydrocarbons with a concentration >100 ppb may result in widespread exposure to marine fauna (including transient, EPBC-listed species, such as marine mammals, turtles and seabirds) and benthic habitats, such as coral reefs, seagrass, mangroves and deeper filter-feeding communities, such as the continental slope demersal fish community KEF and 125 m ancient coastline KEF. There would likely also be cumulative impacts through bioaccumulation up the food chain. On this basis, the potential consequence associated with entrained/dissolved plumes from the identified spill events is considered to be significant.

A29:

Source of risk or impact	Potential consequence
Introduction of IMP from high risk ballast water and biofouling	The particular values and sensitivities identified as having the potential to be impacted by the proposed activities are: • benthic communities. The introduction of IMPs can result in changes to the structure of benthic habitats and native marine organisms through predation and/or competition for resources, leading to a change in ecological function. Introduced IMPs have been known to colonise areas outside the area where they were introduced. Benthic habitats and communities within Zone 1 are common and well represented. However, in the event an IMP is introduced into Zone 1, and spreads into Zone 2, values and sensitivities with the potential to be exposed include regionally important areas of high diversity, such as shoals, banks and coral reefs. As such, the introduction of an IMP has the potential to result in a medium local, to medium-scale event with short-to-medium-term impact on the environment, with a consequence rating of moderate.

A30:

Source of risk or impact	Potential consequence
Physical presence of vessels and interaction with marine fauna	Particular values and sensitivities with the potential to be impacted are: • transient, EPBC-listed species; specifically, marine mammals, whale sharks and turtles. Vessels supporting the petroleum activity may interact with marine fauna potentially resulting in injury or death from vessel strike. Collisions between vessels and cetaceans occur more frequently where high vessel traffic and cetacean habitat occurs (Dolman & Williams-Grey 2006). Vessel speed has been demonstrated as a key factor in collisions with marine fauna such as cetaceans and turtles and it is reported that there is a higher likelihood of injury or mortality from vessel strikes on marine mammals when vessel speeds are greater than 14 knots (Laist et al. 2001; Vanderlaan & Taggart 2007). The potential for vessel strike applies to all marine mammals, whale sharks and turtle species within the region; however, humpback whales have a potentially higher likelihood due to their extended surface time. This higher likelihood of collision is reduced, however, as Zone 1 is located hundreds of kilometres offshore, away from humpback BIA areas (migration and calving) located approximately 180 km north of Zone 1. The reaction of whales to approaching ships is reported to be quite variable. Dolman and Williams-Grey (2006) indicate that some cetacean species, such as humpback whales, can detect and change course to avoid a vessel. Humpback whales are subject to a DEE Conservation Advice which requires the assessment of vessel strike on humpback whales and encourages the implementation of mitigation measures and vessel strike incident reporting to the National Ship Strike Database. As such, control measures are included below, to align with the DEE Conservation Advice and address vessel strike on humpback whales. Another marine mammal with a BIA in the region (approximately 100 km to the west of Zone 1) is the blue whale, which is also subject to a DEE Conservation Management Plan. The Conservation Management Plan identifies that, since 2006, there have been two records of likely ship strikes of blue whales in Australia. In 2009 and 2010, there were blue whale strandings in Victoria, near the Bonney Upwelling with suspected ship-strike injuries visible. Where blue whales are feeding at or near the surface, they are more susceptible to vessel strike. However, the open-ocean environment allows for whales to invoke

