ICHTHYS PROJECT GAS EXPORT PIPELINE (OPERATION) ENVIRONMENT PLAN SUMMARY

EP Summary

Document No.: F075-AH-PLN-10004
Security Classification: Public

Document distribution

Copy no.	Name	Hard copy	Electronic copy
00	Document control	☑	☑
01	NOPSEMA	☐	☐

Notice

All information contained with this document has been classified by INPEX as Public and must only be used in accordance with that classification. Any use contrary to this document's classification may expose the recipient and subsequent user(s) to legal action. If you are unsure of restrictions on use imposed by the classification of this document you must refer to the INPEX Sensitive Information Protection Standard or seek clarification from INPEX.

Uncontrolled when printed.

Table of contents

List of tables

List of figures

List of Appendices

Abbreviations and acronyms

Abbreviation / acronym	Description
°C	degrees Celsius
AFMA	Australian Fisheries Management Authority (Cwlth)
AHS	Australian Hydrographic Service
AIMS	Australian Institute of Marine Science
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
AS/NZS	Australian/New Zealand Standard
AUV	autonomous underwater vehicle
BIA	Biologically Important Area
BOM	Bureau of Meteorology
CASA	Civil Aviation Safety Authority
CCR	central control room
CMR	Commonwealth marine reserve
CO_2	carbon dioxide
CPF	central processing facility (offshore)
Cwlth	Commonwealth
DAWR	Department of Agriculture and Water Resources (Cwlth)
dB	decibel
DEC	Department of Environment and Conservation (WA)
DEE	Department of the Environment and Energy (Cwlth) (formerly known as DoE)

Abbreviation / acronym	Description
dense phase	When a pure or mixed compound is heated and compressed above the critical temperature and pressure, such that it becomes a dense, highly compressed fluid that demonstrates properties of both liquid and gas.
DER	Department of Environment Regulation (WA)
DEWHA	Department of the Environment, Water, Heritage and the Arts
DME	Department of Mines and Energy (NT)
DMP	Department of Mines and Petroleum (DMP)
DoE	Department of the Environment (Cwlth)
DoFWA	Department of Fisheries (WA)
DP	dynamic positioning
DPIF	Department of Primary Industries and Fisheries (NT)
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EIS	environmental impact statement
EMBA	environment that may be affected
EP	environment plan
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cwlth)
FIS	filtered inhibited seawater
FMA	field management area
FPSO	floating production, storage and offtake (facility)
GEP	gas export pipeline
GEP gas	The contents of the GEP during operations
GERB	gas export riser base
GT	gross tonnage
ha	hectare(s)
HFO	heavy fuel oil

Abbreviation / acronym	Description
HSE	health, safety and environment
HSEQ	health, safety, environment and quality
HSEQ-MS	health, safety, environment and quality management system
Hz	hertz
IAP	incident action plan
IAPP	International Air Pollution Prevention
IFO	intermediate fuel oil
IMO	International Maritime Organization
IMP	invasive marine pest
IMR	inspection, maintenance and repair
IMT	incident management team
INPEX Operations Australia Pty Ltd	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 partners.
Ichthys LNG Pty Ltd	Ichthys LNG Pty Ltd is the titleholder of Pipeline Licences WA-22-PL and NT/PL4
ISPP	International Sewage Pollution Prevention
KEF	key ecological feature
kHz	kilohertz
km	kilometre
LAT	lowest astronomical tide
LNG	liquefied natural gas
LPG	liquefied petroleum gas
m/m	mass-for-mass
m/s	metres per second

Abbreviation / acronym	Description
MARPOL 73/78	International Convention for the Prevention of Pollution from Ships, 1973/1978
MEG	monoethylene glycol
MGO	marine gas oil
MoC	management of change
MODU	mobile offshore drilling unit
MoU	memorandum of understanding
NatPlan	National Plan for Maritime Environmental Emergencies
NEBA	net environmental benefit analysis
nm	nautical mile
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority (Cwlth)
NOPTA	National Offshore Petroleum Titles Administrator
NO_X	mononitrogen oxides
NT	Northern Territory
NT DoT	Northern Territory Department of Transport
NT EPA	Northern Territory Environmental Protection Authority
NT PaWC	Northern Territory Parks and Wildlife Commission
ODS	ozone-depleting substance
OIM	Offshore Installation Manager
OIW	oil-in-water
OPEP	oil pollution emergency plan
operations stage	The principal activity will be the flow of GEP gas from the CPF to the Ichthys LNG Plant in Darwin
OPGGS (E) Regulations	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cwlth)
OPGGS Act	*Offshore Petroleum and Greenhouse Gas Storage Act 2006* (Cwlth)

Abbreviation / acronym	Description
OSCP	oil spill contingency plan
OSMP	Operational and Scientific Monitoring Program
OSPAR	Oslo (1972) and Paris (1974) Convention for the Protection of the Marine Environment of the North-East Atlantic
OSRL	Oil Spill Response Limited
OSV	offshore support vessel
OWR	oiled wildlife response
OWS	oil–water separator
PIG	pipeline inspection and gauging tool
PLMS	pipeline management system
PLONOR	pose little or no risk (to the environment)
PLR	pig launcher and receiver
PMS	preventative maintenance system
ppb	parts per billion
ppm	parts per million
PPRR	prevention, preparedness, response, recovery
PRS	pipeline repair system
PSV	platform supply vessels
PTS	permanent threshold shift
PWC	Power and Water Corporation (NT)
PWC gas	Gas provided by Power and Water Corporation
Ramsar Convention	The Convention on Wetlands of International Importance, especially as Waterfowl Habitat
RBI	risk-based inspection
ROV	remotely operated underwater vehicle
SOPEP	shipboard oil pollution emergency plan

Abbreviation / acronym	Description
SO_X	sulfur oxides
start-up stage	The start-up stage commences with the first introduction of gas into the GEP using either GEP gas from the CPF, via the GERB or Northern Territory Power and Water Corporation (PWC) natural gas from the Ichthys LNG Plant. During the start-up stage, the GEP will be brought up to operating pressure using GEP gas from the CPF, via the GERB.
t	tonne
TTS	temporary threshold shift
WA	Western Australia
WA-50-L	The production licence within which the Ichthys Field is being developed
WA DoT	Department of Transport (WA)
WA DPaW	Western Australian Department of Parks and Wildlife
WAFIC	Western Australian Fishing Industry Council
WestPlan MOP	State Emergency Management Plan for Marine Oil Pollution (WA)

1 INTRODUCTION

This Environment Plan 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 Ichthys Project Gas Export Pipeline (Operation) EP (the EP) accepted by NOPSEMA.

1.1 Background

INPEX Ichthys Pty Ltd, on behalf of the Ichthys Upstream Unincorporated Joint Venture Participants is developing the Ichthys Field in the Browse Basin off the north-west coast of Western Australia to produce condensate for export to markets in Japan and elsewhere and export gas for further processing at the Ichthys liquefied natural gas (LNG) plant in Darwin. Additional condensate, liquefied petroleum gases (LPGs) and LNG will be produced onshore from the export gas on behalf of the Ichthys Downstream Incorporated Joint Venture.

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. Water depths in the Ichthys Field are approximately 250 m and the field consists of two reservoirs: an upper reservoir in the Brewster Member and a lower reservoir in the Plover Formation.

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 facility (FPSO) equipped with hydrocarbon processing and monoethylene glycol (MEG) regeneration facilities. The FPSO will have a condensate storage capacity of more than 1 000 000 barrels and will transfer the condensate to tankers for export to overseas markets. The gas will be transferred from the CPF via an 889 km gas export pipeline (GEP) to an onshore processing plant at Bladin Point in Darwin, The Ichthys LNG Plant (Figure 1-1).

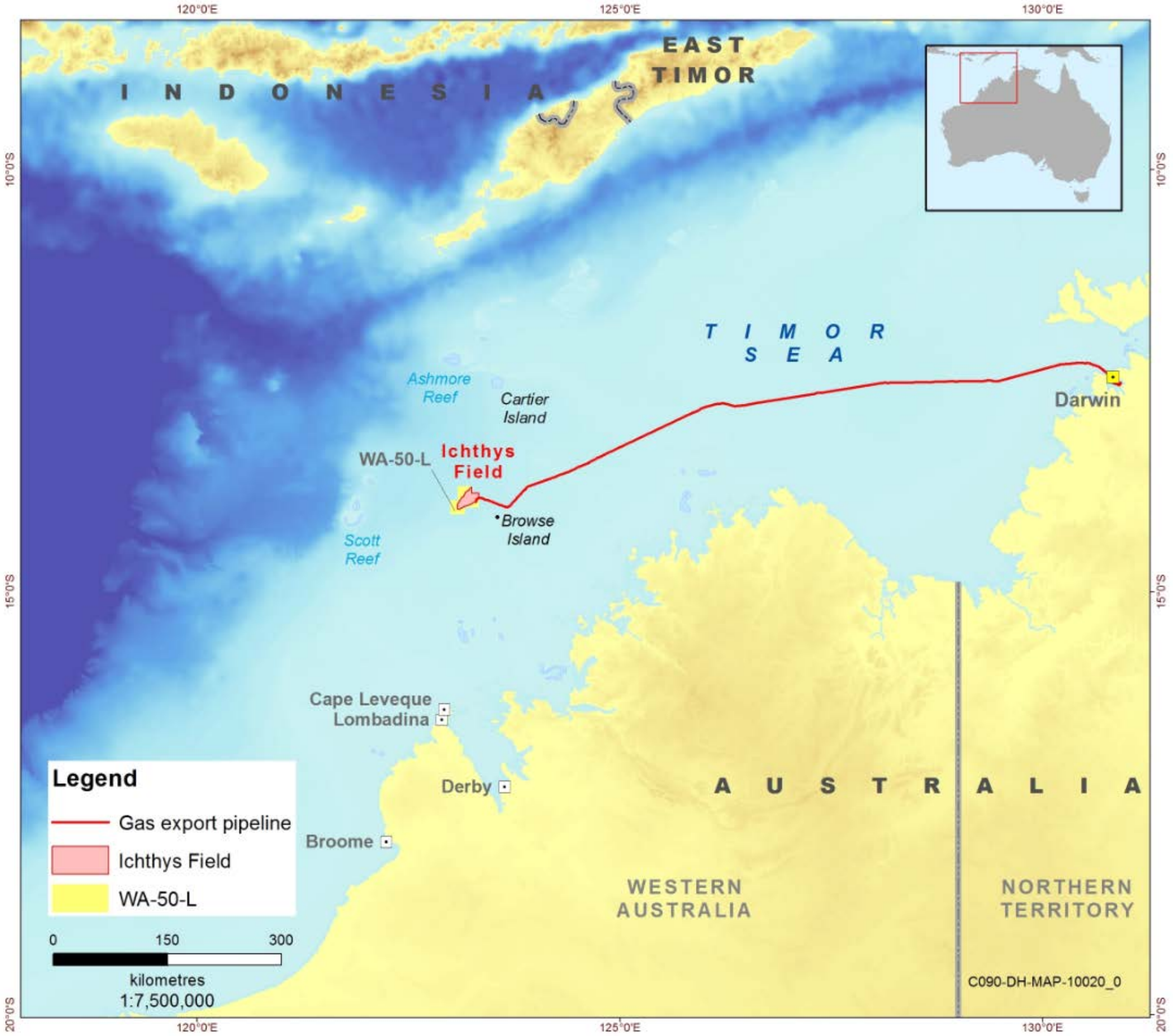


Figure 1-1: Location of the GEP route and the Ichthys Field

1.2 Activity overview

The *Ichthys Project Gas Export Pipeline (Operation) Environment Plan* (the EP) describes:

- operation of the GEP to transport GEP gas from the offshore facility to the Ichthys LNG Plant in Darwin
- inspection, maintenance and repair (IMR) activities of the GEP during the start-up and operations stages
- vessel activities within the operational area (Zone 1).

Table 1-1 provides an overview of the start-up and operation of the GEP IMR works within title areas WA-22-PL and NT/PL-4.

Table 1-1: Overview of activity description

Ichthys Project GEP operation	
Pipeline licence area	WA-22-PL and NT/PL4.
Basin	Browse
Gas field	Ichthys Field
Hydrocarbon type	Gas and condensate normally in dense phase (referred to as "GEP gas").
Activity location	The GEP is approximately 889 km long, with approximately 793 km of it located within Commonwealth waters, between the Ichthys Field and the Northern Territory (NT) three-nautical-mile (nm) limit (Figure 1-1). Activities covered by the EP are wholly located in Commonwealth waters and the operational area is defined as a two-kilometre-wide corridor, 1 km either side of the GEP centreline, up to the Gas Export Riser Base (GERB). The water depths range from ~250 m below lowest astronomical tide (LAT) at the GERB, to ~30 m LAT, at the boundary of Commonwealth waters and the NT three-nautical-mile limit.
Activity description	Operation of the GEP involves the transportation of GEP gas through the GEP to the Ichthys LNG Plant in Darwin. Inspections provide assurance that infrastructure is performing according to design. They also proactively identify maintenance and/or repair activities that may be required to protect the GEP integrity. Inspection activities within the EP include: • remotely operated underwater vehicle (ROV) or autonomous underwater vehicle (AUV) inspections • marine acoustic surveys. Maintenance and repair activities described in the EP are not intended to occur but, if required, may include: • seabed intervention (e.g. jetting, mass flow excavation, installing grout bags, rock placement or concrete mattress installation) • marine growth removal • pigging to recover the integrity of, or isolate, the GEP in the event of a repair • clamp repairs • major repairs, including use of a pipeline repair system (PRS) used to replace sections of pipe.
Vessels	Typically, a single vessel can be used to conduct IMR activities. However, depending on the nature and location of a repair activity, additional vessels may be required. Typically, vessels will use Group II hydrocarbons such as marine gas oil (diesel). However, Group IV

Ichthys Project GEP operation	
	hydrocarbons such as intermediate fuel oil (IFO) 180 or heavy fuel oil (HFO) 380 may be used if a heavy-lift vessel is required for a repair activity.
Expected activity commencement	Mid-2017
Duration	The Ichthys Project has a design life of 40 years. The EP will cover continuous operation of the GEP, and associated IMR activities, for five years from the date of acceptance of the EP.

1.3 Titleholder's details and nominated liaison person

Ichthys LNG Pty Ltd is the titleholder of Pipeline Licences WA-22-PL and NT/PL4.

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	Sandy Griffin
Position	Team Lead Environmental Approvals
Business address	100 St Georges Tce, Perth, WA 6000
Telephone number	+61 8 6213 6000
Fax number	+61 8 6213 6455
Email address	Sandy.Griffin@inpex.com.au

2 DESCRIPTION OF ACTIVITY

2.1 Commencement

The EP will be activated at the commencement of the start-up stage of the GEP, defined below, currently expected to be in mid-2017.

The timing provided above is indicative and may be subject to potential delays caused by weather events, construction delays and other factors. The Ichthys Project has a design life of 40 years; consequently, this EP will be reviewed in accordance with the EP.

2.1.1 Start-up stage

The start-up stage commences with the first introduction of gas into the GEP using either:

- GEP gas from the CPF, via the GERB

or

- Northern Territory Power and Water Corporation (PWC) natural gas from the Ichthys LNG Plant.

During the start-up stage, the GEP will be brought up to operating pressure using GEP gas from the CPF, via the GERB.

2.1.2 Operations stage

During the operations stage, the principal activity will be the flow and transportation of GEP gas from the CPF to the Ichthys LNG Plant in Darwin. The operation of the GEP for the purposes of transporting GEP gas to the Ichthys LNG Plant is an entirely closed system, with no planned discharges to the marine environment during normal operation of the GEP. The pressure within the GEP will be monitored from the GERB (GEP inlet pressure) and the Ichthys LNG Plant (GEP outlet pressure).

2.2 Activities

2.2.1 Transfer of GEP gas through the GEP

GEP gas will normally be in ‘dense phase’ (i.e. heated and compressed above its critical temperature and pressure, such that it becomes a dense, highly compressed fluid that demonstrates properties of both liquid and gas), and will travel through the GEP, from the Offshore Facility to the Ichthys LNG Plant.

The transfer of dense phase gas via a pipeline is uncommon in Australian waters. However, it is a requirement for this activity due to the length of the GEP and the required inlet pressure at the Ichthys LNG Plant.

The GEP is a 42-inch outer diameter, steel pipeline, installed with concrete weight and asphalt enamel external coating. The concrete coating provides a degree of protection for the GEP's integrity against potential impacts, such as from dropped objects or fishing gear. The GEP has been installed with 5 hot-tap-tees and one midline dummy spool, all with ‘over-trawl’ covers installed.

GEP gas consists of Ichthys Field reservoir hydrocarbons which have been processed on the CPF and FPSO to remove most of the water and long-chain hydrocarbons. The GEP gas consists primarily of natural gases with a minor fraction of light condensate (C_5–C_{13}), a very light oil, when at ambient temperature (25 °C) and pressure (1 bar). The expected components of GEP gas are provided in Table 2-1. For the Ichthys GEP, dense phase will be achieved only by high pressure and the temperature will be that of the ambient seawater.

The GEP will typically operate with an inlet pressure of approximately 200 bar on the offshore end. Due to the 889 km length of the GEP, a significant pressure drop will occur as the gas transits towards the Ichthys LNG Plant, because there are no compressors along the GEP. The inlet pressure at the Ichthys LNG Plant boundary (the onshore end of the GEP) will typically be between 65 bar and 110 bar. Because of the very high operating pressures, the GEP gas will normally be in dense phase, hence no liquid hydrocarbons will be present within the GEP while operating. It is estimated that at any moment in time, the GEP will contain approximately 10 000 m^3 of condensate (C_5–C_{13}) if it were processed th6rough the Ichthys LNG Plant and stabilised to ambient temperature and pressure.

The flow into and out of the GEP is dependent on the CPF and Ichthys LNG Plant production rates. The pressure in the GEP will vary depending on accumulated inventory and will be monitored from the CPF and Ichthys LNG Plant central control rooms (CCRs) respectively.

Table 2-1: Expected GEP gas composition

Component	Mol (%)
Methane (C_1)	72.92
Ethane (C_2)	10.60
Propane (C_3)	4.24
Butane (C_4)	1.87
C_5–C_7	1.10
C_8–C_{13}	0.03
Carbon dioxide (CO_2)	8.71
Nitrogen (N_2)	0.50
Water (H_2O)	<0.01
Hydrogen sulfide (H_2S)	<0.01

2.2.2 Inspection, maintenance and repair (IMR) activities

Inspection

Inspection of the GEP will be conducted in accordance with a risk-based inspection (RBI) schedule.

Inspections of the pipeline will generally involve a vessel travelling along the route of the pipeline using towed acoustic instruments, or may involve using a Remotely Operated Vehicle (ROV) connected to the vessel via an umbilical, or an Autonomous Underwater Vehicle (AUV) which is launched and recovered from the vessel.

Typically, vessels will be on site for approximately 5–60 days per year depending on the type of inspection. Events such as cyclones, known dropped/dragged objects or seismic activity that could affect the GEP may also trigger inspections. Foreseeable inspection activities are detailed in Table 2-2 below.

Table 2-2: Inspection activities

Inspection activity	Description
ROV/AUV inspections	ROVs/AUVs will be deployed from a vessel to undertake visual, cathodic protection and pipeline integrity inspections.
Marine acoustic surveys	These may include the use of sidescan sonar and multibeam echo sounders and are typically conducted by towed acoustic instruments or by launching AUVs containing acoustic survey equipment from a vessel.

Maintenance and repairs

Maintenance and repair activities will be conducted based on the results of inspection and monitoring of the GEP. If maintenance or repairs are required, a vessel may remain on site for approximately 15 to 60 days at a time, depending on the nature of the work required. A major repair activity could take approximately 150 days, involving several individual vessel scopes of work throughout the major repair. However, depending on circumstances additional field time may be required. Maintenance and repair activities are described in Table 2-3.

Table 2-3: Maintenance and repair activities

Maintenance and repair activities	Description
Maintenance	
Seabed intervention activities	Involves activities such as physical seabed intervention/excavation alongside the GEP infrastructure to gain access to, or enable maintenance and/or repairs. Excavation could involve activities such as jetting, side-casting or mass flow excavation. Seabed intervention activities could include the installation of grout bags, concrete mattresses, rock placement or other physical structures to stabilise, protect and repair infrastructure on the seabed and/or to prevent ongoing erosion of the seabed.
Cathodic protection	Involves activities such as the replacement of anodes and cathodic

Maintenance and repair activities	Description
system maintenance	protection equipment. This equipment may be added to, or placed adjacent to the GEP infrastructure using a vessel and ROV spread. Over time, anodes and cathodic protection equipment become naturally depleted and therefore they are not recovered. To retain protection, new anodes will be added by means of an adjacent skid structure. There will be no emissions, discharges, or wastes generated from cathodic protection system maintenance.
Marine growth removal activities	Involves the removal of marine growth and calcareous deposits using mechanical techniques and/or chemical treatments using a vessel and ROV spread.
Repair	
Clamp repair (minor repair)	Minor repairs using clamps may be required following a minor physical impact or integrity issue with the GEP. In the event that a minor/clamp repair is required, the seabed around the GEP may need to be excavated to enable access for the clamp to be placed around the full diameter of the GEP. Alternatively, the GEP may be lifted and grout-bags placed under the GEP, or mud-mats and hydraulic operated pipe lifting frames may be installed on the seabed to raise the GEP off the seafloor to allow clamp access. Once full access to the GEP is achieved, the concrete weight and asphalt enamel coating will be removed using physical removal techniques, such as high-pressure water blasting. The exposed GEP outer steel surface will then be physically smoothed in preparation for the clamp installation. The clamp will then be lowered around the GEP section to be repaired, locked into position and grout injected to seal the clamp around the repair location.
Major repair	A major repair may be required following scenarios such as a large physical impact to the GEP (e.g. a dragging anchor deforming or rupturing the pipe) or an inspection pig stuck inside the GEP). The PRS is a combination of equipment which, when used together, enables a section of the GEP to be cut out and replaced. It would be deployed from the back deck of a support vessel and supported with ROVs. The PRS equipment includes: • hydraulic-actuated pipeline lifting frames • pipe-cutting/preparation tools, including but not limited to, diamond wire cutters, grinding and water-blasting equipment • repair spool activation tooling • repair spool leak-test equipment. In the event that a major repair is required, generally, the following activities would be undertaken using the PRS to isolate, repair and recondition the GEP: • seabed intervention, including but not limited to, installation of a survey array to ensure accurate seabed positioning, and installation of PRS lifting frames and cradles for repositioning of the GEP • cutting and removal of the damaged section • physical removal of the concrete weight and asphalt enamel

Maintenance and repair activities	Description
	coating • physical smoothing of the outer steel surface to allow pipe repair flange installation/connection • lowering and connection of the repair spool • potential flushing of the repair spool with MEG or chemically treated filtered inhibited seawater (FIS) to displace raw seawater • activation of repair flange to connect the spool to the GEP • leak-test of the repair spool • potential recovery and rectification, and re-installation of the repair spool if leak-tests fail • ROV inspections during and after repair. During the repair process, isolation will be used to prevent seawater ingress and hydrocarbon release, as described below.
Isolations and pigging activities during a repair	During a major repair, the GEP would need to be isolated to prevent seawater ingress and prevent further escape of hydrocarbons. Isolation of the GEP would be achieved through the placement of isolation tools inside the GEP on both sides of the repair location. Isolation methods could include: • launching isolation pigs from the GERB and/or Ichthys LNG Plant • inserting isolation tools such as foam pigs or airbags directly into the GEP at the repair location • inserting hot-tap isolations directly into the GEP either side of the repair location Following the successful repair, pig trains containing products such as potable water, FIS and/or MEG slugs may be used to recondition (i.e. displace any seawater) from the inner walls of the GEP. The discharges associated with the recommissioning would be managed at the Ichthys LNG Plant. (Note – Pigging activities at the GERB may require the use of a heavy-lift vessel to install a pig-launcher-receiver (PLR) onto the GERB. Pigs can be driven from the GERB with GEP gas. However, if alternatives (other than GEP gas) are used to drive them from the GERB, such as FIS, nitrogen gas or air, a flooding spread would be required at the GERB location. If needed, these vessel activities and any associated discharges at the GERB would be managed in accordance with the *Offshore Facility (Operation) EP* (X075-AH-PLN-00015). Therefore they are not part of the Activity described in this document.