Source of risk or impact	Potential consequence
	avoidance behaviour in threatening situations. The Blue Whale Conservation Management Plan highlights that minimising vessel collision is one of the top four priorities and requires assessment of vessel strike on blue whales, assures that incidents are reported in the National Ship Strike Database, and that control measures proposed will align with these priorities. Whale sharks do not breach the surface as cetaceans do; however, they are known to swim near to the water surface; hence, are susceptible to vessel strike. The foraging area for whale sharks (BIA) is located approximately 30 km to the east of Zone 1 and whale sharks are also subject to a DEE Conservation Advice which notes that the threat to the recovery of the species includes strikes from vessels. While the DEE Conservation Advice does not specify any particular measures for whale shark strike reporting, a control measure requiring compliance with the Whale Shark Wildlife Management Program no. 57 (DPaW 2013) addresses avoidance of whale sharks and, as such, is considered to align with the Conservation Advice for whale sharks. Turtles transiting the region are also at risk from vessel strike when they periodically return to the surface to breathe and rest. Only a small portion (3–6%) of their time is spent at the surface, with routine dive times lasting anywhere between 15 and 20 minutes nearly every hour. The presence of vessels has the potential to alter the behaviour of individual turtles. Some turtles have been shown to be visually attracted to vessels, while others show strong avoidance behaviour (Milton et al. 2003). As large aggregations of turtles are not known in areas that will be frequently transited by vessels, any impacts due to the visual attraction are expected to be localised and of minor consequence at the population level for these mobile and broad-ranging species. Zone 1 is relatively small in relation to the expansive open ocean surrounding it, and the potential for the displacement of cetaceans by operational activities is considered to be low. Additionally, there are no recognised feeding or breeding grounds for cetaceans or turtles within the area surrounding the offshore facility. There is potential for a small number of individual marine fauna to be impacted by vessels associated with the petroleum activity and any potential vessel strike to marine fauna is likely to be limited to isolated incidents. In the unlikely event of the death of an individual whale or turtle, it would not be expected to have a significant effect at the population level.

A31:

Source of risk or impact	Potential consequence
Physical presence of vessels resulting in disruption to other marine users	Particular values and sensitivities with the potential to be impacted are: • Shipping operators and commercial, traditional, and recreational fisheries. Other marine users in the vicinity of Zone 1 may be impacted by vessel presence (and the presence of PSZ exclusion) because of the loss of navigable space available to conduct their activities. The implications of such disruptions include changes to sailing routes and journey times, or reduced ability to fish in an area (Zone 1). The worst-case consequence from a loss of access to an area could result in economic losses and/or potential reduction in employment levels. A review of commercial shipping routes indicates there are no defined shipping lanes in the vicinity of Zone 1. The marine traffic density in the vicinity of Zone 1, located outside major shipping lanes, is low with existing marine vessel movements in the area dominated by vessels servicing petroleum industry

Source of risk or impact	Potential consequence
	operations. Given the distance to shipping lanes, and relatively small area of Zone 1 in the Indian Ocean, the consequence of reduced navigable space is considered to be insignificant. Several state-managed and Commonwealth-managed fisheries overlap Zone 1 and Zone 2 and have the potential to operate within the area. Of the commercial fisheries potentially overlapping Zone 1, where support vessels associated with the petroleum activity will be operating, there is a deepwater (>200 m) fishing area which coincides with a small section of Zone 1 (from approximately Browse Island towards WA-50-L), targeting scampi and deepwater prawns. The North West Slope Trawl Fishery (NWSTF) fishes at low levels, with only negligible trawl fishing occurring in the Ichthys Field between 2002 and 2009 (AFMA 2012). Based on the low level of identified fishing activity associated with the NWSTF (or other potential operators) and the relatively small spatial area occupied by supporting vessels in Zone 1 in comparison to the entire fishing ground available to commercial operators, the potential loss of navigable space in which a fishing operator could conduct their activities is considered to be insignificant. Zone 1 is situated within the MoU box for Indonesian traditional fishing (DSEWPaC 2012). Therefore, Indonesian fishing vessels may be present in the area when transiting between fishing grounds at Scott Reef and Browse Island. Impacts to traditional fishers from the presence of vessels associated with the petroleum activity may include minor deviations in transiting routes; however, interference and disruption are not likely to extend travel times significantly. Given the relatively small size of the development where support vessels will be operating in relation to the total size of the MoU box, impacts are expected to be insignificant. Recreational fishing may also operate off the WA coast during certain times of the year, with the closest location to Zone 1 being Scott Reef, approximately 140 km from Zone 1 (Fletcher & Santoro 2014). Generally, there is little recreational fishing that occurs within Zone 1 because of its distance from land, lack of features of interest and deep waters. Therefore, the potential for economic losses in the recreational fishing industry as a result of vessel presence is considered to be of insignificant consequence.