2.2.3 Vessel activities

Vessel IMR activities could occur at any time after the activity commences. Vessels used for IMR activities are expected to range between approximately 30 m and 130 m in length. However, vessel type and specifications will depend on availability and specific activity requirements. All maintenance and repair vessels will operate using dynamic positioning (DP) preventing the need for anchoring (except in vessel-safety-related emergency situations). Inspection vessels conducting marine acoustic surveys will not be required to be DP vessels; however, neither they will they anchor while conducting the petroleum activity. Heavy-lift vessels would likely only be required in the event of a pipeline repair, where the use of the PRS is necessary.

Vessels may use Group II fuel (marine gas oil – MGO) or Group IV fuel (IFO 180 or HFO 380). Lifting and transfer of equipment and supplies between vessels may be required in Zone 1.

Vessels used during an emergency situation may not be subjected to all pre-mobilisation inspections/controls due to insufficient time; however, controls relating to relevant environmental risks from vessel activities during an emergency condition are addressed in the EP.

3 EXISTING ENVIRONMENT

The GEP route stretches from the GERB to the boundary of Commonwealth waters (Figure 1-1).

In the event of a spill, the environment that may be affected (EMBA) covers a considerably larger area than the pipeline corridor. Consequently, these areas have been defined as follows:

- Zone 1: A corridor 1 km either side (2 km total width) centred over the GEP route (note that all distances discussed regarding environmental values and sensitivities within this section are measured from the closest point to Zone 1).
- Zone 2: The outer extent of the EMBA is a conservative estimate based upon the sum of overlayed stochastic runs of worst-case oil spill models for all seasons as shown in Figure 3-1.

Australia's offshore waters have been divided into six marine regions in order to facilitate their management by the Australian Government under the EPBC Act. Both Zone 1 and Zone 2 are located within both the North-west Marine Region (NWMR), and North Marine Region (NMR).

3.1 Physical environment

The air temperature at Browse Island (within the NWMR) shows mean maximum temperatures of 33.3 degrees Celsius (°C) and a minimum of 25.1°C (BOM 2015a). 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).

Darwin (within the NMR) is located in the monsoonal tropics of northern Australia and experiences two distinct seasons – a hot, wet season from November to March and a warmer dry season from May to September. April and October are transitional months between the wet and dry seasons. Maximum temperatures are defined as hot all year round, but November is the hottest month with an average of 33.3 °C, while June and July usually experience the lowest average daily temperatures with a range of 20 °C minimum to 30 °C maximum (BOM 2015b).

The NWMR has a pronounced monsoon season between December and March, which brings with it heavy rainfall. The strongest winds and heaviest rainfall are associated with the passage of tropical cyclones, which can occur in the region at any time during the period from November to April.

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 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 prior to propagation eastwards and southwards across the wide continental shelf. The NWMR experiences some of the largest tides along a coastline adjoin an open ocean in the world. In the eastern section of the GEP route, closest to Darwin, the area is influenced primarily by strong diurnal tidal flows and less by ocean currents. The Joseph Bonaparte Gulf (south east of the GEP route) is subject to the highest tidal range in the region (up to 7–8 m).

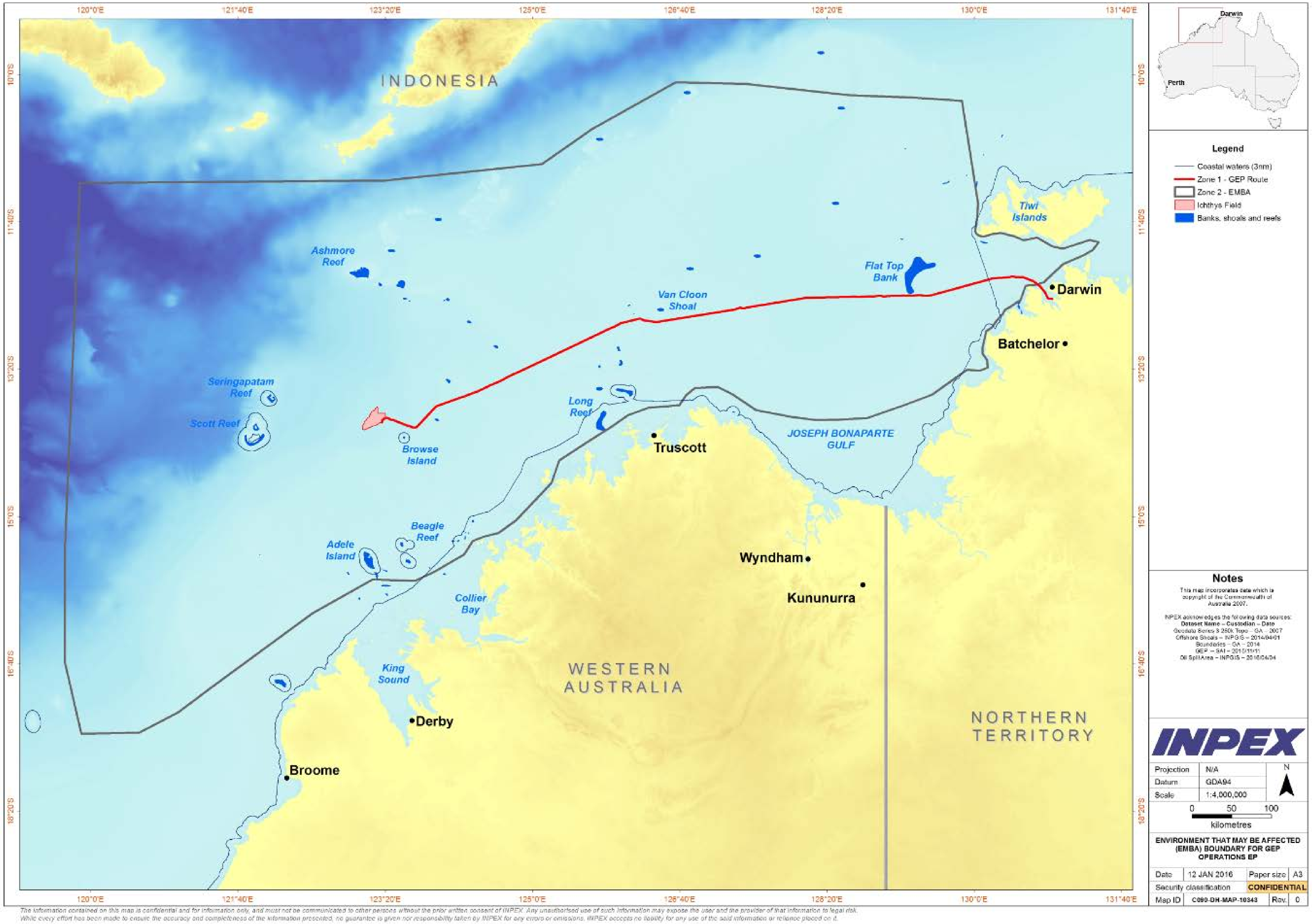


Figure 3-1: Environment that may be affected (EMBA)

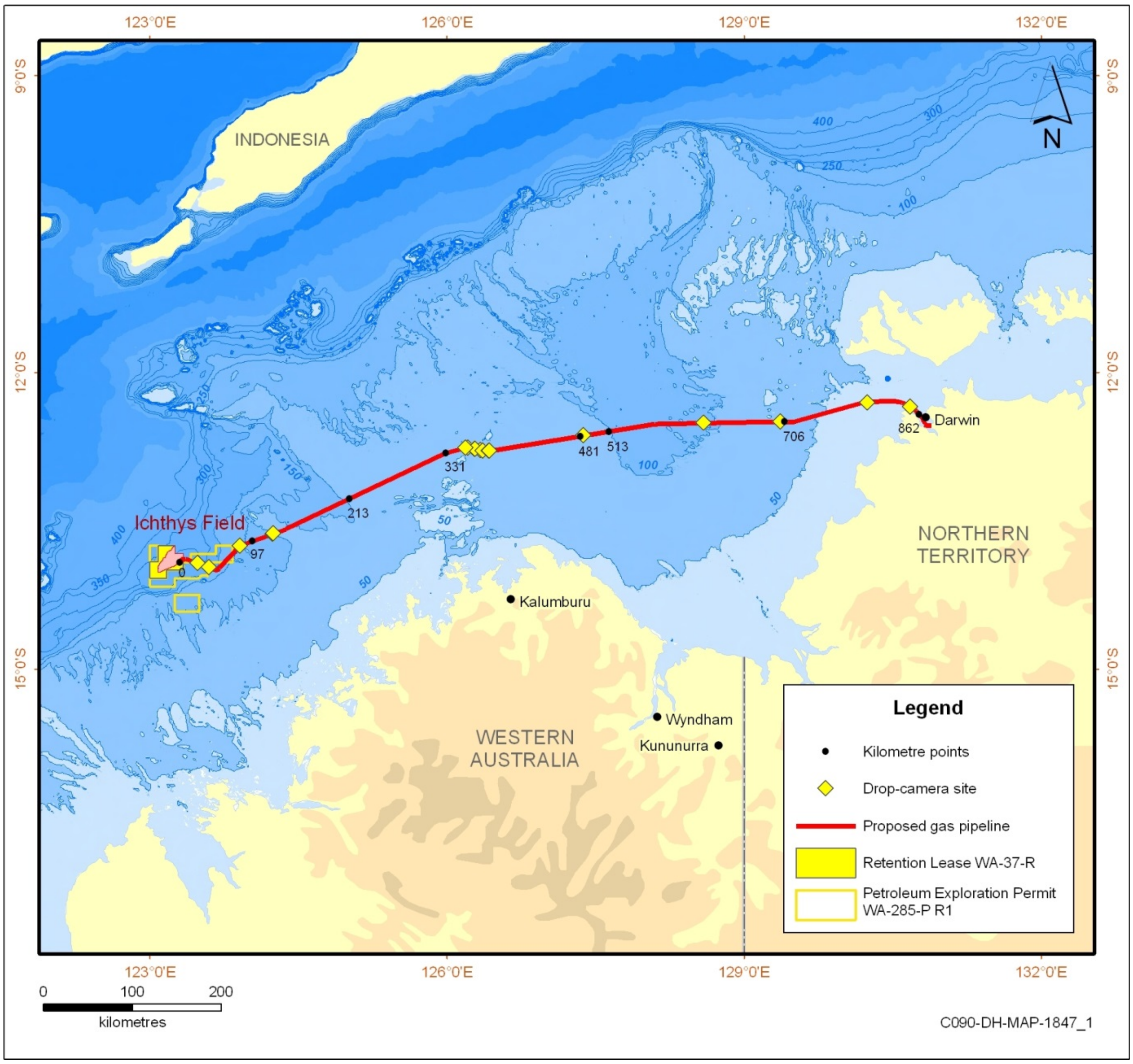
Summertime tropical cyclones generate waves propagating radially out from the storm centre. Depending upon the storm size, intensity, relative location and forward speed, tropical cyclones may generate swell with periods of 6–18 seconds (s) from any direction and with wave heights of 0.5–9.0 m. During 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.

3.2 Biological environment

3.2.1 Benthic habitats and communities

Benthic habitats at 18 sites along the GEP route from the Ichthys Gas Field to Darwin Harbour were characterised based on results of drop-camera surveys (URS 2008). The 18 drop-camera stations were selected based on results from geophysical and geotechnical surveys of the GEP route also undertaken in 2008 (Neptune Geomatics 2009), which identified areas of geological and bathymetric interests that may support notable habitat and associated biota (Figure 3-2).

Neptune Geomatics (2009) conducted a geophysical and geotechnical investigation of the entire GEP route in 2008. This survey utilised multibeam echo-sounder to map bathymetry, side-scan sonar to measure seabed reflectivity and identify seabed features, and a sub-bottom profiler to obtain shallow, high-resolution seismic data for interpretation of shallow geology.



Source: INPEX. 2010. *Ichthys Gas Field Development Project: draft environmental impact statement.*

Figure 3-2: GEP route benthic habitat drop-camera survey sites

In summary, the majority of the pipeline route (>98%) encompasses featureless, unconsolidated clay, silts and sands, with the most dominant seabed features being areas of pockmarks and sand waves. Detailed descriptions of the seabed geology and associated biota identified through the drop-camera survey (URS 2008) are provided below:

- Drop-camera station 1 - The geophysical survey indicated that this station would be dominated by large sand waves. Whilst the sand waves were evident on the ship's echo-sounder, their size was too great to be captured by the drop camera field of view. The sparse epibenthic fauna present were predominantly colonial hydroids, with some sea pens (Pteroeidae), feather stars (Crinoids) and ascidians also noted.
- Drop-camera station 2 - The geophysical survey indicated that this station would be dominated by megarippled sand, with some large sand waves (up to 4.9 m in height). The sand waves were not captured within the field of view of the drop camera, but there were scattered sea pens (Pteroeidae), sea whips (Junceela), feather stars (Crinoidea), hydroids, bryozoans and sea stars (Asteroidea) present.

- Drop-camera station 3 - The geophysical survey indicated that the seabed at this station would be characterised by a high density of large (>5 m) pockmarks. These features were not evident, due either to their size relative to the drop camera field of view or because the drop camera landed in an area of seabed between pockmarks. Visibility was too low for a panoramic view of the seabed to be captured. No epibenthic fauna were noted at this station, though the fine sand substrate was peppered with small (up to 5 cm diameter) holes typical of those made by burrowing invertebrates such as bivalves, shrimp and polychaete worms.
- Drop-camera station 4 - The geophysical survey indicated that the seabed at this station would be characterised by a high density of smaller (<5 m) pockmarks. These features were not evident, due either to their size relative to the drop camera field of view or because the drop camera landed in an area of seabed between pockmarks. The substrate was characterised by clay/silt sands. Only occasional (two to four individuals) feather stars (Crinoidea) were noted at this site. Additionally, a grinner fish (Sauridae) was noted on the seabed.
- Drop-camera station 5 - The geophysical survey indicated that the seabed at this station would be characterised by rock outcrops in an existing paleochannel. Small rocky outcrops were evident, with epibenthic fauna attached to the hard substrate. The sandy substrate was peppered with small (<5 cm diameter) holes. Sea fans (Gorgonians), sea whips (Junceela), feather stars (Crinoidea), tree soft coral (Dendronephthya) and sponges were all noted at low abundances at this site.
- Drop-camera station 6 - The geophysical survey indicated that the seabed at this station would be characterised by rock outcrops in an existing paleochannel. Small rocky outcrops were evident, with epibenthic fauna attached to the hard substrate. Sea pens (Pteroeidae), sea fans (Gorgonians), sea whips (Junceela), feather stars (Crinoidea), bryozoans, hydroids, and sponges were all noted at relatively high abundances at this site. The stations were dominated by crinoids, which were the most abundant epibenthic fauna noted during the whole drop-camera survey.
- Drop-camera station 7 - The geophysical survey indicated that the seabed at this station would be characterised by the western rock slope of a paleochannel. However, the rocky substrate at this station was covered with a sand veneer and there was only a very low abundance of epibenthic fauna (sea whips, tree soft coral and hydroids).
- Drop-camera station 8 - The geophysical survey indicated that the seabed at this station would be characterised by low relief subcrop, with sandy substrate overlying rock. Feather stars (Crinoidea) were common at this site, with a ball sponge and tree soft coral (Dendronephthya) noted.
- Drop-camera station 9 - The geophysical survey indicated that the seabed at this station would be characterised by rocky outcrops. Occasional rocky substrate was recorded by the drop camera. Feather stars (Crinoidea) were common at this site, with bryozoans, urchins, hydroids and sponges also present.
- Drop-camera station 10 - The geophysical survey indicated that the seabed at this station would be characterised by outcrops on a north-south ridge. However, the drop camera reached the seafloor between outcrops and only flat sandy substrate was recorded. The visibility was too low, the current too strong and the drop camera insufficiently manoeuvrable, to risk searching the seafloor for the outcrops. Sea fans (Gorgonians), sea whips (Junceela), tree soft coral (Dendronephthya), bryozoans, hydroids were all relatively common on the seabed at this station, indicating that the sandy substrate was probably only a thin veneer over rock.
- Drop-camera station 11 - The geophysical survey indicated that the seabed at this station would be characterised by outcrops on a north-south ridge. A sandy

substrate with occasional rocky outcrops was evident. Sea fans (Gorgonians), sea whips (Junceela), tree soft coral (Dendronephthya), sponges, bryozoans and hydroids were all relatively common on the seabed at this station.

- Drop-camera station 12 - The geophysical survey indicated that the seabed at this station would be characterised by a sub-crop ridge area. There were no rock outcrops evident and the seabed comprised a flat sandy substrate with shell and coral fragments. Epibenthic fauna were rare at this site, with only occasional sea pens (Pteroeidae) and a sea star (Asteroidea) noted.
- Drop-camera station 13 - The geophysical survey indicated that the seabed at this station would be characterised by a sub-crop ridge area. Small rocky outcrops were evident, with epibenthic fauna attached to the hard substrate. Feather stars (Crinoidea) were common at this site, with a few present on tree soft corals (Dendronephthya).
- Drop-camera station 14 - The geophysical survey indicated that the seabed at this station would be characterised by a subcrop area. Some small rocky outcrops were evident, with epibenthic fauna attached to the hard substrate. Only sea fans (Gorgonians) and sea whips (Junceela) were noted.
- Drop-camera station 15 - The geophysical survey indicated that the seabed at this station would be characterised by a subcrop area. Some small rocky outcrops were evident, with epibenthic fauna attached to the hard substrate. Sea fans (Gorgonians), sea whips (Junceela), feather stars (Crinoidea), bryozoans, tree soft corals (Dendronephthya), sea stars (Asteroidea) and sponges were all noted at this location.
- Drop-camera station 16 - The geophysical survey indicated that the seabed at this station would be characterised by clay/silt substrate. A very low density of epibenthic fauna was recorded at this station with only the occasional sea pen (Pteroeidae) noted.
- Drop-camera station 17 - The geophysical survey indicated that the seabed at this station would be characterised by a sandy substrate with a distinct single large outcrop (3 m high, approximately 60 m long and 200 m wide). The outcrop was not located and the low visibility, strong currents and low manoeuvrability of the drop camera precluded a search from being undertaken. The silty substrate supported only a very low density of epibenthic fauna—the occasional sea pen (Pteroeidae) and sea whip (Junceela).
- Drop-camera station 18 - The geophysical survey indicated that the seabed at this station would be characterised by megarippled sand, with some sand waves up to ~3.5 m high. The drop camera showed the megaripples, though not the larger sand waves. No epibenthic fauna were recorded at this site.

In summary, a range of benthic communities, linked mainly to substrate type and water depth, were identified. Feather stars were the most commonly seen species on the several rocky outcrops surveyed. Sea pens, sea fans, sea whips, soft corals of the genus Dendronephthya, bryozoans, hydroids, and sponges were also recorded on the soft substrate in several locations. In general, benthic communities of ecological interest along the GEP route are sparsely distributed and are mainly associated with hard substrates which are only present along (approximately) 2% of the GEP route.

The species in the communities surveyed are common throughout north-west Australian offshore waters. No primary producing organisms were recorded due to the lack of available light at the seabed. Both species richness and abundance of individuals decreased with increasing distance from land and with increasing water depth (INPEX 2010).

Given the large regional area associated with Zone 2, a large number of different benthic communities occur within this area. These habitats include banks, shoals, coral reefs and seagrasses.

Banks and shoals

There are many shoals that occur within the region those closest to Zone 1 include:

- Echuca Shoal (approximately 9 km from GEP closest point of the route)
- Eugene McDermott Shoals (approximately 38 km from closest point of the GEP route)
- Flat Top Bank (approximately 3 km from GEP closest point of the route)
- Gale Bank (approximately 18 km from GEP closest point of the route)
- Heywood Shoal (approximately 22 km from closest point of the GEP route)
- Penguin Shoal (approximately 25 km from closest point of the GEP route)
- Van Cloon Shoals (approximately 12 km from closest point of the GEP route).

The submerged shoals within Zone 2 can support diverse tropical ecosystems, including phototrophic benthos typical of tropical coral reefs. The shoals support a diverse biota, including algae, reef-building corals, hard corals and filter-feeders. In general the flora and faunal assemblages are typical of the oceanic reefs of the Indo–West Pacific region (INPEX 2010), with many of the species in common with those found at the Ashmore, Cartier and Scott Reef complexes.

Coral reefs

Coral reefs within the region can be categorised into three general groups: fringing reefs, large platform reefs, and intertidal reefs. Corals are significant benthic primary producers that play a key ecosystem role in many reef environments and have an iconic status in the environments where they occur. Scattered coral reefs are present on low intertidal and shallow subtidal rocky substrate along the WA and NT coastline. Some of the larger, more regionally significant coral reefs within Zone 2 include:

- Ashmore Reef (approximately 175 km from the closest point of the GEP route)
- Cartier Island (approximately 134 km from the closest point of the GEP route)
- Seringapatam Reef (approximately 134 km from the closest point of the GEP route)
- Scott Reef (approximately 137 km from the closest point of the GEP route)
- Hibernia Reef (approximately 200 km from the closest point of the GEP route)
- Outer islands of the Bonaparte and Buccaneer archipelagos (approximately 65 km from the closest point of the GEP route).

These reefs, in particular Ashmore Reef, are recognised as having the highest richness and diversity of coral species in Western Australia (Mustoe and Edmunds 2008, cited in Department of State Development 2010). Scott Reef and the intertidal reefs surrounding the outer islands of the Bonaparte Archipelago also exhibit very high coral species diversity (INPEX 2010).