A32:

Source of risk or impact	Potential consequence
Seabed intervention activities	The particular values and sensitivities identified as having the potential to be impacted by these activities are: • benthic communities Seabed intervention activities may result in physical disturbance and the displacement of seabed sediments. Displacement of sediments may result in temporary, localised plumes of suspended sediment and subsequent deposition of sediment resulting in smothering of marine benthic habitat and benthic communities in the immediate vicinity of the intervention activities. Physical disturbance of the seabed may cause temporary and permanent loss of benthic habitats and associated infauna and epifauna. Surveys undertaken in the development area using sub-bottom profiling, multibeam echo sounder, side-scan sonar and visual ROV transects did not identify any obstructions or features on the seafloor, such as boulders, reef pinnacles or outcropping hard layers (Fugro Survey Pty Ltd. 2005a; Fugro Survey Pty Ltd 2005b and RPS 2007). The results of the surveys indicate the soft substrate habitats of

Source of risk or impact	Potential consequence
	WA-50-L is typical of deep continental shelf seabed habitats which are widely distributed in deeper parts of the Browse Basin (RPS 2007), and this habitat is common throughout the NWMR (Baker et al. 2008). These habitats support biota typical of the broader region and this is reflected in the survey results which indicate the epibenthic fauna is diverse but sparsely distributed (RPS 2008). The seabed comprises heavily rippled sediments suggestive of strong near-seabed currents and the lack of seabed features and the soft sediment conditions, in Zone 1, have been confirmed during the installation of the subsea infrastructure in 2014 and 2015. The total disturbance footprint from permanent and temporary seabed intervention activities may range from approximately <1 m^2–50 m^2 from the placement of grout bags/concrete mattresses up to approximately 400 m^2 for excavations. In the context of WA-50-L, covering an area of approximately 57 000 ha, it is considered that potentially impacted benthic habitats and associated biota are well represented in the region and losses due to seabed intervention activities will represent a very small fraction of the widespread available habitat. Parts of the ancient coastline KEF, particularly where it exists as a rocky escarpment, are thought to provide biologically important habitats in areas otherwise dominated by soft sediments (DSEWPaC 2012). It is considered that the hard substrate of the escarpment is likely to support a range of sponges, corals, crinoids, molluscs, echinoderms and other benthic invertebrates (DSEWPaC 2012). The ancient coastline KEF is located, approximately 27 km south of Zone 1. Therefore, benthic communities associated with the KEF are not expected to be impacted from seabed intervention activities in Zone 1 as any silt plumes generated would have dissipated over this distance in the presence of near-seabed currents and it is not expected that sedimentation/smothering impacts would occur to benthic communities. Therefore, the potential consequence on benthic communities is a localised impact at the site of seabed intervention activities in Zone 1 from physical disturbance or smothering/sedimentation associated with silt plumes, which is expected to be limited given the sparse cover of benthic communities reported in Zone 1, is assessed to be of inconsequential ecological significance.

A33:

Source of risk or impact	Potential consequence
Routine effluent discharges of sewage effluent, grey water and food waste from vessels during oil spill response	The values and sensitivities with the potential to be impacted are: • transient, EPBC-listed species (marine fauna). Due to the potentially limited availability of suitable oil spill response vessels and short timeframes for mobilisation, oil spill response vessels may not be fitted with sewage disinfection systems, sewage macerators or food macerators. Therefore, transient, EPBC-listed species, such as marine turtles and marine avifauna may be exposed to untreated sewage, grey water and food scraps, particularly when response vessels are conducting activities near breeding rookeries, such as Ashmore Island, Browse Island, Cartier Island and Scott Reef. The duration of any exposure is likely to be limited, from a few days to weeks, depending on the duration of the oil spill response activity. Due to the local currents and deep offshore waters surrounding these offshore islands, any temporary changes to water quality that may occur are expected to be short-term and localised, and are therefore considered to be insignificant.

A34:

Source of risk or impact	**Potential consequence**
Aerial and/or vessel-based surface dispersant application during oil spill response	The values and sensitivities with the potential to be impacted are: • transient, EPBC-listed species (marine fauna) • benthic communities (submerged reefs and shoals, and seagrasses) • BIAs associated with turtle and marine avifauna nesting. Applying a dispersant can reduce the amount of hydrocarbon present on the surface of the water column; therefore, reducing the exposure of surface sensitive receptors (such as seabirds and turtles), shorelines and intertidal biota. In addition, reducing the surface expression of the hydrocarbon creates a safer working environment for response personnel and can have benefits to air-breathing fauna. Dispersants have an inherent level of toxicity. Additionally, chemically dispersed hydrocarbons may, in certain instances, have a higher level of toxicity to benthic communities than the hydrocarbons themselves. Dispersant use results in increased entrainment in the water column, increasing the bioavailability of the hydrocarbon potentially impacting subtidal values and sensitivities, particularly in shallow-water environments. Monitoring undertaken after the Montara spill resulted in entrained hydrocarbons concentrating in the top 25 m of the water column (AMSA 2010). The distance at which receptors could be impacted by dispersed hydrocarbons has been assessed using the 500 ppb threshold for surface released entrained/dissolved hydrocarbons. RPS APASA (2014d) conducted a series of dispersant effectiveness modelling simulations for a 1000 m^3 IFO release, at various locations along the GEP route. The modelling used a number of 'worst-case volume of oil ashore' and 'worst-case time/concentration at a receptor' stochastic modelling runs. The dispersant modelling report (RPS APASA 2014d) remodelled the identified worst-case stochastic model runs, with various dispersant treatments (vessel, aerial, or both), and compared 'with dispersant versus without dispersant' outcomes for surface oil concentrations, shoreline contact, and 'entrained/dissolved' concentrations at various receptors. Five of the modelling scenarios resulted in 70 m^3 to 120 m^3 of oil being successfully dispersed within <2.5 km of a sensitive receptor. Timings ranged from instantaneous contact to a few hours to contact. The increase in entrained/dissolved oil concentrations (due to dispersant application) received at this receptor ranged from 454 ppb to 1607 ppb. These received concentrations are similar too, or up to three times higher, than the 500 ppb threshold. In another modelled scenario, 48 m^3 of oil was successfully dispersed, at 12 km from Browse Island. Prevailing wind and current directed this dispersed oil plume directly at Browse Island. The received dispersed oil concentration at Browse Island was 247 ppb, half the concentration of the 500 ppb threshold. In another scenario, 50 m^3 of oil was successfully dispersed, 15 km from Browse Island. The modelled wind and currents resulted in the dispersed oil plume reaching Browse Island in 20 hours. The received concentration was 8.4 ppb, two orders of magnitude below the 500 ppb threshold. These results demonstrate that increasing the distance and/or time for the dispersed oil to reach a receptor results in a significant decrease in received entrained/dissolved oil concentrations at the receptor. Based on the conclusions of RPS APASA (2014d), the INPEX dispersant application decision matrix, incorporates a highly conservative no dispersant application buffer of 20 km around any wholly submerged feature. Dispersant application closer than 20 km to intertidal reefs or islands can occur, in consultation with relevant state/territory agencies, provided the Operational NEBA demonstrates a net environmental benefit is anticipated.

Source of risk or impact	Potential consequence
	The closest submerged shoals to the Ichthys Field are Echuca and Heywood shoals, 79 km and 96 km away, respectively. They have average depths of 26 m and 33 m, respectively, and Browse Island has submerged and intertidal habitat (concentrated in a shallow, subtidal zone <20 m depth). Dispersant sprayed on the sea surface close to these sensitive receptors may result in additional impacts to submerged/intertidal habitats. The degree of impact associated with the toxicity of the dispersant and dispersed hydrocarbon is, however, dependent on the operational use and the performance standards engaged for the application. The 20 km no dispersant application buffer around wholly submerged receptors should prevent impacts to these receptors. Impacts from dispersant application closer to submerged/intertidal receptors, such as Browse Island, are expected to be short-term and localised with the potential for minor or temporary impacts. These impacts (at intertidal locations, such as Browse Island) would only occur when the Operational NEBA demonstrated a net environmental benefit for dispersant use. The decision to conduct dispersant application (including consideration of the associated consequences) within 3 nm of Browse Island would only occur under direction/instruction from WA DoT, as it is the control agency within state waters.