Reef habitats at Browse Island are not diverse. Rocky shore habitat is represented only by exposed beach rock, and there are no intertidal sand flats. The lagoon habitat is poorly developed, with poor water circulation, and it shows evidence of recent infill and high mortality. The reef platform, especially on the western side, is high and barren in many places. Only the reef crest and seaward ramp habitats around the edge of the reef support moderately rich assemblages of molluscs. The shallow subtidal zone is narrow, and supports relatively small areas of well-developed coral assemblages (INPEX 2010).

Seagrass

There is no seagrass within Zone 1 (due to water depth and lack of suitable habitat). Seagrasses do occur in Zone 2 along the mainland coastline of the Northern Territory and Western Australia and within the protected coastal areas of islands, including the Tiwi Islands, outer Darwin Harbour and in the waters surrounding of the Van Diemen Gulf adjacent to Arnhem Land (Roelofs et al. 2005). Ashmore Reef also has a high coverage of seagrass that supports a small dugong population (Whiting & Guinea 2005).

3.2.2 Shoreline habitats

There are many islands that occur within the NWMR and NMR. There are no islands within Zone 1; however, numerous small islands are present within Zone 2. Some of the major islands within or adjacent to Zone 2 and that typify the diverse range of habitats that are present throughout the region include the following:

- Adele Island (approximately 161 km from the closest point of the GEP route)
- Ashmore Reef (approximately 175 km from the closest point of the GEP route)
- Browse Island (approximately 9.5 km from the closest point of the GEP route)
- Cartier Island (approximately 134 km from the closest point of the GEP route)
- Scott Reef (approximately 137 km from the GEP route)
- Tiwi Islands (approximately 66 km from the closest point of the GEP route)
- Vernon Islands (approximately 95 km from the closest point of the GEP route).

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 Territory and Western Australian coastlines with extensive mangrove communities along the Kimberley, Joseph Bonaparte and Tiwi Islands' coastlines (Zone 2).

3.2.3 Marine fauna

Listed marine species

Species of conservation significance within Zone 2 were identified through a search of the EPBC Act Protected Matters database (DoE 2015a).

In order to identify if any of these species may have known or likely habitats and hence potential to be present in Zone 1, an additional search of the EPBC Act Protected Matters database was undertaken for Zone 1 only. A comparison of the results of the Zone 2 and Zone 1 searches is presented in the EP.

All 'listed species' identified as potentially present in Zone 2 (i.e. the EMBA) have been grouped into categories and their presence or presence of species habitat in Zone 1 and Zone 2 are described below.

Terrestrial and wetland birds

The search of the EPBC database identified eleven species potentially present within Zone 2. These species may migrate through Zone 2 to terrestrial and wetland habitat on the mainland and/or larger coastal islands. It is considered unlikely that Zone 1 would provide any significant resources to support these species.

Seabirds

The search of the EPBC database identified 20 seabird species in Zone 2, with seven of these listed species also found to be present in Zone 1. This is supported by vessel-based surveys conducted around the Ichthys gas field and Browse Island, and to the west as far as Scott Reef by the Centre for Whale Research (CWR) in 2008. Seabirds observed included frigatebirds, boobies, terns, noddies, tropicbirds, petrels, shearwaters and gulls, with the brown booby the most common species recorded. Of the species recorded during the vessel-based surveys, a number are migratory species listed under the EPBC Act, including the streaked shearwater, brown booby, masked booby, lesser frigatebird, bridled tern, lesser crested tern and little tern. These migratory species can be expected to be encountered in low numbers as they are likely to transit through Zone 1 and Zone 2.

The area contains habitat for foraging seabirds and therefore within Zone 1 and Zone 2 seabird foraging is likely to occur. Five of the seven species identified through the EPBC search as likely to be present Zone 1 are known to breed within Zone 2. However, only one BIA overlaps Zone 1 associated with the lesser frigatebird which has a high usage around breeding sites. A breeding colony of Crested Terns is also present on Browse Island situated 9.5 km away from Zone 1 at its closest point (Clarke 2010). Adele Island (located 161 km from Zone 1) is a declared nature reserve in order to protect the seabird breeding colonies present there.

Shorebirds

The EPBC search identified fifteen species of shorebirds which may be present or have habitat within Zone 1 and Zone 2, with only one species (Osprey) considered to breed in Zone 2. Browse Island and Scott Reef may be important sites for migratory shorebirds in the North West Marine Region. Given that Browse Island and Scott Reef are relatively close to Ashmore Reef and Cartier Island (and the EAA Flyway), and they provide similar potential shorebird foraging and roosting opportunities, these four sites may form a network of inter-connected sites used by shorebirds to varying degrees (DSEWPaC 2012c).

Sharks and rays

Twelve sharks and rays species may occur within Zone 2. Only the Speartooth Shark was not identified via EPBC search to occur in Zone 1 because it inhabits tidal rivers and estuaries not present in Zone 1 (DoE 2016l). However, sharks with known coastal habitats such as the Northern River Shark and sawfish (Narrow, Dwarf, Green and Sawtooth) are not expected to occur within the open ocean location of Zone 1, and therefore are only likely to be present in coastal habitats on the very periphery of Zone 2.

It is considered possible that larger pelagic sharks such as the Great White, Whale and Mako sharks may transit through Zone 1, however the likelihood of these species occurring in Zone 1 is expected to be very low. This is because the GEP route is not considered to provide habitat that is of breeding or feeding importance and therefore these species are unlikely to be common or resident in Zone 1. Listed manta rays have been observed within Zone 2, but for the same reasons as the large pelagic sharks, are unlikely to be common or resident within Zone 1.

Pipefish and seahorses

The EPBC search identified 38 species of the family Syngnathidae potentially present within Zone 2. Syngnathidae is a group of bony fishes that includes seahorses, pipefishes, pipehorses and sea dragons. Seahorses and pipefishes are a diverse group and occupy a wide range of habitats. However the species identified in the EPBC search (Appendix C) generally display a preference for shallow water habitats such as seagrass and macroalgal beds, coral reefs, mangroves and sponge gardens (Foster & Vincent 2004; Lourie et al. 2004; Scales 2010). These habitats do occur in the shallower areas of Zone 2. Along the GEP route (Zone 1), water depths are greater than 40m and preclude the presence of seagrass; and hard bottom substrates, which can potentially support coral, macroalgae sponge garden communities, are very limited (approximately 2% of the GEP route) and occur at depths (> 70 m) which also precludes macroalage. Thus pipefish and seahorses are unlikely to be common along the GEP route, but will have better representation in Zone 2 where these habitats are more abundant.

Dugong

Dugongs spend most of their time in the neritic zone, especially near tidal and subtidal seagrass meadows (DSEWPaC 2012d). None of these habitats are represented in Zone 1 so it's unlikely that dugongs will be common or resident populations anywhere along the GEP route. Dugongs are only likely to traverse through Zone 1 when migrating between shallow coastal environments that support seagrass. They do inhabit Zone 2 however, where these habitats occur within the wider region.

Seasnakes

The EPBC search identified 25 sea snakes within Zone 2, however only 21 were potentially present within Zone 1.

Most of the knowledge of sea snakes in the North Marine Region, where Zone 1 and 2 occur comes from trawler bycatch. These studies indicate that sea snakes in northern regions of Australia tend to breed in shallow embayments and estuaries which are only represented in Zone 2. Therefore these species may be seen in Zone 1 open water habitats along the GEP route but their presence is unlikely to be common.

Turtles

Six of the seven species of marine turtle in the world are known to inhabit Australian waters, and the EPBC search identified that all six of these species may occur in Zone 1 and Zone 2. Important breeding, nesting and foraging areas for marine turtles are found throughout Zone 2, and a BIA associated with flatback, loggerhead and olive ridley turtle foraging also intersects Zone 1. Therefore, foraging turtles are likely to be present in Zone 1.

Crocodiles

The estuarine crocodile has a tropical distribution that extends across the northern coastline of Australia, where it can be found in coastal waters, estuaries, freshwater lakes, inland swamps and marshes, as well as far out to sea (Webb et al. 1987). While this species could be sighted in Zone 1, its preference for estuaries and swamps and coastal waters indicates it is uncommon and more likely to be observed in Zone 2 where these preferred habitats occur. Similarly the freshwater crocodile would not occur in Zone 1 and is highly unlikely to occur in Zone 2 as it primarily occupies freshwater habitats.

Whales and other cetaceans

The EPBC search identified a total of 26 cetacean species potentially present in Zone 2, with 24 species potentially present in Zone 1.

Cetaceans are likely to show a wide range of habitat preference within Zone 1 and 2 (DSEWPaC 2012e).

The four species of inshore dolphins including Australian Snubfin, Indo-Pacific bottlenose, Indo-Pacific Humpback and Spotted bottlenose dolphins are found predominantly in shallow coastal waters, with various BIAs present within Zone 2, however not intersecting Zone 1. Their presence in Zone 1 is not expected.

Oceanic dolphins, such as Rough-toothed dolphins, Risso's dolphin, Long-snout spinner dolphins, are expected in Zone 1, as these species typically inhabit inshore and offshore waters. Some oceanic dolphin species, such as the Striped dolphin and Frasers dolphin prefer waters >1000 m deep, and are therefore less likely to be present in Zone 1.

Some whale species are more likely than others to be present within Zone 1. Antarctic Minke Whales, Sperm Whales, Dwarf Sperm Whale, Pygmy Sperm Whale, False Killer Whales, Short-finned Pilot Whales, Curvier's and Blaiinville's Beaked Whales are most likely to be found around areas of upwelling's and canyons on the continental shelf, generally in waters deeper than 500 m, and therefore are not likely to be present within Zone 1.

However due to habitat preferences and migratory routes, other species such as Killer Whales, Bryde's whales and Humpback whales are more likely to occur in Zone 1.

Pygmy Blue Whales are thought to migrate through the north west region between warm water (low-latitude) breeding grounds and cold water (high-latitude) feeding grounds, however typically migrate along the 500 m depth contour, and therefore would be unlikely to be present in Zone 1.

As a result of this wide variation in habitat use and migratory patterns, cetaceans are likely to swim through or occur in Zone 1 and 2.

Listed threatened and migratory species

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 35 "listed threatened" species (19 of which are marine species) and 66 "listed migratory" species (42 of which are marine species) that potentially use or pass through Zone 2.

Conservation management plans

In addition to species being identified as threatened or migratory and Matters of National Environmental Significance (MNES), depending on the threat classification, the DEE has established management policies, guidelines, plans and other materials for threatened fauna, threatened flora (other than conservation-dependent species) and threatened ecological communities listed under the EPBC Act.

In particular, the objectives of DEE recovery plans and conservation advice, seek to support the long-term recovery of various species outlining research and management measures that must be undertaken to stop the decline of, and support the recovery of a species, including the management of threatening processes.

Species identified during the EPBC Act Protected Matters search that have a conservation advice or a recovery plan in place, as well as any particular relevant actions to assist their recovery and conservation, including threat abatement plans, are summarised in the EP.

Biologically Important Areas

The DEE has, through the marine bioregional planning program, identified, described and mapped Biologically Important Areas (BIAs) for protected species under the EPBC Act. BIAs spatially and temporally define areas where protected species display biologically important behaviours (including breeding, foraging, resting or migration), based on the best available scientific information. These areas are those parts of a marine region that are particularly important for the conservation of protected species.

This subsection provides an overview of the EPBC-listed species, identified by the EPBC Act Protected Matters search, that are associated with a BIA.

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 in 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, both of which are 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 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, and a known foraging area for pygmy blue whales is present around Scott Reef.

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

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 2016a). Within Zone 2, there is a dugong BIA (foraging) at Ashmore Reef.

Dolphins

Coastal dolphin BIAs are present within Zone 2. 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 2016b).

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 2016c).

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 2016d).

Marine turtles

There is one BIA for marine reptiles intersected by Zone 1. This is the Joseph Bonaparte Depression which provides significant foraging habitat for olive ridley, flatback and loggerhead turtles. Details of each species known breeding rookeries, life-cycle, broader distribution and diet are discussed below.

Breeding rookeries / genetic stocks

Adult turtles show strong fidelity to feeding and breeding grounds, migrating long distances (up to thousands of kilometres) to return to the region where they hatched (Limpus 2009).

Major nesting areas for the Western Australian population of loggerhead turtles include Muiron Islands, Ningaloo Coast south to about Carnarvon and islands near Shark Bay, including Dirk Hartog Island (approximately 1000 km south of Zone 1) (DEE 2016). Loggerhead turtle breeding reportedly peaks between October to April (DEE 2016).

Genetic analysis is being undertaken to provide better resolution of geographic boundaries for flatback turtles in Western Australia. The flatback stocks breed along the NT, Joseph Bonaparte Gulf and Kimberley coastline at all times of the year, with a reported peak between June to September, whereas the Pilbara stock reportedly has a peak breeding season between October and March (DEE 2016).

Low density nesting of olive ridley turtles has been described on the Kimberley coast, but genetic relatedness is currently unknown. Breeding of olive ridley turtles in the Northern Territory has been reported all year around, with peaks between April to August (DEE 2016). The Kimberley stock nesting is reportedly year round, with a peak around May to July.

Inter-nesting distribution including foraging areas

Satellite tagging of nesting female loggerhead turtles from the Ningaloo/Pilbara coast of Western Australia have shown dispersal as far as north-west, through Indonesia to southern Borneo, north-east as far as the Tiwi Islands and as far south as the Great Australian Bight (Waayers et al 2015). Flatback turtles are known to forage across the Australian continental shelf as far north as Indonesia and Papua New Guinea (DEE 2016). There is limited tag recovery data for olive ridley turtles, but satellite tracking data indicates that they appear to remain on the Australian continental shelf (Waayers et al 2015; Whiting et al 2008).

Diet

Loggerhead turtles are carnivorous, feeding predominantly on benthic invertebrates in habitats ranging from near shore to 55 m (Limpus 2009). During their post-hatchling stage, they feed on algae, pelagic crustaceans and molluscs (Boyle and Limpus 2008).

Flatback turtles are primarily carnivorous, feeding on soft-bodied invertebrates. Juveniles eat gastropod molluscs, squid, siphonophores (Zangerl et al 1988). Limited data indicate that cuttlefish (Chatto 1995), hydroids, soft corals, crinoids, molluscs and jellyfish (Zangerl et al 1988) are also eaten.

Olive ridley turtles are primarily carnivorous, feeding on soft-bodied invertebrates such as sea pens, soft corals, beche-der-mer (sea cucumbers) and jellyfish in depth between 15-200m (Limpus 2009).

Abundance of marine turtles in BIA intersecting Zone 1

There is insufficient data to provide a quantitative estimate of abundance or seasonal peak in abundance of these three species of turtles within the marine turtle BIA that intersects Zone 1, or of turtle foraging activity in the wider Zone 2. However, given the above information regarding life-cycle, distribution and diet, it is probable that turtles of all life-stages, may be present, at all times of the year, on the surface and near the seabed, foraging within the marine turtle BIA that intersects Zone 1. As discussed in Section 3.2.1 only 2% of the GEP route is substrate that would support increased densities of benthic/sessile organisms which these species of turtles forage upon at the seabed.

Within Zone 2, a range of BIAs for breeding, foraging and internesting are present for all species of marine turtles. These important areas include Browse Island, Ashmore Reef, Cartier Island, Cassini Island, Joseph Bonaparte Gulf, Joseph Bonaparte Depression and Sandy Islet (Scott Reef). These locations support marine turtle foraging, nesting and internesting areas. Peak nesting periods for all species within these areas are generally between the months of November and April.

Fish and sharks

Within Zone 1 and Zone 2, a single BIA exists for whale sharks (foraging area). Although not specifically identified as BIAs, the Key Ecological Features (KEFs) within Zone 2, are known to provide important habitat for diverse fish assemblages.

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 & Sims 2011; 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).

Whale sharks are widely distributed in tropical Australian waters and within Western Australia, whale sharks aggregate seasonally (March–June) to feed in coastal waters off Ningaloo Reef (Wilson et al. 2006). Taylor (1996) and Rowat and Gore (2007) looked at whale shark movements at Ningaloo Reef and observed that the sharks swim parallel to the reef but found no clear evidence of a north-south migration.

Whilst Ningaloo is the nearest aggregation to the GEP route, it is still 1,200 km to the south. Research on the migration patterns of whale sharks in the western Indian Ocean, indicates that a small number of the WA (Ningaloo) population migrate through the wider vicinity of the Browse Basin region (Jenner et al 2008; Meekan and Radford 2010; McKinnon et al 2002; Wilson et al 2006).

Whale sharks from Ningaloo Reef fitted with satellite trackers were observed to travel either north-east towards Timor Leste, or north-west towards the Indonesia islands of Sumatra and Java, with some individuals passing through the broad vicinity of Scott Reef (McKinnon et al. 2002, Wilson et al. 2006, Meekan and Radford 2010; Sleeman et al. 2010). Aerial (Jenner and Jenner 2009a; RPS 2010, 2011b) and vessel (Jenner and Jenner 2009b; Jenner et al. 2008) surveys conducted in 2008 and 2009, involving over 1,000 hours of observer effort, recorded one whale shark in 2008 and two whale sharks in 2010 in the Browse Basin (Jenner et al. 2008 and RPS 2011a respectively).

Within Zone 2, the whale shark BIA largely follows the ancient coastline at 125 m depth contour KEF. However, based on the levels of whale shark abundance observed in the studies listed above, the likelihood of whale shark presence within this BIA is considered very low, with no specific seasonal pattern of migration.

Marine avifauna

The GEP route is located within what is known as the East Asian–Australasian Flyway (EEA 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 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).

A single BIA overlaps Zone 1, associated with the lesser frigatebird which has a high usage around breeding sites (i.e. within approximately 30 km of a breeding site) These birds are resident and partly nomadic dispersing widely between breeding seasons.

Information regarding seasonal abundance and foraging activities of the lesser frigate bird in the Kimberley region has been investigated through the Shell/INPEX Applied Research Project #6. This included satellite tracking of lesser frigate birds from Adele Island during 2014 (Clarke 2015), and satellite tracking of lesser frigate birds from the Lacepede Islands during the 2015 breeding season (Cannell et al 2016).

The majority of the lesser frigatebirds tagged who were breeding at Adele Island departed for Indonesian waters during the non-breeding months of November to April (Clarke 2015). However, Cannell et al (2015) observed that asynchronous breeding of lesser frigatebirds was occurring. Lesser frigatebirds fledge at approximately 140 days old, but can still be fed by the adults at the nest for at least 4 months after fledging (Diamond 1975). Therefore, adults may be returning to the breeding colonies to provide parental care at both the Lacepede Islands and Adele Island (and therefore potentially any other breeding colonies along the Kimberley Coastline or Timor Sea islands) throughout the entire year.

Satellite tracking of lesser frigatebirds at Adele Island during the 2014 breeding season indicated these birds normally undertake multi-day foraging trips, generally within ~200km but up to ~700 km from breeding sites (Clarke 2015). Similarly, Cannell et al (2016) reported that during the 2015 breeding season at the Lacepede Islands, some lesser frigatebird multi-day foraging trips ranged in excess of 1,000 km. Therefore, while the majority of lesser frigate bird foraging occurs within the BIAs, some of the reported foraging ranges are far wider than the BIAs.

Based on this recent research, peak abundance and subsequent foraging typically occurs during the breeding season (April to November). However it is noted that some lesser frigatebirds may breed outside this period and/or utilise the region for year round foraging activity.

Lesser frigatebirds are unique among seabirds in that they cannot settle on the sea surface due to the poor waterproofing quality of their feathers. Therefore they are highly mobile and generally feed ‘on-the-wing’. This means that they must capture prey at or above the sea surface (e.g. flying fish). Therefore, whilst their elongated bill regularly comes into contact with the water, their feathers rarely do (Clarke 2015). Lesser frigatebirds also practice kleptoparasitism, whereby they steal food from other species.

Zone 2 overlaps a large number of BIAs present for a number of different marine avifauna species. These areas are generally associated with shoreline habitats and coastal areas of northwest WA and islands within the region. Shoreline habitats are generally used for resting and breeding, while adjacent offshore waters are used for foraging. Specifically, BIAs are located at:

- Ashmore Reef CMR
- Cartier Island CMR
- Adele Island Nature Reserve
- Scott Reef Nature Reserve
- Shorelines along the Kimberley coastline, including several existing and proposed marine parks.

3.3 Socioeconomic and cultural environment

3.3.1 Traditional Indonesian 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 its surrounds, Seringapatam Reef, Browse Island, Ashmore Reef, Cartier Island and various banks and shoals.

The MoU requires fishers to use traditional sail-powered fishing vessels and non-motorised equipment, and prohibits them from taking protected species, such as turtles, dugongs and clams. Fishers target a range of animals, including sea cucumbers (bêche-de-mer), *trochus* (topshell), reef fish and sharks. Indonesian fishing effort is high at Scott Reef and also takes place at Browse Island.

Although a portion of Zone 1 falls within the MoU Box, due to the nature of traditional fishing activities, the actual fishing effort generally only occurs in the shallow subtidal / intertidal habitats of the reefs and islands within Zone 2.

3.3.2 Recreational fishing

A wide range of recreational activities occur 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 and NT coast, including Scott Reef (approximately 137 km from Zone 1 at its closest point).

Recreational fishing activities peak in winter and are concentrated in coastal waters along the Kimberley and Northern Territory coastlines. Fishing charters operate along parts of the mainland coast, including some locations within Zone 2, such as the Tiwi Islands and Flat Top Bank, all of which are readily accessible from Darwin. Some of the recreationally important species of the coastal areas include barramundi, mangrove jack, jewfish and bream.

3.3.3 Commercial fisheries

Within Zone 1 and Zone 2, four Commonwealth-managed fisheries have the potential to operate. They are the North west slope trawl fishery, the Western skipjack fishery, the Western tuna and billfish fishery and the Northern prawn fishery with further details provided in Table 3-1.

Table 3-1: Commonwealth managed commercial fisheries

Commercial fishery	Description
North West Slope Trawl Fishery	The North West Slope Trawl Fishery targets scampi (*Metanephrops australiensis, M. boschmai and M. velutinus*) and deepwater prawns (pink prawn, red prawn, striped prawn, scarlet prawn, red carid and white carid prawn). This fishery is a deepwater (>200 m) fishery which coincides with a small section of Zone 1 (from approximately Browse Island to the Ichthys Field). It is the only active fishery in the region and fishes at low levels, with negligible trawl-fishing in

Commercial fishery	Description
	the Ichthys Field between 2002 and 2009 (AFMA 2012).
Western Skipjack Fishery	The Western Skipjack Fishery targets the skipjack tuna (*Katsuwonus pelamis*) and overlaps Zone 2. The fishery employs the purse seine, pole and line, and longline methods as its techniques (AFMA 2015a). Although permits are in place, no Australian fishing boats have been active since 2009.
Western Tuna and Billfish Fishery	The Western Tuna and Billfish Fishery targets bigeye tuna (*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 2015b).
Northern Prawn Fishery	The Northern Prawn Fishery targets banana prawns (*Fenneropenaeus merguiensis, F. indicus)* tiger prawns (*Penaeus esculentus, P. semisulcatus*) and endeavour prawns (*Metapenaeus endeavouri, M. ensis*). The fishery occasionally operates within the eastern half of Zone 1, but it predominantly operates in the shallower waters of Zone 2, inshore of the eastern half of the GEP route. According to the Australian Fisheries Management Authority there are currently 52 boats with fishing rights in the fishery (AFMA 2015c).

There are eleven state/territory-managed commercial fisheries with the potential to operate in Zone 1 and Zone 2. They are the barramundi fishery, the Coastal line fishery, the Coastal net fishery, the Offshore net and line fishery, the Spanish mackerel fishery, the Trepang fishery, the Kimberley prawn managed fishery, the Mackerel managed fishery, the Northern (north coast) shark fishery, the Northern demersal scalefish fishery and the Pearling oyster managed fishery. Further details are provided in Table 3-2.

Table 3-2: State/territory-managed commercial fisheries

Commercial fishery	Description
Barramundi Fishery	The Barramundi Fishery extends from the high water mark out to 3 nm and targets barramundi (*Lates calcarifer*) and king threadfin (*Polydactylus macrochir*) using gillnets, with the season running from 1 February to 30 September. As of 2014, there were 14 licences in the Barramundi Fishery. The area covered by the fishery does not overlap Zone 1 but covers some parts of Zone 2; namely, around the Tiwi Islands. According to the Northern Territory Seafood Council (NTSC), many areas are excluded from the fishery defined by fishery closure lines, protection zones and various National Parks and Marine Parks (NTSC 2016a).
Coastal Line Fishery	The Northern Territory's Coastal Line Fishery mainly targets black jewfish (*Protonibea diacanthus*) and golden snapper (*Lutjanus johnii*). The fishery is limited to the nearshore waters adjacent to the Ichthys Project GEP route and does not overlap Zone 1. In 2012, there were 18 active licences for the fishery and, according to the Northern Territory's Department of Primary Industries and Fisheries (DPIF), the total reported catch for the fishery in 2012 was 167

Commercial fishery	Description
	tonnes (DPIF 2014).
Coastal Net Fishery	The Northern Territory's Coastal Net Fishery targets a range of species, particularly mullet, blue threadfin (*Eleutheronema tetradactylum*), shark and queenfish (*Scomberoides commersonnianus*). As with the Coastal Line Fishery, the Coastal Net Fishery operates inshore of the Ichthys Project GEP route and does not overlap Zone 1. At present, there are five current licences with mullet accounting for 84% of the total catch in 2012 (DPIF 2014).
Offshore Net and Line Fishery	The Northern Territory's Offshore Net and Line Fishery targets blacktip sharks (*Carcharhinus tilstoni, C. limbatus* and *C. sorrah*) and grey mackerel (*Scomberomorus semifasciatus*). Licence holders are authorised to fish in Zone 1 and Zone 2. In 2012, there were 12 active licences and a total of 861 boat days spent fishing, with most activity undertaken within 12 nm of the shore (DPIF 2014).
Spanish Mackerel Fishery	The Northern Territory's Spanish Mackerel Fishery targets Spanish mackerel (*Scomberomorus commerson*) within Territory waters, generally focused around reefs, headlands and shoals in Zone 2. In 2012, 12 licences were actively operating, with a fishing effort of 719 boat days in 2012 (DPIF 2014).
Trepang Fishery	The professional NT Trepang Fishery area encompasses the zone from the high water mark out to 3 nm. There are 6 licences in the Trepang Fishery, with only one or two boats active over the past few years. Sea cucumbers (Trepang) are typically harvested by hand from the intertidal and subtidal zones in Zone 2. The main species targeted is the sandfish, *Holothuria scabra*, commonly found in coastal areas with soft sediments and seagrass beds. There is no closed season for the Trepang Fishery, although harvesting generally takes place from around April to November due to better water clarity and decreased temperatures (NTSC 2016b).
Kimberley Prawn Managed Fishery	The Kimberley Prawn Managed Fishery 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 in the Kimberley off the north of WA between Koolan Island and Cape Londonderry. Reported fishing effort is low, with the lowest recorded catch of 145 tonnes of banana prawns in 2011 (Fletcher & Santoro 2014).
Mackerel Managed Fishery	Western Australia's Mackerel Managed Fishery targets Spanish mackerel (*Scomberomorus commerson*) in coastal areas around reefs, shoals and headlands as found 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).
Northern (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,

Commercial fishery	Description
	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. There was no reported fishing activity in the northern shark fisheries during 2009–2010 or 2010–2011 (DoF 2012).
Northern Demersal Scalefish Fishery	Western Australia's Northern Demersal Scalefish Managed Fishery 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 longitude 120°E and overlaps Zone 2. During 2013, 8 vessels collectively held and operated the effort individually assigned to the 11 licences. The fishery catches over the past 6 years have all been more than 1000 t, and represent the highest recorded catches since the inception of the fishery in 1998 (Fletcher & Santoro 2014)
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 of 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 the Western Australian Department of Fisheries (DoFWA) to be 6 276 634 oysters representing 89% of the total allowable catch (Fletcher & Santoro 2015).

3.3.4 Shipping

Data from 2013 (ATSB 2013) shows that key shipping routes are present to the north and north-east of Zone 1. Vessel activity within Zone 1 is concentrated towards the east, close to Darwin. These shipping densities match the shipping routes between Australian ports and Asia, and vessels supporting petroleum activities in the NMR and the NWMR.

Within Zone 1, vessel activity is likely to be dominated by petroleum-industry vessels in transit to other petroleum exploration or production facilities within Zone 2. No significant vessel activity is expected within Zone 1 from fishing activities.

3.3.5 Oil & gas industry

There are currently no active oil & gas production facilities in operation close to the GEP route; however, the Browse Basin and Bonaparte Basin are subject to considerable exploration activity. The closest operational production facilities to Zone 1 along the GEP route are those associated with PTTEP Australia's Montara project in the Vulcan sub-basin, approximately 80 km from Zone 1 at its closest point.

Shell is in the process of constructing a floating liquefied natural gas (FLNG) facility for its Prelude and Concerto gas fields located approximately 17 km from the Ichthys Offshore Facility in WA-50-L.

3.4 Summary of particular values and sensitivities

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

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

Value and sensitivity	Description
Receptors that are considered socially important as identified during stakeholder engagement (including social and cultural heritage).	Commonwealth and state/territory managed commercial fisheries.
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.	None identified within Zone 1.
Regionally important areas of high diversity (such as shoals and banks).	None identified along the GEP route. However, Zone 1 includes the following: CMRs • Oceanic Shoals. KEFs • ancient coastline at 125 m depth contour • the carbonate bank and terrace system of the Sahul Shelf • the pinnacles of the Bonaparte Basin.
The world heritage values of a declared World heritage property within the meaning of the EPBC Act.	None identified within Zone 1.
The national heritage values of a National heritage place within the meaning of the EPBC Act.	None identified within Zone 1.
The ecological character of a declared Ramsar wetland within the meaning of the EPBC Act.	None identified within Zone 1.
The presence of a listed threatened species or listed threatened ecological community within the meaning of the EPBC Act.	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
The presence of a listed migratory species within the meaning of the EPBC Act.	

Value and sensitivity		Description
		• marine avifauna.
Any values and sensitivities that exist in, or in relation to, part or all of:	Commonwealth marine area within the meaning of the EPBC Act.	Productivity and diversity associated with planktonic communities and benthic communities.
	Commonwealth land within the meaning of the EPBC Act.	None identified within Zone 1.
BIAs associated with EPBC-listed species.		BIAs within Zone 1 include: Marine turtles • foraging (Joseph Bonaparte Gulf and Joseph Bonaparte Depression). Fish and sharks • whale sharks foraging area • Zone 1 KEFs due to increased species diversity and abundance. Marine avifauna • foraging adjacent to breeding area associated with the lesser frigatebird.

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

Value and sensitivity	Description
Receptors that are considered socially important as identified during stakeholder engagement (including social and cultural heritage).	Traditional, recreational fishing and Commonwealth-managed and state/territory-managed commercial fisheries. Flat Top Bank has been identified as a location of specific value for recreational fishing. The unique coastline of the West Kimberley National Heritage Place has been recognised as important by Aboriginal stakeholders.
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.	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).	Zone 2 includes the following: CMRs

Value and sensitivity		Description
		• Argo-Rowley Terrace • Ashmore Reef • Cartier Island • Joseph Bonaparte Gulf • Kimberley • Oceanic Shoals. KEFs • ancient coastline at 125 m depth contour • Ashmore Reef and Cartier Island and surrounding Commonwealth waters • canyons linking the Argo Abyssal Plain and Scott Plateau • carbonate bank and terrace system of the Sahul Shelf • carbonate bank and terrace system of the Van Diemen Rise • continental slope demersal fish communities • pinnacles of the Bonaparte Basin • Seringapatam Reef and Commonwealth waters in the Scott Reef complex. Benthic communities including banks, shoals, corals and seagrass. Shoreline habitats, including islands, mangroves and sandy beaches.
The world heritage values of a declared World Heritage property within the meaning of the EPBC Act.		None identified within Zone 2.
The national heritage values of a National Heritage place within the meaning of the EPBC Act.		The West Kimberley National Heritage Place. Ashmore Reef, Scott Reef and surrounds, and Seringapatam Reef and surrounds were listed as Commonwealth Heritage Places.
The ecological character of a declared Ramsar wetland within the meaning of the EPBC Act.		Ashmore Reef Commonwealth Marine Reserve – a designated Ramsar Wetland.
The presence of a listed threatened species or listed threatened ecological community within the meaning of the EPBC Act.		A number of threatened species and/or migratory species have been identified as having the potential to transit Zone 2. These have been categorised as marine fauna: • marine mammals • marine turtles • fish and sharks • marine avifauna.
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,	Commonwealth marine area within the meaning of the EPBC Act.	Productivity and diversity associated with planktonic communities and benthic communities.

<table>
<tr><th colspan="2">Value and sensitivity</th><th>Description</th></tr>
<tr><td>part or all of:</td><td>Commonwealth land within the meaning of the EPBC Act.</td><td>Commonwealth land identified (Quail Island Bombing Range). 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. These are mainly associated with coastlines and the adjacent shallow waters and include:
Marine mammals
• humpback whale migration route and aggregation/calving areas
• pygmy blue whale migration route
• dugong foraging at Ashmore Reef
• coastal dolphins breeding, calving and foraging areas.
Marine turtles
• Nesting, internesting and adjacent foraging areas including Browse Island, Ashmore Reef, Cartier Island, Cassini Island, Joseph Bonaparte Gulf, Joseph Bonaparte Depression and Sandy Islet (Scott Reef).
Fish and sharks
• whale shark foraging area
• KEFs associated with increased species diversity and abundance (i.e. continental slope demersal fish communities and the ancient coastline at 125 m).
Marine avifauna
• a number of resting and breeding areas associated with shoreline habitats (e.g. Adele Island, Ashmore Reef, Browse Island, Cartier Island, Sandy Islet (Scott Reef) and nearshore waters and islands of the WA and NT coastline)
• 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 also made reference to a specific GEP construction fact sheet that was sent to GEP specific stakeholders. All subsequent annual engagement programs have provided information on the progress of the GEP construction and precommissioning with the most recent fact sheet in 2016 describing how the GEP should be operating with hydrocarbon in the line by the end of 2017.

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 in relation to the activity addressed in the EP, INPEX prepared a consultation fact sheet in 2016. The 2016 fact sheet described the following:

- Ichthys Project activity status and indicative schedule
- GEP construction, mechanical completion and precommissioning
- Introduction of hydrocarbon into the GEP
- Inspection, maintenance and repair (IMR) activities, including vessels that may be required along the GEP route
- enquiries and feedback information, including how any comments/feedback would be treated in respect of the environment plan submission.

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

The next activities update to stakeholders is scheduled for the first quarter of 2017.

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 Border Force (ABF) (formerly Australian Customs and Border Protection Service) – Broome, Darwin and Canberra offices)	Yes
Australian Fisheries Management Authority (AFMA)	Yes
Australian Institute of Marine Science (AIMS)	No
Australian Maritime Safety Authority (AMSA)	Yes
Commonwealth Scientific and Industrial Research Organisation (CSIRO)	No
Department of Agriculture and Water Resources (DAWR) (Biosecurity)	No
Department of Defence – Royal Australian Navy (RAN) Australian Hydrographic Service (AHS)	No
Department of Defence (Northern Command)	No
Department of Industry, Innovation and Science (DIIS)	No

Stakeholder	Relevant matter raised
Department of the Environment and Energy (DEE) formerly known as the Department of Environment (DoE)	No
Minister for Agriculture and Water Resources (formerly the Parliamentary Secretary to the Minister for Agriculture) – Fisheries portfolio	No
Minister for Resources, Energy and Northern Australia (formerly Minister for Industry)	No
Minister for the Environment	No
National Offshore Petroleum Titles Administrator (NOPTA)	No
Northern Territory departments and agencies; Ministers of relevant portfolios	
Darwin Port Operations Pty Ltd (DPOPL) (formerly Darwin Port Corporation)	No
Department of Mines and Energy NT (DME)	No
Department of Primary Industry and Fisheries NT (DPIF)	Yes
Department of Transport – Marine Safety Branch (NT DoT)	Yes
Minister for Mines and Energy	No
Minister for the Environment; Primary Industry and Fisheries	No
Northern Territory Environment Protection Authority (NT EPA)	Yes
Chief Minister	No
Parks and Wildlife Commission (NT PaWC)	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

Stakeholder	Relevant matter raised
Department of Mines and Petroleum (DMP)	Yes
Minister for Mines and Petroleum	No
Minister for Energy	No
Department of Aboriginal Affairs	No
Kimberley Ports Authority	No
Western Australian Marine Science Institution (WAMSI)	No
Shire of Broome	No
Shire of Derby / West Kimberley	No
Shire of Wyndham / East Kimberley	No
National Native Title Tribunal, relevant Aboriginal and Torres Strait Islanders (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
Indigenous Land Corporation	No
Northern Land Council	No
Larrakia Nation Aboriginal Corporation	No
Tiwi Land Council	No
Larrakia Development Corporation (LDC)	No
Belyuen Community (Cox Peninsula)	No
Kimberley Land Council	No
Bardi and Jawi Niimidiman Aboriginal Corporation (prescribed body corporate) (represents traditional owners in Dampier Peninsula/other areas)	No
Wanjina-Wunggurr (Native Title) Aboriginal Corporation (represents traditional owners in Kalumburu and other areas)	No
Nyamba Buru Yawuru Ltd (Yawuru Native Title Holders Aboriginal Corporation) (represents traditional owners of Broome)	No
KRED Enterprises	No

Stakeholder	Relevant matter raised
Djarindjin Community (Dampier Peninsula)	No
Kooljaman at Cape Leveque (Dampier Peninsula)	No
Lombadina Community (Dampier Peninsula)	No
Commonwealth-managed fisheries stakeholders	
Commonwealth Fisheries Association (CFA)	No
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	No
Jamaclan Marine Services	No
Northern Prawn Fishery (QLD) Trawl Association Inc. (NPFTA)	No
NPF Industry Pty Ltd (NPFI)	No
WA Seafoods	No
Individual licence/permit holders in the following fisheries: North West Slope Trawl Fishery (NWSTF) Western Skipjack Fishery Western Tuna and Billfish Fisheries Northern Prawn Fishery	No
Northern Territory-managed commercial fisheries stakeholders	
Northern Territory Seafood Council (NTSC) (also represents Commonwealth-managed Northern Prawn Fishery)	Yes- See DPIF
Northern Territory Guided Fishing Industry Association (NTGFIA)	No
Individual licence/permit holders in the following fisheries: • Barramundi Fishery • Coastal Line Fishery • Coastal Net Fishery • Demersal Fishery • Mud Crab Fishery • Offshore Net and Line Fishery • Pearl Oyster Fishery • Spanish Mackerel Fishery • Squid Jigging Fishery	No

Stakeholder	Relevant matter raised
• Trepang Fishery	
Western Australian-managed commercial fisheries stakeholders	
Western Australian Fishing Industry Council (WAFIC) (also represents Commonwealth-managed fisheries located offshore WA)	No
Pearl Producers Association of Western Australia (PPA)	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	
Amateur Fishermen's Association of the Northern Territory (AFANT)	No
Recfishwest (WA)	No
Environmental, heritage and marine research groups	
Australian Conservation Foundation (ACF)	No
World Wildlife Fund for Nature (WWF)	No
Centre for Whale Research (WA) Inc.	No
The Environment Centre of the Northern Territory (ECNT)	No
Conservation Council of WA	No
Oil spill response	
Australian Marine Oil Spill Centre (AMOSC)	Yes
Asia-Pacific Applied Science Associates (APASA)	No
Oil Spill Response Limited (OSRL)	No
Business and industry representative bodies	
Industry Capability Network (ICN)	No
Chamber of Commerce NT (CCNT)	No

Stakeholder	Relevant matter raised
Tourism Top End (NT)	No
Broome Chamber of Commerce	No
Australia's North West Tourism	No
Other businesses	
ASCO (Operator of Darwin Marine Supply Base)	No
Mermaid Marine Australia Limited (discontinued in 2016)	No

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

Category, jurisdiction, subcategory	Stakeholder organisation	Engagement	Feedback summary
Authority, Australia, central authority	Australian Fisheries Management 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 engage and continue engagement with identified fisheries and representative bodies, and that the identified fisheries remained accurate according to their records. INPEX continues to check the validity of the licence holders with AFMA and sends fact sheets on an annual basis to inform licence holders of Project updates.
Authority, Australia, central authority	Australian Maritime Safety Authority (AMSA)	Fact sheets were sent to AMSA in addition to regular engagement from 2013 through to 2016 on a variety of topics. INPEX and AMSA developed a memorandum of understanding (MoU) in 2013. INPEX has participated in industry forums and events coordinated by AMSA since developing the MoU. INPEX engage with AMSA from time to time to seek clarification on matters related to equipment stockpiles and arrangements under the national plan.	INPEX provide AMSA with a copy of all NOPSEMA-accepted OPEPs. Relevant text from the MoU is included within the OPEP.
Authority, Australia, central authority	Australian Border Force (ABF)	Email of all fact sheets in 2014, 2015 and 2016 sent to Broome and (from 2016) Darwin offices. Fact sheets redirected to ABF Canberra office from Department of Defence Northern Command in 2016.	Request from team at Canberra office that project updates were of interest and that any future project updates also be sent to Marine Border Command via mbcengagement@border.gov.au mailbox.
Northern Territory, state/local	Northern Territory Environment Protection Authority	Email of fact sheets in 2014, 2015 and 2016. In 2015, INPEX sent an email enquiry to confirm oiled wildlife responsibilities in NT	In 2015, NT EPA advised INPEX that the NT Parks and Wildlife Commission (PaWC) is the response agency for managing, clean-up, care and rehabilitation of oiled wildlife. INPEX may

Category, jurisdiction, subcategory	Stakeholder organisation	Engagement	Feedback summary
authority	(NT EPA)	waters during an oil spill (for offshore and nearshore plans).	provide assistance; however, would do so only under the direction of an NT-appointed wildlife coordinator. INPEX was also informed that PaWC was in the process of developing a wildlife plan. INPEX remains in contact with NT EPA in relation to the EP and OPEP (and other oil spill response plans required under NT approvals).
Northern Territory, territory/local authority	NT Department of Transport – Marine Safety Branch (NT DoT)	Email of fact sheets in 2014, 2015 and 2016. In January and February 2016, INPEX sent emails to NT DoT enquiring about dispersant use, preferred engagement approach, and location of oil spill response stockpiles in Darwin.	The NT DoT response to the January 2016 email enquiry advised it would like to adopt the same approach as is used by WA DoT in relation to the use of dispersant on any spill potentially heading towards NT waters. This process is summarised as: • INPEX to notify NT DoT of any spill that has the potential to enter NT waters • INPEX to notify NT DoT of any dispersant spraying activities in commonwealth waters where there is the potential for the spill / dispersed spill to reach NT coastal waters. • Notification will include the Operational Net Environmental Benefit Analysis (NEBA) for dispersant use. INPEX also agreed to provide a copy of the OPEP to be issued to NT DoT for information once it has been accepted by NOPSEMA. NT DoT responded to the email in February and advised of the locations in Darwin of the oil spill response equipment and who manages them (i.e. Darwin Port and AMSA).
Authority, Northern Territory,	NT Department of Primary Industry and Fisheries	Engagement in 2013, 2014, 2015 and 2016 with DPIF and NTSC for determinations of relevant fisheries (potentially impacted by the	NTSC (as authorised by DPIF) advised INPEX to engage and continue engagement with identified fisheries and representative bodies. DPIF provided updated lists/contacted information for

Category, jurisdiction, subcategory	Stakeholder organisation	Engagement	Feedback summary
territory/local authority and commercial fishing industry association	(DPIF) and Northern Territory Seafood Council (NTSC)	Project activities), updated contact details for licence holders in relevant fisheries and representative industry associations.	identified fisheries. INPEX continues to check the validity of the licence holders with NTSC and DPIF and sends fact sheets on an annual basis to inform licence holders of Project updates.
Authority, Western Australia, state/local authority	WA Department of Parks and Wildlife (DPaW)	Fact sheet and emails in July 2014. March 2015 – Phone call and follow-up emails. May 2015 – Briefing provided on INPEX activities and baseline monitoring in the Browse Basin. March 2016 – provided fact sheet and clarified names of reserves.	DPaW confirmed it has an interest in petroleum industry activities, including any potential oil spill trajectories that are likely to affect DPaW-managed lands or waters, or areas documented, or likely to be important for conservation significant wildlife. 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 that it does not issue these permits prior to an incident. DPaW advised INPEX to consider the risk of oiled wildlife occurring on Browse Island as 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. 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.

Category, jurisdiction, subcategory	Stakeholder organisation	Engagement	Feedback summary
Authority, Western Australia, state/local authority	WA Department of Environmental Regulation (DER) Hazard Management Branch Contaminated Sites Branch	Email of fact sheets in 2014, 2015 and 2016 to DER Pollution Reporting Line and Contaminated Sites contacts regarding spill notifications (OPEP emergency contacts list). Briefing to DER personnel by INPEX Emergency Response personnel on broader Ichthys Project activities in Broome in 2015.	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.

Category, jurisdiction, subcategory	Stakeholder organisation	Engagement	Feedback summary
Authority, Western Australia, state/local authority	WA Department of Transport – Marine Safety Branch (WA DoT)	Email of fact sheets and a briefing held in December 2014. Fact sheets also sent in 2015 and 2016.	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 the EP.

Category, jurisdiction, subcategory	Stakeholder organisation	Engagement	Feedback summary
		Between October 2015 and April 2016, INPEX was invited to attend industry workshops to discuss revision of the WestPlan Marine Oil Pollution (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. 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. INPEX attended each workshop and provided comments on the draft guidance note.