A35:

Source of risk or impact	Potential consequence
Shoreline clean-up, protect and deflect and containment and recovery waste generated during oil spill response	The values and sensitivities with the potential to be impacted are: • transient, EPBC-listed species (marine fauna) • marine fauna BIAs in Zone 2 (turtles and marine avifauna nesting). A shoreline clean-up response will generate a significant quantity of hydrocarbon-contaminated solid waste. Contaminated solids will include personal protective equipment (PPE), spill clean-up equipment (shovels, rakes, etc.) and the oily contaminated sediments collected from shorelines. Inappropriate management of the oily contaminated waste could result in localised contamination of shoreline sediments and harm to individuals of protected species. Protect and deflect/contain and recover response activities would generate a significant quantity of hydrocarbon-contaminated solid waste. Contaminated solids would include personal protective equipment (PPE), oil coated booms, skimmers etc. and the oily contaminated liquids and sediments collected during the response activity. Inappropriate management of the oily contaminated waste could result in localised contamination of the marine environment and shoreline sediments resulting in harm to individuals of protected species.

A36:

Source of risk or impact	Potential consequence
Wildlife hazing	The values and sensitivities with the potential to be impacted are: • transient, EPBC-listed species (marine fauna). Wildlife hazing can increase the survival of wildlife potentially affected by a spill (particularly seabirds, marine mammals and reptiles in transit) by encouraging wildlife to move away from the location of the spill. There may be potential for

Source of risk or impact	Potential consequence
	increased stress to wildlife individuals involved in hazing activities or the potential to cause wildlife to move into the area affected by the spill from poorly implemented hazing activities. Any potential impacts are considered to be of inconsequential ecological significance to protected species, as the potential impacts are to individuals, not populations of protected species, and are therefore regarded as insignificant.

A37:

Source of risk or impact	Potential consequence
Pre and post-contact wildlife response	The values and sensitivities with the potential to be impacted are: • transient, EPBC-listed species (turtles and marine avifauna) • marine fauna BIAs in Zone 2 (turtles and marine avifauna nesting). Pre-contact and post-contact wildlife response (capture, cleaning, relocation and rehabilitation of wildlife) can increase the survival rates for wildlife which may be, or has become oiled at sea or onshore. There may be a potential for increased stress to some animals due to their capture and containment during capture, cleaning, relocation and/or rehabilitation. However, any potential impacts are considered to be of inconsequential ecological significance to protected species, as the capture, relocation cleaning, relocation and/or rehabilitation is conducted to increase survival rates of individuals.

A38:

Source of risk or impact	Potential consequence
Turtle nesting disturbance during shoreline responses	The values and sensitivities with the potential to be impacted are: • transient, EPBC-listed species (turtles) • marine fauna BIAs in Zone 2 (turtles). Physical presence and movement of personnel across turtle-nesting beaches could potentially cause damage to buried turtle eggs, reducing turtle-nesting success. Artificial light is known to disorientate marine turtles, particularly hatchlings and female adults returning to the sea from nesting areas on the shore (Pendoley 2005). Incorrect management of personnel and equipment on turtle-nesting beaches could result in a minor impact on a small proportion of a turtle-nesting population.

A39:

Source of risk or impact	Potential consequence
Quarantine during shoreline responses	The values and sensitivities with the potential to be impacted are: • transient, EPBC-listed species (marine avifauna) • marine fauna BIAs in Zone 2 (marine avifauna nesting). The *Threat abatement plan to reduce the impacts of exotic rodents on biodiversity on Australian offshore islands of less than 100 000 hectares* (DEWHA 2009) identifies that exotic rodents (such as rats) have been a major cause of extinction and decline of island biodiversity. Introduction of rodents to

Source of risk or impact	Potential consequence
	any of the offshore islands in Zone 2 could result in a medium-term impact on a population of protected species of moderate consequence.