Category, jurisdiction, subcategory	Stakeholder organisation	Engagement	Feedback summary
		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 • response strategies • proposed incident management team (IMT) structure exercise and testing arrangements of spill response plans.	At the time of submission of the EP INPEX had not received a response to the letter sent 26 April 2016. INPEX understands that WA DoT is prioritising its responses to operators at this time. A follow-up email was sent on the 30 August 2016 asking if WA DoT could advise where INPEX is placed, in the order of priority, for a response to the letter.
Authority, Western Australia, state/local authority	Department of Fisheries WA (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. Since 2013, DoFWA has advised INPEX to maintain contact with fishing stakeholders via	INPEX (has since 2013 and) continues to check the validity of identified fisheries with DoFWA and as requested sends fact sheets on an annual basis to inform fishing industry bodies and licence holders of Project updates. INPEX provided an email response to DoFWA's April email enquiry, and a detailed letter in response to DoFWA's letter

Category, jurisdiction, subcategory	Stakeholder organisation	Engagement	Feedback summary
		engagement with WAFIC, the Pearl Producers Association, Recfishwest and directly with licensed fishing operators in relevant fisheries. In response to the 2016 fact sheet and in relation to the GEP, DoFWA initially emailed (April) and then sent a letter to INPEX (May) requesting INPEX to identify a full range of mitigation strategies that would be presented in the EP. DoFWA requested that the GEP Operation Oil Pollution Emergency Plan include contact details for its department and that it is notified within 24 hours of INPEX reporting an incident to the appropriate authority. DoFWA also requested further information on provision and use of baseline data and information regarding biosecurity for vessels moving into WA waters interstate or internationally.	(May), both providing all requested information including a description of risks, impacts and controls to be included in the EP and how INPEX had, or could, address DoFWA's request and feedback. In July, DoFWA acknowledged the detailed information provided by INPEX had addressed its concerns. INPEX has incorporated feedback from DoFWA engagement within the EP, OPEP and has noted DoFWA's interest for future stakeholder engagement.
Authority, Western Australia, state/local authority	WA Department of Mines and Petroleum (DMP)	Fact sheets sent from 2013 to 2016.	Request for DMP to be notified of the start and cessation of any offshore activities (to nominated email address: petroleum.environment@dmp.wa.gov.au). INPEX has noted this as an ongoing consultation requirement.
Oil spill response	Australian Marine Oil Spill Centre (AMOSC)	Fact sheets sent 2014, and 2015 and 2016. 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	Receipt of fact sheets was acknowledged. 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 the GEP at the Offshore Facility end near to Browse Island and the location of the fixed-wing assets.

Category, jurisdiction, subcategory	Stakeholder organisation	Engagement	Feedback summary
		a response. August 2016 – INPEX sent a draft of the OPEP to AMOSC for review and requested AMOSC to confirm its ability to perform the tasks required of them under the plan.	AMOSC clarified its ability to make aviation assets available and advised INPEX to confirm availability of search and rescue aircraft with AMSA. 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.

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 (ACF) • World Wildlife Fund for Nature (WWF) • 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 has been 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

CONSEQUENCE TABLE			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
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, these have been refined to environmentally sensitive or biologically important receptors (values and sensitivities). These 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.
- BIAs 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?
Inspection maintenance and repair (IMR) activities	
Emissions and discharges	
Grout, concrete, steel swarf and asphalt discharges	Yes
Marine growth and limescale removal chemical discharges	Yes
Controlled releases during GEP repair	Yes
Waste management	
Wastes generated during IMR activities	No – through implementation of IMR activities, the only wastes expected to be generated include the following resulting from maintenance activities or a GEP repair: • removed concrete coating /asphalt debris and grout • removed steel swarf/steel shavings • damaged pipe removed/replaced. The above wastes are assessed as emissions and discharges from IMR activities.
Noise and vibration	
Noise and vibration from submerged IMR equipment	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). Maximum sound levels for side-scan sonar and multi-beam systems have been modelled for different seabed types and a range of water depths and have conservatively estimated the distances over which the sound propagates (Zykov, 2013). The results suggest that sound levels are likely to fall below the thresholds for PTS and

	TTS onset within a few metres from the source. However it is not expected that a cetacean would encounter survey equipment or persist in such close proximity for such an interaction to occur.
Loss of containment	
Accidental release from submerged IMR equipment	Yes
Loss of containment of GEP infrastructure	Yes
Seabed (land) disturbance	
Seabed intervention activities	Yes
Vessel activities	
Emissions and discharges	
Change in air quality from power generation and waste incineration on vessels	Yes
Change in light levels from vessels	Yes
Cooling water discharges from vessels	Yes
Sewage, grey water and food waste discharges	Yes
Oily water and bilge discharges	Yes
Discharge of desalination brine from vessels	Yes
Waste management	
Inappropriate waste handling and disposal	Yes
Noise and vibration	
Vessel operations (engines)	No - Vessel engines and dynamic positioning 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 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 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	
Accidental release overboard	Yes
Loss of containment from a vessel collision resulting in a 250 m^3 Group II / 100 m^3 Group IV spill	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
Seabed (land) disturbance	
Anchoring during vessel activities	Yes
Social and cultural heritage	
Physical presence of vessels resulting in disruption to other marine users	Yes
Oil spill response activities	
Emissions and discharges	
Routine discharges – sewage effluent, grey water and food waste from vessels	Yes
Chemical dispersant application	Yes
Waste management	
Shoreline clean-up	Yes

Inappropriate vessel-based waste handling and disposal	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 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 as low as reasonably practicable (ALARP). Cost may include financial cost, time or duration, effort, occupational health and safety risks, or environmental impacts associated with implementing the control.

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
	Engineering	**Detection**	Design measures that facilitate early detection of a hazardous event
	Engineering	**Control**	Design measures that limit the extent/escalation potential of a hazardous event
	Engineering	**Mitigation**	Design measures that protect the environment should a hazardous event occur
	Engineering	**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
  - takes into consideration conservation management plans/threat abatement plans
- the level of environmental risk has been assessed to be ALARP.

A summary of the potential impacts and risks with details on identified control measures are shown in Table 5-2 and Table 5-3. 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 and Table 5-3.

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
Emissions and discharges				
Marine growth and lime-scale removal chemicals	If physical removal of marine growth is unsuccessful, weak acids such as acetic acid (vinegar), sulfamic acid, or similar, may be used to remove residual marine growth and limescale deposits. A temporary reduction in pH has the potential to expose marine flora and fauna to a change in water quality that may result in reduced ecosystem productivity and/or diversity.	A1	• The INPEX *Chemical, Assessment and Approval Procedure* has been used to preferentially select marine growth and lime-scale removal chemicals with a low environmental hazard rating so as to reduce the potential for environmental impact.	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
Controlled release during GEP major repair	Controlled discharges of hydrocarbons, MEG, FIS and potable water have the potential to result in changes to water quality. A decline in water quality has the potential to result in impacts to marine flora and fauna and may result in behavioural changes and reduced ecosystem productivity or diversity.	A2	• Use isolation tools to prevent the discharge of residual GEP contents in the event of a major repair. • Following a repair, the residual hydrocarbons and seawater in the GEP would be sent to the Ichthys LNG Plant for processing, to prevent a large release to the marine environment. • The INPEX *Chemical Assessment and Approval Procedure* preferentially selects chemicals (FIS/MEG) with a low environmental hazard rating so as to reduce the potential for environmental impact. • Stakeholder engagement to raise awareness regarding the location and status of the GEP prior to it appearing on marine charts. • INPEX will inform DoFWA and other potentially affected stakeholders in the event that the Pipeline Repair System is mobilised to conduct a repair.	Low
Concrete, asphalt, steel swarf and pipe/metal discharges	During various maintenance and repair activities, discharges of grout, asphalt enamel, concrete weight coating, steel shavings and damaged pieces of pipe/metal, may be released to the marine environment. These discharges have the potential to result in changes in water and sediment quality through seabed disturbance which may result in reduced ecosystem productivity and/or diversity.	A3	• Recovery of damaged section of pipe to surface. • ROV inspection before and after work to confirm recovery of damaged pipe. • The INPEX *Chemical Assessment and Approval Procedure* preferentially selects grouting chemicals with a low environmental hazard rating so as to reduce the potential for environmental impact. • Engineering analysis / environmental assessment of possible repair techniques to assess alternative methods, characteristics of the repair location in relation to sensitive receptors and seasonal variability.	Low
Vessel atmospheric emissions	Atmospheric emissions produced from vessels have the potential to result in localised changes in air quality and	A4	• Marine diesel engines on board vessels 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	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
	subsequent exposure of marine avifauna to air pollutants.		vessel and engine size, type and class) and have associated Engine International Air Pollution Prevention (EIAPP) and International Air Pollution Prevention(IAPP) certificates. • Installation of equipment or systems on board vessels that contain Ozone Depleting Substances (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). • 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), vessels >400 gross tonnes (GT) will have the following certifications: 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. • 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	

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
			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). • 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). • Vessels >400 GT will carry a Ship Energy Efficiency Management Plan (SEEMP), 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 vessels	Light emissions from vessels' 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.	A5	• None identified	Low
Vessel sewage, grey water and food waste discharges	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	A6	• Vessels ≥400 GT have an International Sewage Pollution Prevention (ISPP) certificate and confirm that an IMO-approved sewage treatment plant or sewage comminuting and disinfecting system is on board. • Vessels will macerate food waste to a particle size <25 mm prior to disposal. Disposal will take place while the vessel is en route.	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
	result in changes to ecosystem productivity or diversity.		• If macerator is not operational, food waste will either be frozen and stored onboard (for onshore disposal) or manually macerated to <25 mm prior to disposal.	
Vessel cooling water discharges	Cooling water 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.	A7	• Engines and machinery adequately maintained to ensure efficient operation.	Low
Vessel desalination brine discharges	Discharging desalination brine has the potential to cause changes in surface water salinity.	A8	• None identified	Low
Vessel oily water / bilge discharges	Contaminated deck drainage and bilge discharges, or failure to treat oily water to suitable oil-in-water (OIW) concentrations before discharge, has the potential to expose marine fauna to changes in water quality and/or result in impacts through direct toxicity.	A9	• Vessel inspections confirming MARPOL 73/78 compliant oil-water-separator (OWS) are operational and maintained. • Spill kits will be available on board vessels and crew trained in deck spill response.	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
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 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.	A10	• Appropriate storage of hydrocarbons and chemicals. • Offshore waste/garbage management plan. • Induction of personnel into the waste/garbage management plan. • Use of licensed onshore waste facility or contractor to receive / dispose of vessel waste.	Low
Loss of containment				
Accidental release from vessel or submerged IMR equipment	An accidental release or loss of containment event that reaches the marine environment has the potential to result in changes to water quality. A decline in water quality has the potential to result in impacts to marine flora and fauna and may result in reduced	A11	• Prevent onboard spills through appropriate storage (secondary containment) of hydrocarbons and chemicals, including their associated waste constituents. • Reduce the volume of oil from onboard 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.	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
	ecosystem productivity and/or diversity.		• Premobilisation servicing/inspection of submersible IMR equipment. • Approved ship oil pollution emergency plan (SOPEP). • Preventative maintenance system (PMS) of external equipment, such as winches and cranes, to minimise the risk of leaks. • Lifting procedures implemented to reduce the risk of dropped objects. • Induction of personnel on appropriate hydrocarbon and chemical storage and handling procedures, including the use of secondary containment and spill kits.	
Minor loss of containment of GEP infrastructure	A leak or spill of PWC or GEP gas has the potential to result in changes to water quality through entrained and dissolved hydrocarbon exposure.	A12	• GEP Integrity Management Plan. • GEP Pipeline Repair Plan. • GEP pressure monitoring. • GEP leak verification inspection. • Conduct inspections of the CPF/FPSO mooring system, in accordance with the Mooring IMM Plan, during operations. • INPEX *Lifting Standard*. • Implement the Field Management Plan. • Concurrent operations for vessel-based maintenance and repair activities of the GEP, outside of the Ichthys FMA. • Environmental assessment of GEP loss of containment events. • Stakeholder consultation	Mode-rate

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
Biodiversity conservation and protection				
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 of vessels and IMR equipment 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 and associated receptors dependent on them.	A13	• Vessels will have an antifouling coating applied 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 are to comply with the *Biosecurity Act 2015* and the *Australian Ballast Water Management Requirements, Version 6* (DAWR 2016). • Project vessels 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, unless otherwise agreed with the Department of Agriculture and Water Resources (DAWR).	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.	A14	• Interactions between support vessels and cetaceans will be consistent with EPBC Regulations 2000 – Part 8, Division 8.1 (Regulation 8.05) *Interacting with cetaceans* (modified to include turtles): o Support vessels will not travel faster than 6 knots within 300 m of a cetacean or turtle (caution zone) and minimise noise. o Support vessels will not approach closer than 50 m of a dolphin or turtle and 100 m of a whale (with the exception of bow riding). o If a cetacean shows signs of being disturbed, support vessels will immediately withdraw from the caution zone at a constant speed of less than 6 knots. Interactions between support vessels and whale sharks will be consistent with the Whale Shark Wildlife Management Program no. 57 (DPaW 2013b); specifically, support vessels will not	Low

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
			travel faster than 8 knots within 250 m of a whale shark (exclusive contact zone) and not approach closer than 30 m of a whale shark. • Vessel crew will receive an induction to inform them of the requirements of EPBC Regulations 2000 – Part 8, Division 8.1 (Regulation 8.05).	
Social and cultural heritage				
Physical presence of vessels resulting in disruption to other marine users	The physical presence of vessels in Zone 1 has the potential to cause disruption to other marine users, including shipping operators and fisheries, through the reduction of space available to conduct shipping and fishing activities.	A15	• Stakeholder engagement plan. • AMSA and AHS will be informed of GEP IMR vessel activities.	Low
Seabed (land) disturbance				
Seabed intervention activities and anchoring	Undertaking seabed intervention activities has the potential to physically disturb the seabed close to the GEP in Zone 1. A disturbance to benthic communities has the potential to result in reduced ecosystem productivity or diversity. Anchoring may result in physical disturbance at the immediate location of the anchor and its chain.	A16	• Use of dynamic positioning (DP) vessels to avoid anchoring. • Differential global positioning system (DGPS). • If working in an area of hard substrate, a pre and post ROV survey will be undertaken to verify the work area and to validate that the footprint of disturbance from seabed intervention activities does not exceed the expected area of disturbance. • 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
	Seabed intervention activities may also result in the localised generation of silt plumes which could affect the surrounding benthic communities.			
Emergency condition – vessel collision				
Vessel collision resulting in a Group II (250 m^3 MGO) or Group IV (100 m^3 HFO) spill	Group II and Group IV oils that reach the marine environment have the potential to result in changes to water quality and impacts to marine flora and fauna through surface, entrained, dissolved, and shoreline hydrocarbon exposure that may result in reduced ecosystem productivity and/or diversity.	A17	• Vessels fitted with lights, signals, an automatic identification system (AIS) transponders and navigation equipment as required by the *Navigation Act 2012*. • Implement the field management plan. • AMSA and the Australian Hydrographic Service (AHS) will be informed of GEP IMR vessel activities. • INPEX will provide all available support to AMSA in AMSA's performance of its 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 a vessel when it is a 'facility' under the OPGGS Act. • Develop an Operational NEBA in accordance with the OPEP to confirm effectiveness of response strategies before their implementation. • Develop and implement incident action plans (IAPs) using the processes described within the OPEP. • Implement oil spill response controls • Response effectiveness will be in accordance with the OPEP. • Emergency response preparedness is maintained by implementing the security and emergency management arrangements of the EP.	Mode-rate

Source of risk or impact	Hazards and threats	Consequence assessment reference #	Control measures	Residual risk ranking
Emergency condition – major loss of containment of GEP infrastructure				
Major loss of containment of GEP infrastructure (GEP rupture). Emergency condition.	A major loss of containment/rupture of the GEP infrastructure has the potential to result in changes to water quality, predominantly through entrained and dissolved hydrocarbon exposure.	A18	• Implement the GEP Incident Management Guide. • Verification of competency (VOC) of CPF and Ichthys LNG Plant CCR Operators. • Develop an Operational NEBA in accordance with the OPEP to confirm effectiveness of response strategies before their implementation. • Develop and implement incident action plans (IAPs) using the processes described within the OPEP. • Implement oil spill response controls. • Response effectiveness will be in accordance with the OPEP. • Emergency response preparedness is maintained by implementing the security and emergency management arrangements of the EP. • INPEX will provide support to WA DoT in their performance as control agency for a spill which reaches WA waters, resulting from a loss of integrity of the GEP.	Mode rate

Oil spill response strategies

Not all techniques are appropriate for every hydrocarbon spill. Different types of 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 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

Oil Spill Response Strategies				
All aspects				
Source of risk or impact	**Hazards and threats**	**Consequence assessment reference #**	**Control measures**	**Residual risk ranking**
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	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. Increased concentrations of entrained hydrocarbons within the water column, potentially contacting submerged sensitive receptors. Incorrect management of hydrocarbon-contaminated wastes generated during shoreline clean-up has the potential to create additional contamination of the shoreline or declines in water quality. Poorly implemented wildlife response has the potential to cause stress or suffering to wildlife impacted by the spill.	A19 to A25	• 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. • In the event of a spill in the western 200 km of Zone 1, IMT to evaluate (through the Operational NEBA) the opportunity to use the mobile dispersant spray system and 16 m^3 dispersant stockpile that is maintained in WA-50-L at all times. • Develop an Operational NEBA in accordance with the OPEP to confirm the effectiveness of response strategies before their implementation. • 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	Mode-rate

Oil Spill Response Strategies				
deflect and/or contain and recover.	Capture, cleaning and rehabilitation of oiled wildlife has the potential to create additional stress to animals. Turtle nesting disturbance during shoreline responses. The movement of equipment and personnel onto offshore islands has the potential to introduce terrestrial exotic pests, including rats.		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 where dispersant and spray equipment is located in WA-50-L. o at the INPEX aviation contractor base in Broome. • 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 terrestrial exotic pests 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" (PDCA) 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 0.

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

HSEQ-MS element	Description	Performance monitoring
		they start work at or visit any of the vessels described in the EP. 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

HSEQ-MS element	Description	Performance monitoring
		management on a periodic basis.
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 tested.	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 Inductions covering security and emergency management processes are provided to all personnel before they start work. Emergency response capability is maintained and updated on an annual basis.

HSEQ-MS element	Description	Performance monitoring
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. Learnings 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
- INPEX HSEQ audit on the Ichthys Project every two years to confirm alignment with the INPEX HSEQ-MS implementation
- 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 Vessel inspections

Inspections will be undertaken to ensure that the environmental performance outcomes and standards documented in this EP can be achieved. The inspections will be conducted on vessels before mobilisation to complete a scope of work. Findings during the inspections will be converted into actions that will be tracked within an actions tracking database.

Based on the intermittent and infrequent nature of the IMR activities described in the EP, the duration of a vessel's scope of work is unknown however is estimated to range from 5-60 days per year. Should an IMR vessel's scope of work extend beyond 60 days, an additional environmental inspection, to confirm compliance with this EP, will be conducted. Following the completion of an IMR vessel scope of work, a report on EP compliance will be prepared.

6.3 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.

6.3.2 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
- a GEP rupture.

In the event of a significant impact to MNES, INPEX will provide a written notification to DEE (Cwlth) within three days of becoming aware of the event, and provide additional information as available, if requested by DEE.

6.3.3 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.

6.3.4 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 this 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 GEP start-up and operation
- provide high-level guidance and process support for the INPEX 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 a new facility becomes operational
- when the arrangements for an activity are significantly amended
- not later than 12 months following the most recent test.

The INPEX IMT will conduct a minimum of two Project-specific oil spill drills per year, using NOPSEMA-accepted OPEPs.

Drills will use the *INPEX Emergency Contacts Directory, Oil Spill Equipment Tracking Register* and *Oil Spill Forms Register* to test notifications processes, contracted service provider activations, and logistics assumptions, twice yearly.

A notification and communication drill between the Ichthys LNG Plant, CPF and the INPEX IMT will occur before the introduction of hydrocarbons into the GEP infrastructure.

Strategic NEBA are provided (in the OPEP) for Group I (GEP gas), Group II (MGO) spills, and Group IV (IFO/HFO) spills.

The Strategic NEBAs have been prepared by assessing the likely effectiveness, constraints, logistical issues, and environmental effects of response measures. The objective is to select the most suitable and effective responses to minimise environmental impacts.

During an oil spill emergency event, the IMT will develop an Operational NEBA by evaluating the validity of the assumptions of the Strategic NEBA and ALARP considerations. The Operational NEBA would need to consider the specific conditions of the spill event, such as the oil type, spill location and trajectory, the sea state and weather forecast, which may have a bearing on the effectiveness and feasibility of implementing various responses.

7.1 Primary response measures

The outcomes of the evaluation (Strategic NEBA), 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
Oil spill trajectory modelling (OSTM)	INPEX maintain a contracted spill modelling service provider to provide 24-hour support.	OSTM activated within 2 hours
Aerial surveillance	Aerial surveillance can only be undertaken during daylight hours and is guided using the OSTM modelling results. There is a dedicated full time emergency helicopter, plus a minimum of 4 crew change helicopters available in Broome at all times. The crew change helicopters have the INPEX oil spill observation aid available in Broome, ready for use during a spill observation event. This resource can be mobilised to any location along the GEP route within 5 hours. 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 aircraft 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 12 months of the year at $100,000 per month. The cost for this is not considered reasonable based on the availability of alternative means of aerial surveillance (helicopter surveillance available all year). The addition of an extra aircraft will not significantly reduce the time of response. Personnel formally trained through the AMOSC aerial 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 a helicopter co-pilot using the INPEX oil spill observation aid, and data from other operational and monitoring evaluation techniques, should still provide adequate information for the INPEX IMT to conduct its role.	Information from project assets will be available within 5 hours. Aerial surveillance using a trained aerial observer within 48 hours.
Vessel surveillance	Smaller support vessels, less than 30 m in length, are available in Broome and Darwin. These smaller vessels, in an emergency, could be along-side a smaller wharf to load marine crew, spill and supplies within 6 hours, and then transit to the spill location within approximately 24 hours from the time they	Within 24 Hours

	were activated (assuming vessel speed of 14 knots). For example at 14 knots, a vessel departing from Broome can reach the western half of the GEP route in 18 hours, and at 14 knots, a vessel departing from Darwin can reach KP 450 (mid-way point along the GEP route) in 18 hours. Whilst small support vessels can be mobilised to the location of the spill faster than larger support vessels, aerial surveillance is considerably faster than any vessel surveillance platform. Therefore, resources will be focused on aerial surveillance, rather than vessel surveillance.	
	If a spill occurred in proximity to the offshore facility or the NT / Commonwealth waters boundary, vessel surveillance could be undertaken faster if a PSV (larger platform support vessels) was on standby at the facility or close to NT waters, however this cannot be guaranteed. A PSV on route between the NT and WA-50-L would potentially be available to divert to the spill location and undertake vessel surveillance in <48 hours, depending on location of the spill, however again this cannot be guaranteed. The time to mobilise a new PSV to Darwin or Broome wharf, loaded with crew and provisions and sail to location cannot be improved to less than 48 hours. There are less berth spaces available on wharfs in Broome and Darwin for these larger vessels. Therefore, immediate access to wharf space cannot be guaranteed. Additional time alongside the wharf is also required for bunkering and provisioning a large vessel. Therefore, at least 24 hours is required for mobilisation activities in Broome or Darwin. The vessel also requires at least 18 hours to transit to the spill location.	Within 48 hours
Electronic surface tracking buoy(s)	INPEX has purchased several surface tracking buoys which it positions at high-risk locations, such as IMR vessels 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 Civil Aviation Safety Authority (CASA) has granted permission to undertake this aerial deployment activity). If the IMR vessel has been involved in a vessel collision, it will not be available to follow the spill to deploy additional tracker buoys. Note, there is limited, if any surface slick associated with the a GEP rupture, and during the initial stages, due to gas cloud risks, no vessel will search for, or approach the rupture location, to deploy tracker buoys.	Immediately (from IMR vessel). 48 hours for aircraft deployment.
Satellite imagery analysis	Sourced via OSRL. Information gained from satellite imagery would be used in combination with other controls such as aerial /vessel surveillance and OSTM. No greater response effort has been identified.	Images within 48 hours

7.2 Secondary response measures

Due to the various oil types, weather conditions and the nature of potential spill scenarios being either at surface or subsea, several secondary response measures were identified as potentially being suitable.

The secondary response measures identified include:

- wildlife hazing
- pre-contact and post-contact wildlife response
- shoreline clean-up
- vessel and aerial dispersant application
- protect and deflect/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, pre-contact and post-contact wildlife response are subject to regulatory approvals. In addition dispersant application may only be conducted in state/territory waters under the instruction of the WA/NT DoT.

Table 7-2: Arrangements and capabilities – wildlife hazing

Technique	Resource capability and availability	Implementation time
Vessel-based wildlife hazing	INPEX can mobilise any available large support vessel (e.g. a PSV) from the Ichthys Field to Broome, load with supplies and personnel, and return to Ichthys Field or other similar distance location within 48 hours. Transit each way takes 18 hours, and up to 12 hours is required for loading in Broome. Similar timeframes are also required to mobilise, load the vessel and transit to the spill location for large support vessels/equipment departing from Darwin. The timeframe, for mobilising vessels already on hire, cannot be guaranteed to be less than 48 hours. 12 hours is required at the wharf to load provisions, equipment and conduct bunkering activities. Additionally, there is no guarantee that wharf space will be available for large vessels at short notice. To improve the response time it would be necessary to maintain a large vessel, capable of deploying open ocean containment boom in Broome or Darwin. This would incur stand by costs of approximately $20,000 per vessel per day. Any vessel would still need to wait for wharf space to become available, to load the relevant response equipment, then depart for the spill location. The additional cost is not considered reasonable, given that the response time would only be reduced by perhaps 12 to 24 hours. It should be noted that the relocation of equipment stockpiles from their storage facilities in Broome / Darwin to the wharf will not result in any additional time, as the positioning of this equipment on the wharf would occur whilst the support vessel is in transit to Broome / Darwin.	Within 48 hours

	Smaller support vessels (< 30 m) are available in Broome and Darwin. These smaller vessels, in an emergency, could be along-side a smaller wharf to load marine crew, spill response equipment and supplies within 6 hours, and then transit to the western half of the GEP route, or other similar distance location within approximately 24 hours from the time they were activated (assuming a vessel speed of 14 knots). It should be noted that the duration of the small support vessel to reach the spill location, will be dependent on weather and vessel speed. In addition, if a small support vessel is towing a tender, (for shoreline access), vessel speeds will be limited to 10 knots, resulting in approximately 30% additional transit time to the spill location.	Within 24 hours

Table 7-3: Arrangements and capabilities – pre and post-contact wildlife response

Technique	Resource capability and availability	Implementation time
Oiled wildlife response personnel	A WA DPaW / NT PaWC 'oiled wildlife adviser' is available to the IMT (via NT/WA DoT) under the (in draft) *West Australian Oiled Wildlife Response Plan* and *West Kimberley Oiled Wildlife Response Plan* and NT OSCP. Approximately 20–30 OWR personnel could be mobilised to Broome/Darwin within 24 hours for mobilisation to support an OWR. Primary source of personnel: • AMOSC has an OWR capability available on behalf of industry to provide OWR management support in the field. • WA DPaW has local, regional and state resources that can provide OWR management support in the field. • 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). The areas potentially impacted by a spill are quite remote and thus, numbers of responders are limited by accommodation and logistics support It is estimated	24 hours to mobilise personnel to Broome/Darwin, to board vessels and/or helicopters

Technique	Resource capability and availability	Implementation time
	that up to 24 personnel could work on Browse Island on a single day, based on one utility helicopter. Similar numbers would be expected using small boats for shoreline access. However, it should be noted that personnel numbers are not constrained, as INPEX's arrangements with contracted labour hire and other industry capability (e.g. AMOSC) provides access to additional personnel if required. It is possible that OWR personnel may try to capture and recover oiled wildlife at sea. However, it is more likely that OWR activities will be undertaken onshore.	
Oiled wildlife response kit	Section 3 of the *West Kimberley Oiled Wildlife Response Plan* identifies a large number of OWR kits, including those located in Broome, Exmouth and Dampier. AMOSC maintains an 'oiled wildlife response capability register' on behalf of industry to support an OWR. INPEX could purchase additional OWR kits however as response planning indicates that OWR centres are most likely to be set up 'on-water', the number of centres is limited to the number of platforms (vessels) available to support the OWR centres. Given the worst case scenario is 7 m^3 of oil ashore at Browse Island, and limited numbers of limited species breeding / resting there, large numbers of oiled wildlife are not expected, even in a worst-case situation. Therefore, additional 'on-water' centres are not anticipated to be required. In addition, the types of equipment contained in the OWR kits onshore is equipment that is typically maintained and available as part of routine supplies on support vessels and the CPF/FPSO, and therefore resupply or bulking of stocks of OWR kits at an 'on-water' centre should not present a limitation to the response capability.	OWR kits are stored in Broome and can be accessed to mobilise on to support vessels in immediately.
Helicopters	Crew change helicopters Utility helicopters suitable for landing on Browse Island are available. Using a BK-117, H-135 or H-145 light utility helicopter, the helicopter's maximum capacity is two pilots transporting six passengers. CASA specifies a maximum Flying Duty Period of 12 hours with 8 hours flying limit for both pilots. Therefore, based on 1 hour per return trip (CPF to Browse Island and back), it would be possible conduct up to 8 return trips per day. This equates to a maximum of 24 personnel working onshore on a single day, via helicopter access. 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	Within 5 hours Within 7 days.

Technique	Resource capability and availability	Implementation time
	standby, reoccurring training and maintenance of the aircraft, is considered to be grossly disproportionate to the environmental benefit gained.	

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

Technique	Resource capability and availability	Implementation time
Shoreline clean-up personnel	INPEX maintain 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/NT 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), and the NT OSCP (NT DLP 2012), additional personnel to assist with direct clean-up activities may also be provided, if requested by the INPEX IMT.	24 hours to mobilise personnel to Broome/Darwin to board vessels and/or helicopters.
Shoreline clean-up equipment	Shoreline clean-up equipment can be mobilised from the Broome or Darwin stockpiles. Machinery such as graders could be used to potentially assist with shoreline clean-up, however this often creates a larger volume of oily contaminated sands to be removed. In addition, heavy machinery could damage sensitive turtle nesting habitat. Therefore, response equipment will almost certainly be limited to hand-held equipment, which results in less disturbance when conducting a clean-up operation. Consequently, increasing response effort is limited to increasing numbers of personnel and manual cleaning equipment (shovels etc.). Given the availability of manual clean-up equipment additional stocks can be purchased as required in Broome or Darwin.	6 hours to mobilise shoreline response equipment from the warehouse to a support vessel alongside in Broome/Darwin Port.
Helicopters	Crew change helicopters Using a BK-117, H-135 or H-145 light utility helicopter, the helicopter's maximum capacity is two pilots transporting six passengers. CASA specifies a maximum Flying Duty Period of 12 hours with 8 hours flying limit for both pilots. Therefore, based on 1 hour per return trip (CPF to Browse Island and back), it would be possible conduct up to 8 return trips per day. This equates to a maximum of 24 personnel working onshore on a single day, via helicopter access. 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	Within 5 hours Within 7 days.

	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) has already occurred and only clean-up is being performed. 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.	

Table 7-5: Arrangements and capabilities associated with vessel-based and aerial-based dispersant application

Technique	Resource capability and availability	Implementation time
WA-50-L dispersant stockpile and mobile spray system	In WA-50-L, a stockpile of 16 m^3 of Slickgone NS dispersant and a mobile spray system is available to be rapidly deployed onto an available support vessel. 5 m^3 of dispersant, applied at a 20:1 ratio, is sufficient to treat a 100 m^3 HFO spill. Therefore, 16 m^3 is more than sufficient to treat a worst credible HFO spill from an IMR vessel. Therefore increased volume of dispersant would not result in increased response efficiency. Implementation times are variable depending on the location of the spill along the length of the GEP and linked to availability of support vessel with spray equipment. The only method to ensure a faster response is to maintain a vessel with dispersant spray capability alongside the IMR vessel at all times. This is not considered a cost effective option, given the generally large distances between the GEP route and sensitive shorelines (modelling predicting that only Browse Island (WA) and Vernon Islands (NT) would receive shoreline contact). There is also the availability of alternatives such as fixed wing aerial dispersant capability, which is located near Darwin, to cover the Vernon Island scenario.	Commencement of dispersant spraying will depend on the location of available support vessels to WA-50-L and the distance of the spill from WA-50-L.
Vessel-based dispersant trained personnel	Personnel working in WA-50-L where the dispersant stockpile and mobile spray system are stored will be trained in vessel-based dispersant application.	Trained personnel will always be available, located in WA-50-L, who can mobilise the dispersant spray system to an available support vessel.
FWAD dispersant stockpiles, aircraft and personnel	Stockpiles that can be rapidly mobilised by air or road to the FWAD airbases are located in Darwin, Broome and Exmouth. Aircraft are available through AMOSC/AMSA. A key control and contractual requirement of the FWAD contract 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 (via stakeholder consolation) has confirmed that Air Attack Supervisors are government-appointed personnel,	Within 24 hours dependant on spill location. Stockpiles are located in Darwin which can be rapidly transported to Darwin Airport. FWAD aircraft are located in

	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 approximately 24 hours to mobilise one Air Attack Supervisor to the FWAD-nominated airfield (Darwin or Mungalalu Truscott Airport). To increase FWAD aircraft availability for the western half of the GEP route, additional aircraft could be positioned at Broome. However, given that dispersant spray aircraft can rapidly mobilised from Batchelor to the likely nominated airfield for a response to a spill in the western half of the GEP route (Mungalalu Truscott Airport), the costs of maintaining additional FWAD aircraft in Broome are not considered ALARP, and without the Air Attack Supervisor, this additional aircraft will not mobilise.	Batchelor, and are contracted to be able to mobilise (wheels-up) within 4 hours. Depending on the location of key personnel (such as the government-appointed Air Attack Supervisor), key personnel may take up to 24 hours to mobilise to the nominated airfield.

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

Technique	Resource capability and availability	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).
Protect and deflect/contain and recover equipment	Level 1 protect and deflect/contain and recover equipment can be mobilised from the stockpiles located in Broome. Additional equipment, including Level 2/3 stockpiles can be mobilised as required (within 48-72 hours) The stockpiles in Darwin and Broome mobilised to the wharf, ready for loading onto support vessels within 6 hours. This transit from stockpile location to the wharf will not limit the response timeframe. The only identified method to further improve the speed of these types of responses would be to have additional vessels on stand-by, or in the Ichthys Field, pre-loaded with spill response equipment The various spill response equipment stockpiles in	24 hours to mobilise Level 1 equipment from the warehouse to support vessels alongside in Broome.

Technique	Resource capability and availability	Implementation time
	Darwin and Broome require regular maintenance, testing and checking and therefore can't be permanently stored and maintained on board a vessel. In addition, there may be an operational requirement to have specific 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 possible (space and weight limitations) to store and maintain all potentially required types of equipment offshore at all times. In addition, the time taken to mobilise equipment from the Ichthys Field to other vessels, then transit to any locations along the GEP route may not provide any faster response compared to mobilising equipment from Broome or Darwin.	
Helicopters	Crew change helicopters Utility helicopters suitable for landing on Browse Island are available. Using a BK-117, H-135 or H-145 light utility helicopter, the helicopter's maximum capacity is two pilots transporting six passengers. CASA specifies a maximum Flying Duty Period of 12 hours with 8 hours flying limit for both pilots. Therefore, based on 1 hour per return trip (CPF to Browse Island and back), it would be possible conduct up to 8 return trips per day. This equates to a maximum of 24 personnel working onshore on a single day, via helicopter access. 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 maintenance of the aircraft, is considered to be grossly disproportionate to the environmental benefit gained.	Within 5 hours Within 7 days
Waste management	Waste management contractors, which can receive oil-contaminated waste, are available in Broome and Darwin. No greater response effort can be obtained as the waste contract allows for immediate receipt of waste at the request of INPEX.	Oil-contaminated waste can be received immediately

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. This 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
- AMSA (for vessel-based spills)
- environmental science coordinators (WA DoT or NT DoT) for spills entering NT/WA waters.

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

AMSA is responsible for monitoring (OSMP implementation) in instances where AMSA is the control agency (i.e. vessel-based spills). INPEX will provide support to AMSA, in accordance with the MoU.

Consultation with relevant regulatory authorities, regarding progress and outcomes of the OSMP, will occur as part of ongoing notifications and reporting during a Level 2 or Level 3 spill.

8 REFERENCES

AFMA—see Australian Fisheries Management Authority.

AIMS—see Australian Institute of Marine Science.

AMSA—See Australian Maritime Safety Authority.

ANZECC/ARMCANZ—see Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand.

APASA—see Asia-Pacific Applied Science Associates.

Australian Petroleum Production and Exploration Association – see APPEA

APPEA. 2008. Code of Environmental Practice. Viewed online 1st February 2016 at <http://www.appea.com.au/wp-content/uploads/2013/05/Code_of_Environmental_Practice.pdf>

Asia-Pacific Applied Science Associates. 2013b. *Ichthys Gas Field Development Umbilicals, Risers and Flowlines Quantitative Oil Spill Exposure Assessment: Potential Oil Spills During Subsea Installation for the Ichthys Production Field*. Unpublished report (#J0211) prepared by Asia-Pacific Applied Science Associates for McDermott Australia Pty. Ltd.

ATSB – See Australian Transport Safety Bureau.

Australian and New Zealand Environment and Conservation Council and the Agriculture Resource Management Council of Australia and New Zealand (ANZECC/ARMCANZ). 2000. *Australian and New Zealand guidelines for fresh and marine water quality*. Volume 1, 'The guidelines' (National water quality management strategy; no.4). Australian and New Zealand Environment and Conservation Council, and the Agriculture Resource Management Council of Australia and New Zealand.

Australian Fisheries Management Authority (AFMA). 2012. North West Slope Trawl Fishery. Viewed online on 22 September 2015 at <http://www.afma.gov.au/fisheries/north-westslope- trawl-fishery/>.

Australian Fisheries Management Authority (AFMA). 2015a. Skipjack Tuna Fishery. Viewed online on 22 September 2015 at <http://www.afma.gov.au/fisheries/skipjack-tuna-fishery/>.

Australian Fisheries Management Authority (AFMA). 2015b. Western Tuna and Billfish Fishery. Viewed online on 22 September 2015 at <http://www.afma.gov.au/fisheries/westerntuna- and-billfish-fishery/>.

Australian Fisheries Management Authority (AFMA). 2015c. *Northern Prawn Fishery*. Viewed online on 22 September 2015 at <http://www.afma.gov.au/fisheries/northern-prawnfishery/>.

Australian Institute of Marine Science (AIMS). 2012. *Montara: 2011 Offshore Banks Assessment Survey. 2012*. Final Report prepared by the Australian Institute of Marine Science for PTTEP Australiasia (Ashmore Cartier) Pty. Ltd.

Australian Maritime Safety Authority (AMSA). 2010. *Montara Well Release Monitoring Study S7.2 Oil Fate and Effects Assessment Modelling of Chemical Dispersant Operation*. Report prepared by the Australian Institute of Marine Science for PTTEP Australasia (Ashmore Cartier) Pty. Ltd.

Australian Maritime Safety Authority (AMSA). 2013. *Technical guideline for the preparation of marine pollution contingency plans for marine and coastal facilities*. Australian Maritime Safety Authority, Canberra, ACT.

Australian Maritime Safety Authority (AMSA). 2014. *National plan for maritime environmental emergencies*. Australian Maritime Safety Authority, Canberra, ACT. Viewed online on 10 November 2014 at <http://www.amsa.gov.au/forms-and-publications/Publications/national_plan/pdf>.

Australian Maritime Safety Authority (AMSA). 2015a. *The Effects of Maritime Oil Spills on Wildlife including Non-avian Marine Life.* Viewed online on 17 August 2015 at <http://www.amsa.gov.au/environment/maritime-environmental-emergencies/nationalplan/ general-information/oiled-wildlife/marine-life/index.asp>.

Australian Maritime Safety Authority (AMSA). 2015b. *Fixed Wing Aerial Dispersant Capability Joint Standard Operating Procedures (SOP) Version 1.2*. Prepared by the Australian Maritime Safety Authority, the Australian Marine Oil Spill Centre and Aerotech First Response.

Australian Transport Safety Bureau (ATSB), 2013. *Australian Shipping Occurrence Statistics 2005 to 2012. Marine Research Report MR-2013-002*. Viewed online on 19 August 2015 at: https://www.atsb.gov.au/media/4119146/mr-2013-002_final.pdf

Azis, P., Al-Tisan I., Daili, M., Green, T., Dalvi, A. and Javeed, M. 2003. *Chlorophyll and plankton of the Gulf coastal waters of Saudi Arabia bordering a desalination plant.* Desalination, 154 (2003), pp. 291–302.

Baker, C., Potter, A., Tran, M. and Heap, A.D. 2008, *Geomorphology and sedimentology of the northwest marine region of Australia*, record 2008/07. Geoscience Australia, Canberra.

Bamford, M., Watkins, D., Bancroft, W., Tischler, G. and Wahl, J. 2008. *Migratory Shorebirds of the East Asian–Australasian Flyway; Population Estimates and Internationally Important Sites*. *Wetlands International*. Oceania. Canberra, Australia.

Ban, N.C., Alidina, H.M., Ardron, J.A. 2010. Cumulative impact mapping: Advances, relevance and limitations to marine management and conservation, using Canada's Pacific waters as a case study. Mar. Policy 34:876-886.

Bannister, J.L., Kemper, C.M. and Warneke, R.M. (1996). *The Action Plan for Australian Cetaceans*. Canberra: Australian Nature Conservation Agency. Viewed online 6 May 2016 at: <http://www.environment.gov.au/resource/action-plan-australian-cetaceans>.

Beasley, I.L., Arnold, P.W. and Heinsohn, G.E. 2002. Geographical variation in skull morphology of the Irrawaddy dolphin, *Orcaella brevirostris*. *Raffles Bulletin of Zoology*. 10:15-24.

BirdLife International. 2012. *Light pollution has a negative impact on many seabirds including several globally threatened species*. Presented as part of the BirdLife State of the world's birds website. Viewed online on 22 March 2016 at <http://www.birdlife.org/datazone/sowb/casestudy/488>.

BirdLife International. 2016. Tiwi Islands: Sites – important bird and biodiversity areas (IBAs). Viewed online on 11 August 2016 at < http://www.birdlife.org/datazone/sitefactsheet.php?id=23452>

BOM—see Bureau of Meteorology.

Boyle, M.C., and Limpus, C.J. (2008) The stomach contents of post-hatchling green and loggerhead sea turtles in the southwest Pacific: an insight into habitat association. Marine Biology, 155 (2). pp. 233-241.

Brunnschweiler, J.M., Baensch, H., Pierce, S. J., and Sims, D.W. 2009. Deep-diving behaviour of a whale shark Rhincodon typus during long-distance movement in the western Indian Ocean. *Journal of Fish Biology*, 74:706-714.

Brunnschweiler, J.M., and Sims, D.W. 2011. Diel oscillations in whale shark vertical movements associated with meso-and bathypelagic diving. *American Fisheries Society Symposium* 76:457–469.

Bureau of Meteorology. 2015a. *Climate Statistics*. <http://www.bom.gov.au/> (Accessed: 01 March 2015).

Bureau of Meteorology. 2015b. *Climate statistics for Australian locations: Summary statistics Darwin Airport.* Viewed online on 17 March 2015 at: <http://www.bom.gov.au/climate/averages/tables/cw_014015.shtml>.

Burns, K.A., Garrity, S.D. and Levings, S.C. 1993. How many years before mangrove ecosystems recover from catastrophic oil spills? *Marine Pollution Bulletin* 26(5) 239–248.

Burns, K., Daniel, S., Lloyd, J., Hanlon, M., Skepper, C. and Mitsopoulos, G. 2011. *Monitoring plan for the Montara well release, Timor Sea monitoring study S3: Assessment of fish for the presence of oil*. Accessed on 18 August 2015 at <http://www.environment.gov.au/system/files/pages/bcefac9b-ebc5-4013-9c88-a356280c202c/files/montara-s3.pdf>.

Campagna, C. Short, F.T. Polidoro, B.A. McManus, R. Collette, B.B. Pilcher, N.J. Mitcheson, Y.S. Stuart, S.N. and Carpenter, K.E. 2011. Gulf of Mexico Oil Blowout Increases Risks to Globally Threatened Species*. BioScience* 61:393–397.

Cannell, B. Allen, P. Ridley, A. Clarke, R. Herrod, A. 2015. *Shell/INPEX Applied Research Program 6 Milestone Report #4 - Investigating the breeding and foraging parameters of seabird species in the Browse Basin to determine their vulnerability to impacts associated with potential oil spills, and their ability to recover. Comparison between the Lacepede and Adele Islands in 2014.* Prepared for Shell Australia Pty Ltd (Shell) and INPEX Operations Australia Pty Ltd (Inpex).

Cannell, B. Allen, P. Surman, C. Ridley, A. 2016. *Shell/INPEX ARP6 Milestone Report #5 –Report describing the diet composition, foraging habitat and behaviour and breeding of the target seabird species at Lacepede Island during the breeding season in 2015*. Prepared for Shell Australia Pty Ltd (Shell) and INPEX Operations Australia Pty Ltd (Inpex).

Chatto R. 1995. Sea turtles killed by flotsam in northern Australia. Marine Turtle Newsletter, 69: 17–18.

Clark, R.B. 1984. *Impact of oil pollution on seabirds*. Environmental Pollution 33:1–22.

Clarke, R.H. 2010. *The Status of Seabirds and Shorebirds at Ashmore Reef and Cartier and Browse Islands: Monitoring Program for the Montara Well release – Pre-impact assessment and First Post-Impact Field Survey*. Report prepared for PTTEP Australasia and the Department of the Environment, Water, Heritage and the Arts (now the Department of the Environment), Australia.

Clarke. 2015. *Shell/INPEX Applied Research Program (ARP6) Milestone Report #2 Seabirds and shorebirds at Adele Island.* Prepared for Shell Australia Pty Ltd (Shell) and INPEX Operations Australia Pty Ltd (Inpex).

Connell, D.W., Miller, G.J. and Farrington, J.W. 1981. Petroleum hydrocarbons in aquatic ecosystems—behavior and effects of sublethal concentrations: Part 2. *Critical Reviews in Environmental Science and Technology* 11(2):105–162.

Dean, T.A., Stekoll, M.S., Jewett, S.C., Smith, R.O. and Hose, J.E. 1998. Eelgrass (*Zostera marina* L.) in Prince William Sound, Alaska: effects of the Exxon Valdez oil spill. *Marine Pollution Bulletin* 36: 201–210.

DEE- see Department of the Environment and Energy

Department of Agriculture and Water Resources (DAWR). 2016. *Australian Ballast Water Management Requirements, Version 6*. Department of Agriculture and Water Resources, Canberra, ACT.

DEC—see Department of Environment and Conservation.

Department of the Environment and Energy (DEE) 2016. 'Recovery Plan for Marine Turtles in Australia. Commonwealth of Australia 2017'. Draft September 2016.

Department of the Environment, Water, Heritage and the Arts (DEWHA). 2008. North Marine Bioregional Plan bioregional profile: a description of the ecosystems, conservation values and uses of the North Marine Region. Viewed online on 22 September 2015 at <http://www.environment.gov.au/resource/north-marine-bioregional-plan-bioregionalprofile-description-ecosystems-conservation>.

Department of the Environment, Water, Heritage and the Arts (DEWHA). 2009a. *Threat Abatement Plan to reduce the impacts of exotic rodents on biodiversity on Australian offshore islands of less than 100 000 hectares*. Department of the Environment, Water, Heritage and the Arts. Canberra, Australia.

Department of the Environment, Water, Heritage and the Arts (DEWHA). 2009b. *Threat abatement plan for marine debris on vertebrate marine life.* Commonwealth of Australia.

Department of Environment, Water, Heritage and the Arts (DEWHA). 2010. *Survey guidelines for Australia's threatened birds: Guidelines for detecting birds listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999*. Department of Environment, Water, Heritage and the Arts, Canberra, ACT.

Department of the Environment (DoE). 2015. *Conservation Management Plan for the Blue Whale – A recovery plan under the Environment Protection and Biodiversity Conservation Act 1999*. Commonwealth of Australia 2015. Viewed online on 3 August 2016 at <https://www.environment.gov.au/system/files/resources/9c058c02-afd1-4e5d-abff-11cac2ebc486/files/blue-whale-conservation-management-plan.pdf>

Department of the Environment (DoE). 2016a. SPRAT Profile – Dugong dugon — Dugong. Viewed online 3 August 16 at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=28

Department of the Environment (DoE). 2016b. SPRAT Profile – Sousa sahulensis – Indo-Pacific Humpback Dolphin. Viewed online 6 May 16 at: < http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=87942>

Department of the Environment (DoE). 2016c. SPRAT Profile – Tursiops aduncus – Indian Ocean Bottlenose Dolphin. Viewed online 6 May 16 at: < http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=68418>

Department of the Environment (DoE). 2016d. SPRAT Profile – Orcaella heinsohni — Australian Snubfin Dolphin. Viewed online 9 May 16 at: < http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=45>.

Department of Fisheries (DoF). 2012. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2011/12: The State of the Fisheries. Department of Fisheries, Western Australia.

Department of Parks and Wildlife (DPaW). 2013b. *Whale Shark management with particular reference to Ningaloo Marine Park, Wildlife Management Program no. 57*, Department of Parks and Wildlife, Perth, Western Australia.

Department of Primary Industry and Fisheries (DPIF). 2014. Fishery Status Reports 2012. Viewed online on 22 September 2015 at <http://www.nt.gov.au/d/Fisheries/index.cfm?newscat1=&newscat2=&header=Fishery%20Status%20Reports>.

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

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). 2012. *Marine bioregional plan for the North-west Marine Region*. DSEWPac, Canberra, ACT.

Department of Transport (WA). 2015. *WA State Emergency Management Plan for Marine Oil Pollution*. Western Australian Department of Transport, Perth.

Diesing, M., Stephens, D., and Aldridge, J. 2013. A proposed method for assessing the extent of the seabed significantly affected by demersal fishing in the Greater North Sea. ICES Journal of Marine Science 70: 1085-1096.

DNV—see Det Norske Veritas.

DEWHA—see Department of the Environment, Water, Heritage and the Arts.

Det Norske Veritas. 2010. Recommended Practice DNV-RP-F302. *Selection and Use of Subsea Leak Detection Systems*. Det Norske Veritas. Norway.

Diamond, A. W. 1975. *Biology and behaviour of frigatebirds fregata spp on aldabra atoll*. Ibis 117:302-323

DoE—see Department of the Environment.

DoF – Department of Fisheries.

Dolman, S. and Williams-Grey, V. 2006. *Vessel collisions and cetaceans: What happens when they don't miss the boat. A WDCS Science Report*. The Whale and Dolphin Conservation Society (WDCS). Chippenham, Wiltshire, UK.

Double, M.C, Andrews-Goff, V., Jenner, K.C.S., Jenner, M-N., Laverick, S.M., Branch, T.A. and Gales, N.J. 2014. *Migratory Movements of Pygmy Blue Whales (Balaenoptera musculus brevicauda) Between Australia and Indonesia as Revealed by Satellite Telemetry. PLoS One.* 2014 Apr 9:9(4):e93578. doi: 10.1371/journal.pone.0093578. eCollection 2014.

DPaW—see Department of Parks and Wildlife.

DPIF—see Department of Primary Industries and Fisheries.

DSEWPaC—see Department of Sustainability, Environment, Water, Population and Communities.

Duke, N., Burns, K,. Swannell, J., Dalhaus, O. and Rupp, R. 2000. Dispersant use and a bioremediation strategy as alternative means of reducing impacts of large oil spills on mangroves: the Gladstone field trials. *Marine Pollution Bulletin*. Vol 41, Issues 7–12:403–412.

Duke, N. Wood, A. Hunnam, K. Mackenzie, J. Haller, A. Christiansen, N. Zahmel, K. and Green, T. 2010. *Shoreline Ecological Assessment Aerial and Ground Surveys 7-19 November 2009. As part of the Scientific Monitoring Study of the Montara Monitoring Plan*. A report commissioned by PTTEP Australasia (Ashmore Cartier) PL for the Department of the Environment, Water, Heritage and the Arts.

Environment Australia. 2003. *Recovery Plan for Marine Turtles in Australia*. Prepared by the Marine Species Section Approvals and Wildlife Division, Environment Australia in consultation with the Marine Turtle Recovery Team. Canberra. Australia.

Epstein, N., Bak, R.P.M. and Rinkevich, B. 2000. Toxicity of 3rd generation dispersants and dispersed Egyptian crude oil on Red Sea coral larvae. *Marine Pollution Bulletin*, 40: 497–503.

Fandry, C.B. and Steedman, R.K. 1994. Modelling dynamics of the transient barotrophic response of continental shelf waters to tropical cyclones. *Continental Shelf Research*. 14: 1723–1750.

Ferguson, N., White, C. R. and Marshall, D. J. 2013. Competition in benthic marine invertebrates: the unrecognized role of exploitative competition for oxygen. *Ecology*, 94(1):126–135

Fletcher, W.J. and Santoro, K. (eds). 2012. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2011/12: The State of the Fisheries. Department of Fisheries, Western Australia.

Fletcher, W.J. and Santoro, K. (eds). 2014. *Status reports of the fisheries and aquatic resources of Western Australia 2013/14: The state of the fisheries*. Department of Fisheries, Western Australia.

Fletcher, W.J. and Santoro, K. (eds). 2015. *Status reports of the fisheries and aquatic resources of Western Australia 2014/15. The state of the fisheries*. Department of Fisheries, Western Australia.

Foden, J., Rogers, S.I., Jones, A.P. 2011. Human pressures on UK seabed habitats: a cumulative impact assessment. Mar Ecol Prog Ser 428: 33-47.

French-McCay, D.P 2002. Development and application of an oil toxicity and exposure model, OilToxEx. *Environmental Toxicology and Chemistry*, 21(10):2080–2094.

French-McCay, D.P. 2003. Development and Application of Damage Assessment Modelling: Example Assessment for the North Cape Oil Spill. *Marine Pollution Bulletin,* 47(9–12): 341-359.

French-McCay, D.P. 2009. *State-of-the-art and research needs for oil spill impact assessment modelling.* pp. 601-653, 2009 in Proceedings of the 32nd AMOP Technical Seminar on Environmental Contamination and Response, Emergencies Science Division, Environment Canada, Ottawa, ON, Canada.

Fucik, K.W., Bight, T.J. and Goodman K.S. 1984. *Measurements of damage, recovery, and rehabilitation of coral reefs exposed to oil*. pp. 115–134 in Cairns Jr., J. and Buikema Jr., A.L. (eds.), Restoration of Habitats Impacted by Oil Spills, Butterworth Publishers, Boston, MA.

Goodbody-Gringley, G., Wetzel, D.L., Gillon, D., Pulster, E. and Miller, A.I. 2013. *Toxicity of Deepwater Horizon Source Oil and the Chemical Dispersant, Corexit® 9500, to Coral Larvae.* PLOS ONE 8(1): e45574.

Gray, C. A. 1996. Intrusions of surface sewage plumes into continental shelf waters: interactions with larval and pre settlement juvenile fishes. *Marine Ecology Progress Series*, 139:31–45.

Gubbay, S. and Earll, R. 2000. R*eview of literature on the effects of oil spills on cetaceans. Scottish National Heritage Review No. 3*. Report to Talisman Energy (UK) Limited and Scottish Natural Heritage.

Hänninen, S. and Sassi, J. 2009. *Estimated nutrient load from waste waters originating from ships in the Baltic Sea area – Updated 2009*. VTT-R-07396-08. Report to the Technical Research Centre of Finland (VTT). Helsinki, Finland.

Harrison, P.L. 1999. *Oil pollutants inhibit fertilisation and larval settlement in the scleractinian reef coral Acropora tenuis from the Great Barrier Reef, Australia in Sources, Fates and Consequences of Pollutants in the Great Barrier Reef and Torres Strait: Conference Abstracts*. Great Barrier Reef Marine Park Authority, Townsville, Queensland.

Hearn, C.J. and Holloway, P.E. 1990. A three dimensional barotrophic model of the response of the Australian North West Shelf to tropical cyclones. *Journal of Physical Oceanography*, 20:60-80.

Heyward, A.J., Farrell, P.D. and Seamark, R.F. 1994. *The effect of petroleum based pollutants on coral gametes and fertilisation success*. p. 119 in the Sixth Pacific Congress on Marine Science and Technology, Townsville, Australia.

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

Heyward, A., Radford, B., Burns, K., Colquhoun, J. and Morre, C. 2010b. *Montara surveys: Final report on benthic surveys at Ashmore, Cartier and Seringapatam reefs*. Report prepared by the Australian Institute of Marine Science for PTTEP Australasia, West Perth, Western Australia.

Heyward, A., Jones, R., Meeuwig, J., Burns, K., Radford, B., Colquhoun, J., Cappo, M., Case, M., O'Leary, R., Fisher, R., Meekan, M. and Stowar, M. 2011a. *Monitoring study S5 banks & shoals: Montara 2011 offshore banks assessment survey*. Report prepared by the Australian Institute of Marine Science for PTTEP Australasia, West Perth, Western Australia.

Heyward, A., Speed, C., Meekan, M., Cappo, M., Case, M., Colquhoun, J., Fisher, R., Meeuwig, J. and Radford, B. 2013. *Montara: Vulcan, Barracouta East and Goeree shoals survey 2013.* Report prepared by the Australian Institute of Marine Science for PTTEP Australasia, West Perth, Western Australia.

IFC—see International Finance Corporation.

International Finance Corporation (IFC). 2007. *Stakeholder Engagement: A Good Practice Handbook for Companies Doing Business in Emerging Markets*. IFC, Washington D.C.

INPEX. 2010. *Ichthys Gas Field Development Project: draft environmental impact statement*. Report prepared by INPEX Browse Limited, Perth Western Australia, for the Commonwealth Government, Canberra ACT, and the Northern Territory Government, Darwin, Northern Territory.

ITOPF—see International Tank Owners Pollution Federation.

International Tanker Owners Pollution Federation (ITOPF). 2011. *Effects of Oil Pollution on Fisheries and Mariculture*. Technical Information Paper 11. ITOPF, London. Viewed online on 21 August 2015 at: http://www.itopf.com/fileadmin/data/Documents/TIPS%20TAPS/TIP11EffectsofOilPollutionon FisheriesandMariculture.pdf

International Whaling Commission (IWC). 2011. *Ship Strikes: Whales and Ship Strikes*. Viewed online on 12 May 2016 at < https://iwc.int/ship-strikes>.

Jackson, J.B.C., Cubit, J.D., Keller, B.D., Batista, V., Burns, K., Caffey, H.M., Caldwell, R.L., Garrity, S.D., Getter, C.D., Gonzalez, C., Guzman, H.M., Kaufmann, K.W., Knap, A.H., Levings, S.C., Marshall, M.J., Steger, R., Thompson, R.C. and Weil, E. 1989. Ecological effects of a major oil spill on Panamanian coastal marine communities. *Science* 243:37–44.

Jenner, K.C.S., M.N. Jenner and K.A. McCabe. 2001. Geographical and temporal movements of humpback whales in Western Australian waters. *APPEA Journal*, 749–765.

Jenner, C, Jenner, M and Pirzl, R 2008*. A study of cetacean distribution and oceanography in the Scott Reef/Browse Basin development areas during the austral winter of 2008*. Centre for Whale Research (WA) Inc., Perth.

Jenner, KCS & Jenner, MN. 2009a. *Humpback whale distribution and abundance in the near shore SW Kimberley during winter 2008 using aerial surveys*. Report produced for Woodside Energy Limited, pp. 37.

Jenner, KCS & Jenner, MN. 2009b. *Near-shore Vessel Surveys in the SW Kimberley Region During the Humpback Whale Southern Migration, 2008.* Report produced for Woodside Energy Limited, pp. 29.

Jenssen, B.M. 1994. Review article: Effects of oil pollution, chemically treated oil, and cleaning on the thermal balance of birds. Environmental Pollution, 86:207–215.

Johnson M.R., Boelke C., Chiarella L.A., Colosi P.D., Greene K., Lellis K., Ludemann H., Ludwig M., McDermott S., Ortiz J., Rusanowsky D., Scott M. and Smith J. 2008. *Impacts to marine fisheries habitat from non fishing activities in the Northeastern United States* [Accessed at http://www.nefsc.noaa.gov/publications/tm/tm209/ on 6 April 2016].

Kirwan, M. and Short, J. 2003. *Guanabara Bay oil spill 2000, Brazil – cetacean response*. International Oil Spill Conference (IOSC) Conference Proceedings, 2003, 1035—1037.

Knap, A.H., Sleeter, T.D., Dodge, R.E., Wyers, S.C., Frith, H.R. and Smith, S.R. 1985. *The effects of chemically and physically dispersed oil on the brain coral Diploria strigosa (Dana)—a summary review*. pp. 547–551 in American Petroleum Institute, Proceedings 1985 Oil Spill Conference. API Publication Number 4385. Washington D.C.

Kunhold, W.W. 1978. *Effects of the water soluble fraction of a Venezuelan heavy fuel oil (No. 6) on cod eggs and larvae*. pp.126–130 in Wilson, M.P., McQuin, J.P. and Sherman, K. (eds), In the Wake of the Argo Merchant. Centre for Ocean Management Studies, University of Rhode Island, Rhode Island, USA.

Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S. and Podesta, M. 2001. Collisions between ships and whales. *Marine Mammal Science*, 17:35–75.

Lee, K. 2011. *Toxicity Effects of Chemically Dispersed Crude Oil on Fish*. International Oil Spill Conference Proceedings 2011(1):163.

Leung, H.W. 2000. Ecotoxicology of glutaraldehyde: review of environmental fate and effects studies. *Ecotoxicology and Environmental Safety* 49(1):26–39.

Limpus, C.J. and Chatto, R. 2004. Marine Turtles. In: *Description of Key Species Groups in the Northern Planning Area*. National Oceans Office. Hobart, TAS.

Limpus C. 2006. Status of leatherback turtles in Australia. In: 'Assessment of the conservation status of the leatherback turtle in the Indian Ocean and South East Asia'. (Eds. M Hamann, C Limpus, G Hughes, J Mortimer and N Pilcher) pp. 15-21. (IOSEA Marine Turtle MoU Secretariat: Bangkok).

Lohmann, K.J. and Fittinghoff-Lohmann, C.M. 1992. Orientation to oceanic waves by Green Turtle Hatchings. *Journal of Experimental Biology*, 171:1–13.

Loya, Y. and Rinkevich, B. 1980. Effects of oil pollution on coral reef communities. *Marine Ecology Progress*, Series 3:167–180.

Marquenie, J., Donners, M., Poot, H., Steckel, W., de Wit, B. and Nam, A. 2008. *Adapting the Spectral Composition of Artificial Lighting to Safeguard the Environment*, Petroleum and Chemical Industry Conference Europe – Electrical and Instrumentation Applications, 5th PCIC Europe, pp.1–6.

Marsh, H., T.J. O'Shea and J.R. Reynolds. 2011. *The ecology and conservation of sirenia; dugongs and manatees*. Cambridge University Press, London.

McCauley, RD & Jenner C 2010, *Migratory patterns and estimated population size of pygmy blue whales (Balaenoptera musculus brevicauda) traversing the Western Australian coast based on passive acoustics*, Paper SC/62/SH26 presented to the International Whaling Committee Scientific Committee, 2010 (unpublished).

McIlwaine, D. 2002. *Challenging traditional biodegradation tests: the biodegradation of glutaraldehyde*. Paper presented at the 9th Annual International Petroleum Environmental Conference, Albuquerque, New Mexico, USA, 22–25 October 2002. Viewed online 30 June 20016 at <http://ipec.utulsa.edu/Conf2002/mcilwaine_136.pdf>.

McIntyre, A.D. and Johnston, J. 1975. *Effects of Nutrient Enrichment from Sewage in the Sea.* pp. 131–141 in Gameson A.L.H. (ed.) Discharge of sewage from sea outfalls. Pergamon Press, Oxford.

McKinnon, D, Meekan, M, Stevens, J & Koslow, T 2002. *WA-271-P Biological/Physical Oceanographic and Whale shark movement study: R.V. Cape Ferguson Cruise 2982, 2-24 April 2002.* AIMS Final Report produced for Woodside Energy Limited.

Meekan, MG & Radford, B. 2010. *Migration patterns of Whale Sharks: A summary of 15 satellite tag tracks from 2005 to 2008.* Report produced for Woodside Energy Ltd, Australian Institute of Marine Science, Perth.

Milton, S., Lutz, P. and Shigenaka G. 2003. *Oil Toxicity and Impacts on Sea Turtles*. In Shigenaka, G. (ed.), Oil and Sea Turtles: Biology, Planning, and Response. National Oceanic and Atmospheric Administration (NOAA), USA.

McLoughlin, R.J. Davis, T.L.O. and Ward, T.J. 1988. Sedimentary provinces, and associated bedforms and benthos on the Scott Reef-Rowley Shoals platform off north-west Australia. *Australian Journal of Marine and Freshwater Research*, 39(2):133–144.

Mrosovsky, N., Ryan G.D. and James M.C. 2009. *Leatherback turtles: The menace of plastic.* Marine Pollution Bulletin, 58(2):287–289.

National Offshore Petroleum Safety Environment Authority (NOPSEMA) 2014 *Issues Paper IP1411 (Consultation Requirements under the OPGGS Environment Regulations 2009 - Rev 2).*

National Research Council (NRC). 1985. *Oil in the Sea: Inputs, Fates, and Effects*. The National Academies Press. Washington, DC.

National Research Council (NRC). 2005. *Oil spill dispersants: efficacy and effects*. National Research Council , Washington, D.C. USA.

National Oceanic and Atmospheric Administration (NOAA) 2010. *Oil and sea turtles: biology planning and response.* US Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Office of Response and Restoration, 116 pp.

Negri, A.P. and Heyward, A.J. 2000 Inhibition of fertilization and larval metamorphosis of the coral Acropora millepora (Ehrenberg, 1834) by petroleum products. *Marine Pollution Bulletin*, 41(7–12):420–427.

Neptune Geomatics. 2009. *Ichthys Gas Field Development: Plan C Offshore Pipeline Geophysical and Geotechnical Survey Results Report*. Report prepared by NeptuneGeomatics, Perth, for INPEX Browse, Ltd., Perth, WA.

Northern Territory Seafood Council. 2016a. Barramundi Fishery. Viewed online on 11 August 2016 at < http://www.ntsc.com.au/barramundi>

Northern Territory Seafood Council. 2016b. Trepang Fishery. Viewed online on 11 August 2016 at < http://www.ntsc.com.au/trepang http://www.ntsc.com.au/barramundi>

NRC—see National Research Council.

NTSC - see Northern Territory Seafood Council.

OSPAR 2012. *OPSAR List of Substances Used and Discharged Offshore which are*

Considered to Pose Little or No Risk to the Environment (PLONOR). OSPAR Agreement 2013-06 (Replacing Agreement 2004-10). Viewed online on 16 March 2016 at <http://www.ospar.org/documents?d=32939

Paulay, G., Kirkendale, L., Lambert, G. and Meyer, C. 2002. *Anthropogenic biotic interchange in a coral reef ecosystem: A case study from Guam.* Pacific Science 56(4):403–422.

Pendoley, K.L. 2005. Sea turtles and the environmental management of industrial activities in north-west Western Australia. PhD thesis. Murdoch University, Perth, Western Australia.

Peters, E.C., Meyers, P.A., Yevich, P.P. and Blake, N.J. 1981. Bioaccumulation and histopathological effects of oil on a stony coral. *Marine Pollution Bulletin* 12(10):333–339.

Poot, H., Ens, B.J., de Vries, H., Donners, M.A.H., Wernand, M.R. and Marquenie, J.M. 2008. *Green light for nocturnally migrating birds*. Ecology and Society, 13(2):47. Available at http://www.ecologyandsociety.org/vol13/iss2/art47/. Accessed online on 22 April 2016.

Portland Cement 2013. Material safety data sheet (MSDS). Viewed online on 10 October 2014 at <http://www.cementaustralia.com.au/wps/wcm/connect/website/packagedproducts/resources/96ff490045f9011b80808e6685a73cbc/CA001+Portland+Cement.pdf>.

Qiu, B. Mao, B. and Kashino, Y. 1999. Intraseasonal variability in the Indo-Pacific Throughflow and the regions surrounding the Indonesian Seas. *Journal of Physical Oceanography*, 29, 1599–1618.

Reiersen, L.-O and Fugelli, K. The Effect of the Water Soluble Fraction of North Sea Crude Oil on the Transport Mechanism of Taurine in Erythrocytes from Flounder, Platichthys Flesus. In "Fate and Effects of Oil in Marine Ecosystems": Proceedings of the Conference on Oil Pollution Organized under the auspices of the International Association on Water Pollution Research and Control (IAWPRC) by the Netherlands Organization for Applied Scientific Research TNO Amsterdam, The Netherlands, 23–27 February 1987.

Roelofs, A., Rob C., and Neil S. 2005. *A survey of intertidal seagrass from Van Diemen Gulf to Castlereagh Bay, Northern Territory, and from Gove to Horn Island, Queensland.* Report to National Ocean's Office, Department of Primary Industries and Fisheries, CRC Reef Research Centre and NT Department of Infrastructure, Planning and Environment.

Rowat, D. and Gore, M. (2007). *Regional scale horizontal and local scale vertical movements of whale sharks in the Indian Ocean off Seychelles.* Fisheries Research, 84(1), 32-40.

RPS APASA—see RPS Asia-Pacific Applied Science Associates.

RPS. 2007. *Environmental baseline survey results*. Report prepared by RPS Environmental Pty Limited for INPEX Browse, Ltd., Perth, Western Australia.

RPS Asia-Pacific Applied Science Associates. 2014. *Ichthys Offshore Operations Gap Analysis - Quantitative Spill Risk Assessment Scenario OSC 16 updated – GEP Rupture with Decreasing Release Rate Stochastic Modelling Results*. Job Ref #J0312. Prepared by RPS APASA for INPEX, Perth, Western Australia.

RPS Asia-Pacific Applied Science Associates. *2014a. INPEX* – Ichthys GEP Vessel Spills – Dispersant Application Modelling Study*.* Job Ref# J0293. Report prepared by RPS APASA for INPEX Operations Australia, Perth, Western Australia.

RPS Asia-Pacific Applied Science Associates. 2015a. *Ichthys GEP Vessel Spills: Scenario 2 – Results Summary.* Unpublished report #J0285. Prepared for INPEX, Perth, Western Australia.

RPS Asia-Pacific Applied Science Associates. 2015b. *Ichthys GEP Vessel Spills: Quantitative Spill Risk Assessment*. Unpublished report #J0365. Prepared for INPEX, Perth, Western Australia

RPS Asia-Pacific Applied Science Associates. 2015c. *INPEX Darwin OPEP - Quantitative Spill Risk Assessment Case1a.* Email to Harald Lyche of INPEX Operations Australia Pty.

RPS Asia-Pacific Applied Science Associates. 2016a. *Subsea Hydrocarbon Release Dispersion Modelling.* Unpublished report, prepared for INPEX. INPEX Document Number X100-AH-REP-10002. Report prepared by Asia-Pacific Applied Science Associates, East Perth, Western Australia.

RPS Environment and Planning Pty Ltd 2010. *Marine Megafauna 2009 Humpback Whale Survey Report.* Report produced for Woodside Energy Limited.

RPS Environment and Planning Pty Ltd 2011a. *Marine Megafauna Study 2010.* Report produced for Woodside Energy Limited.

RPS Environment and Planning Pty Ltd 2011b. *Humpback Whale Survey Report 2010.* Report produced for Woodside Energy Limited.

RPS Group. 2015. PHAST A*tmospheric Modelling Results – PHAST Modelling Case S1-C2A Results*. Unpublished report. Prepared for INPEX, Perth, Western Australia.

Runcie, J.W. and Riddle, M.J. 2006. Diel variability in photosynthesis of marine macroalgae in ice-covered and ice-free environments in East Antarctica. *European Journal of Phycology*, 41(2):223–233.

Ryan, P.G., Connell, A.D., Gardner, B.D. 1988. Plastic ingestion and PCBs in seabirds: is there a relationship? *Marine Pollution Bulletin*, 19:174–176.

Shigenaka, G. 2001. *Toxicity of Oil to Reef Building Corals: A Spill Response Perspective*. National Oceanic and Atmospheric Administration (NOAA) Technical Memorandum, National Ocean Service, Office of Research and Restoration 8, Seattle, USA.

Sleeman, J. C., M.G. Meekan, B.J. Fitzpatrick, C.R. Steinberg, R. Ancel and C.J.A. Bradshaw. 2010. Oceanographic and atmospheric phenomena influence the abundance of whale sharks at Ningaloo Reef, Western Australia. *Journal of Experimental Marine Biology and Ecology*, 383:77–81.

Standards Australia/Standards New Zealand. 2009. *Risk Management—Principles and guidelines AS/NZS ISO 31000:2009*. ISBN 0-7337-9289-8. 24 pp

Standards Australia/Standards New Zealand. 2012. *Managing environment related risk HB 203:2012*. ISBN 978-1-74342-059-1. 87 pp.

Taylor, J.G. (1996). *Seasonal occurrence, distribution and movements of the whale shark, Rhincodon typus, at Ningaloo Reef, Western Australia*. Marine and Freshwater Research, 47, 637-642.

Tsvetnenko, Y.B., Black, A.J. and Evans, L.H. 1998. Derivation of Australian tropical marine water quality criteria for the protection of aquatic life from adverse effects of petroleum hydrocarbons. *Environmental Toxicology and Water Quality*. Special Issue: 8th International Symposium on Toxicity Assessment. 13:273–284.

United Nations Environment Programme, (UNEP). 1985. GESAMP: *Thermal discharges in the marine environment*. UNEP Regional Seas Reports and Studies No. 45. UNEP.

URS Australia Pty Ltd. 2008. *Ichthys Gas Field Development—Ichthys to Darwin Gas Pipeline Route Marine Habitat Survey.* Prepared for INPEX Browse, Ltd. Perth.

Vanderlaan, A.S.M. and Taggart, C.T. 2007. Vessel collisions with whales: the probability of lethal injury based on vessel speed. *Marine Mammal Science*, 23(1):144–156.

Waayers, D., Mau, R., Mueller, A., Smith, J., and Pet-Soede, L. (2015) A review of the spatial distribution of marine turtle nesting and foraging areas in western Australia. In Proceedings of the Second Australian and Second Western Australian Marine Turtle Symposia, Perth 25-27 August 2014. 2015. Science Division, Department of Parks and Wildlife.

Waldron S., Tatner, P., Jack, I. and Arnott, C. 2001. The impact of sewage discharge in a marine embayment: a stable isotope reconnaissance. *Estuarine, Coastal and Shelf Science* 52:111–15.

Western Australian Department of Transport (WA DoT). 2015. *Western Australian State Emergency Management Plan for Marine Oil Pollution (WestPlan MOP*). Western Australian Department of Transport (WA DoT), Perth, Western Australia.

Western Australian Department of Transport (WA DoT). 2016, *Offshore Petroleum Industry Guidance Note, Marine Oil Pollution: Response and Consultation arrangements*. Western Australian Department of Transport (WA DoT), Perth, Western Australia

Western Australian Environmental Protection Authority (WA EPA). 2008. *Report and Recommendations of the Environmental Protection Authority: Southern Seawater Desalination Project, Water Corporation*. Report 1302 October 2008. Perth Western Australia. <http://epa.wa.gov.au/EPADocLib/2797_Rep1302Desal_61008.pdf on 7 May 16>.

Whiting, S. D., and M. L. Guinea. 2005. Dugongs of Ashmore Reef and the Sahul Banks: a review of current knowledge and a distribution of sightings. *The Beagle-Records of the Museums and Art Galleries of the Northern Territory*. Supplement 1 (2005):207–210.

Whiting, A.U., Thomson, A., Chaloupka, M., and Limpus, C.J. (2008) Seasonality, abundance and breeding biology of one of the largest populations of nesting flatback turtles, Natator depressus: Cape Domett, Western Australia. Australian Journal of Zoology 56: 297-303

Wiese, F. K., Montevecchi, W. A., Davoren, G. K., Huettmann, F., Diamind, A. W., and Linke, J. 2001. Seabirds at risk around offshore oil platforms in the north-west Atlantic. *Marine Pollution Bulletin*, Vol 42(12):1285–1290.

Wilson, S.G., J.J. Polovina, B.S. Stewart and M.G. Meekan. 2006. Movements of Whale Sharks (Rhincodon typus) tagged at Ningaloo Reef, Western Australia. *Marine Biology*, 148:1157–1166.

Witherington, B.E. and Martin R.E. 2003. *Understanding, assessing, and resolving light-pollution problems on sea turtle nesting beaches*. Florida Fish & Wildlife Conservation Commission FMRI Technical Report TR-2 3rd Edition Revised.

Wolanski, E. 1994. *Physical Oceanographic Processes of the Great Barrier Reef*. CRC Press, Boca Raton.

World Health Organization. 2000. *Concise International Chemical Assessment Document 22. Ethylene Glycol; Environmental aspects*. World Health Organization.

Zangerl, R., Hendrickson, L. P., and Hendrickson, J. R. 1988. A redescription of the Australian flat-back turtle *Natator depressus*. Bishop Mus. Bull. Zoo. 1:1-69.

Zieman, J.C., Orth, R., Phillips, R.C., Thayer, G. and Thorhaug, A. 1984. *The effects of oil on seagrass ecosystems*. pp. 37–64 in Cairn, J. and Buikema, A.L. (eds), Restoration of Habitats Impacted by Oil Spills. Butterworth, Boston, USA.

APPENDIX A: CONSEQUENCE ASSESSMENT

A1:

Source of risk or impact	Potential consequence
Marine growth and lime-scale removal chemicals.	In the event of the need to use removal chemicals, the particular values and sensitivities identified as having the potential to be exposed are: • plankton • KEFs • benthic communities • turtle foraging BIA. Typically, a shroud is installed over the area to be treated and the acid is injected and left to react inside the shroud. The shroud is then removed and any residual acid is released to the environment, where it rapidly reacts and neutralises due to the natural buffering capacity of seawater. Volumes would be <1 m^3, and are typically expected to be only a few litres. Marine growth and limescale removal chemicals are weak acids and are typically classified as 'posing little or no risk to the environment' (PLONOR) whereby there are no bioaccumulation or biodegradation concerns with their use (OSPAR 2012). The effect of discharges with elevated pH on the identified values and sensitivities will be influenced by the buffering capacity of the seawater at the point of discharge, which may affect the ionisation and neutralisation of the chemicals. 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 marine growth and limescale removal chemicals are of small volume (<1 m^3) and will likely be rapidly neutralised due to the large buffering capacity of seawater. Reductions in pH can result in impacts to plankton due to the weakening of their calcium skeletons. Plankton in the immediate vicinity of the discharge could be exposed to decreased pH levels 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. Any effects to benthic communities (including KEFs and benthos associated with the turtle foraging BIA) from highly localised, low-level, very short-duration changes in pH are not expected to be ecologically significant or to affect productivity in the Commonwealth marine area. The closest submerged banks and shoals to the GEP route in Zone 1 are Flat Top Bank and Echuca Shoal located 3 km and 9 km away respectively. Therefore, based on these distances, no impacts are expected due to the rapid neutralisation of the small volumes of (<1 m^3) marine growth/limescale removal chemicals. The benthic communities within Zone 1 and in close proximity to the location of the removal chemical discharges have limited ecological significance and are well represented throughout the region, with 98% of the GEP route consisting of featureless, unconsolidated clay or silty sands (INPEX 2010). In areas of rocky outcropping increased density and diversity of epibenthic fauna has been reported (Neptune 2009). The incidental nature of this disturbance (localised, temporary elevation in pH) is not expected to affect regional diversity and productivity of benthic communities. Therefore, the potential consequence associated with the use of marine growth removal chemicals is considered insignificant. Due to the high buffering capacity of the surrounding seawater, infrequent application of the chemicals, rapid neutralisation and dispersion of the marine growth/limescale removal chemicals by prevailing currents, there is no potential for cumulative impacts to arise from the repeated application of

	such chemicals along the GEP.

A2:

<table>
<tr><th>Source of risk or impact</th><th>Potential consequence</th></tr>
<tr><td>Controlled release during GEP major repair.</td><td>
In the event of controlled discharges associated with a major pipeline repair, the particular values and sensitivities identified as having the potential to be exposed are:

commercial, recreational and traditional fisheries
KEFs
transient EPBC-listed species
plankton
benthic communities
turtle foraging BIA
marine avifauna foraging BIA
whale shark foraging BIA.

The key threat to the GEP is an anchor drag, which could result in a worst-case repair scenario requiring 10 × 12.5 m lengths of GEP pipe (i.e. 125 m repair spool).
Based on a volume of 5500 m^3 of residual liquid hydrocarbons/condensate in the GEP, and the GEP's length offshore (882 km from GERB to the beach valve), approximately 0.75 m^3 of liquid hydrocarbons would be present in the 125 m of pipeline to be cut out and replaced with the repair spool. Less residual liquid hydrocarbons are anticipated to remain in the GEP from a rupture at a shallower depth, due to lower ambient seawater pressure.
It is expected that following pressure equilibration with ambient seawater pressure, a significant volume of the damaged section will be filled with seawater, rather than hydrocarbons; therefore, this estimate of 0.75 m^3 is considered conservative.
During repair activities, potable water, FIS and/or MEG may be used for repair spool preservation, flushing and leak-testing. MEG may also be released during isolation/repair pigging.
A summary of individual potential discharges and worst-case volumes associated with controlled releases from the GEP during a major repair is presented below.
<table>
<tr><th>Release scenario</th><th>Discharge constituents</th><th>Worst-case volume (m^3)</th></tr>
<tr><td rowspan="4">Major GEP repair – controlled release</td><td>Residual liquid hydrocarbons</td><td>0.75</td></tr>
<tr><td>MEG</td><td>112.5</td></tr>
<tr><td>FIS</td><td>112.5</td></tr>
<tr><td>Potable water</td><td>112.5</td></tr>
</table>
The above volumes have been calculated on the assumption that the worst-case volume of residual condensate in the GEP after a rupture is 5500 m^3. The offshore GEP is approximately 882 km in length, the GEP with a radius of 21 inches. In the event of a repair, a maximum repair spool length has been assumed to be 10 lengths of pipe, equating to a total length of 125 m with an internal volume of 112.5 m^3.
Residual liquid hydrocarbon release
When the damaged section of GEP is cut and recovered to the surface, residual liquid hydrocarbons could be discharged to the marine environment, as the pipe section is raised through the water column. This release of <1 m^3 of residual liquid hydrocarbons through the water column
</td></tr>
</table>

	has the potential to result in minor, temporary and highly localised effects on water quality and any exposed receptors. The potential consequence is considered to be insignificant. **FIS and potable water release** FIS is seawater treated with a mixture of chemicals to prevent corrosion. FIS chemicals generally include an oxygen scavenger, non-toxic fluorescein dye and biocide. Oxygen scavengers (such as sodium bisulfite or ammonium bisulfate) are used in FIS to remove dissolved oxygen from the seawater. Therefore, when FIS is discharged, it is generally considered anaerobic, which can cause impacts to organisms dependent on dissolved oxygen; however, no impacts to air-breathing organisms such as EPBC-listed turtles, avifauna and marine mammals is expected. 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 major repair to the GEP and sodium bisulfite is considered to be PLONOR), 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. Fluorescein dyes are used in FIS for leak detection. Fluorescein is stable because no functional and reactive groups are present to transform the product. Fluorescein dyes are non-toxic at the concentrations generally used in FIS (approx. 40 ppm) and are listed as PLONOR (OSPAR 2012). During discharge, fluorescein dyes may cause temporary localised discoloration in the immediate vicinity of the release point; however, as the dye is water soluble, it will rapidly disperse in the marine environment with no anticipated impacts to the identified receptors. Biocides, (such as glutaraldehyde or quaternary ammonium chloride) are used in FIS to remove bacteria, which may result in microbial induced corrosion of pipeline walls. Biocides are generally hydrophilic, biodegradable and do not bioaccumulate. Within the FIS, the active chemical component of the oxygen scavenger is sodium bisulfite (45%) and in the biocide it is glutaraldehyde (24%). 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 toxicity of the FIS upon discharge is expected to be limited, due to the oxygen scavenger having been consumed and the formation of 1,5-pentanediol from the degradation of glutaraldehyde. 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 being a minor consequence. Given that the worst-case potential volume of FIS discharged during a major GEP repair – controlled release is 112.5 m^3, i.e. several orders of magnitude lower – the consequence is ranked as insignificant to reflect the temporary and localised nature and scale of this discharge. Similarly, discharges of 112.5 m^3 of potable water at the seabed are not expected to result in any significant impacts, due to rapid dilution to ambient salinity due to high currents of the region. Due to the relatively small volumes of potable water/ FIS releases during a major repair and high current environment along the GEP route resulting in rapid dispersal/dilution of these products, impacts to KEFs and other benthic communities, including a turtle foraging BIA, are anticipated to be highly

	localised and short term. Foraging turtles may be present year round either at the surface or on the seabed, however mobile organisms, such turtles and whale sharks are not expected to remain within a FIS or deoxygenated water plume for any significant length of time, and therefore no impacts on fisheries and transient EPBC-listed species are anticipated. Any impacts on planktonic and benthic communities would not affect biological productivity in the Commonwealth marine area. Therefore, the consequence is considered insignificant. **MEG release** MEG has a half-life of up to 28 days and does not bioaccumulate. MEG is of relatively low toxicity and is highly biodegradable which has led OSPAR (2012) to include MEG on the PLONOR list. The *Australian and New Zealand guidelines for fresh and marine water quality* (ANZECC/ARMCANZ 2000) specify a marine low reliability trigger value of 50 000 µg/L (50 mg/L) for MEG in seawater. The World Health Organization has reported a "no effects concentration" (NOEC) of 24 000 ppm for MEG (WHO 2000). Discharges of MEG associated with a major pipeline repair are estimated to be up to 112.5 m^3. Based on the ecotoxicity data, these discharges pose a negligible risk of ecotoxicity, and significant impacts are not expected, as lethal effects on organisms can only be caused by extended duration exposures (hours to days) at very high concentrations. Due to the rapid dilution that would occur prolonged exposure at high concentrations cannot occur from the proposed MEG discharges during a major repair. Therefore, impacts on all values and sensitivities are expected to be limited to highly localised, short-term and temporary impacts, with inconsequential impacts on transient EPBC-listed species, such as sharks and turtles in BIAs. Any impacts on planktonic and benthic communities would not affect biological productivity in the Commonwealth marine area. Therefore, the consequence of MEG releases associated with a major repair is considered to be insignificant. It should be noted that a major repair of the GEP is an unplanned activity and therefore controlled releases associated with this unplanned event are considered unlikely to occur. Discharges associated with a controlled release at the location of the repair are of relatively small volumes and given the prevailing currents along the GEP, are expected to dilute and disperse rapidly. Therefore, the potential for cumulative impacts associated with multiple releases at a single location is not considered likely.

A3:

Source of risk or impact	Potential consequence
Concrete, asphalt, steel swarf and pipe/metal discharges.	The particular values and sensitivities identified as having the potential to be impacted are: • KEFs in Zone 1 • transient EPBC-listed species • benthic communities • turtle foraging BIA. Anticipated volumes of various discharges include; grout (<1 m^3), asphalt enamel (~0.3 m^3), concrete weight coating (~2.5 m^3), very fine (<1 mm) steel shavings (~3 kg). Large pieces of steel pipe could also be cut out during a GEP major repair. The majority of the GEP route (>98%) is comprised of featureless, unconsolidated clay, silts and sands, with the most dominant seabed features confirmed as pockmarks and sand waves. Although the GEP route traverses three KEFs (i.e. the ancient coastline 125 m depth contour, the

	carbonate bank and terrace system of the Sahul Shelf, and the pinnacles of the Bonaparte Gulf), the environmental values of these KEFs (rocky outcropping, high topographic relief or complexity, resulting in marine fauna aggregations) are generally not present within Zone 1. However, turtle foraging in the BIA (Joseph Bonaparte Gulf) which overlaps Zone 1 may occur throughout the year both at the sea surface and on the seabed. Grout used will typically be a type A-cement, or high-sulfate-resisting Portland cement (type D cement in accordance with Australian Standard AS 1315:1982 *Portland cement*) mixed with small amounts of friction reducer, defoamer and retarder additives. Grout discharged to the marine environment is expected to harden quickly into small inert solid lumps that will settle to the seabed adjacent to the infrastructure within Zone 1. Grouting maintenance and repair activities are not anticipated and are therefore infrequent. Activities will also be of short duration and at specific isolated locations only, as required. The only anticipated impacts associated with grout discharges would be highly localised, minor seabed disturbance and smothering of individuals of sessile benthic fauna immediately adjacent to the GEP. Asphalt enamel, concrete weight coating and steel shavings are all inert substances. When removed from the GEP, these particles are expected to sink to the seabed adjacent to the GEP. These discharges would only occur in the event of a major repair, and therefore, other seabed disturbances associated with mud-mats, pipe-lifting frames, GEP realignment, spool replacement etc., would also be occurring. Therefore, the seabed disturbance associated with these discharges is expected within an already disturbed footprint. The only anticipated impacts associated with asphalt enamel and concrete weight coating discharges would be highly localised, minor seabed disturbance and smothering of individuals of sessile benthic fauna immediately adjacent to the GEP. The very thin (<1 mm) steel shavings will corrode in seawater within a short period. Negligible alterations to seabed sediments would occur as a result of steel swarf discharges. During a major GEP repair, larger pieces of pipe will be cut out (for replacement), resulting in a potential long-term physical disturbance to the seabed and associated benthic communities, particularly sessile benthic fauna. Any physical damage to benthic habitat would be limited in area and is not expected to occur, as damaged pipe will be recovered using the PRS and returned to shore. Due to the very limited physical area of seabed disturbance associated with these discharges, any impacts to benthic communities are not expected particularly in relation to the broader KEFs/BIAs where large areas of similar habitat exist. Therefore, EPBC-listed species, including fish, sharks and turtles dependent on these benthic ecosystems are also not expected to be impacted from these discharges. Therefore, the consequence is considered insignificant. There is little understanding of the cumulative impact of several seabed-based activities in one area and the ability of species or habitats to recover once a pressure (i.e. physical loss of habitat or damage) has been removed (Foden et al 2011). Habitats that require long recovery periods are considered to be more sensitive than those with rapid recovery rates, and the resilience of marine environments to cumulative interactions of multiple pressures is considered to be poorly understood (Ban et al 2010). Seabed disturbance from concrete, asphalt, steel swarf and discharges of pipe/metal, although not planned over the life of this EP, may occur as a result of a requirement to repair the GEP following a rupture. The presence of foraging marine turtles may occur throughout the year (BIA overlaps Zone 1) however the nature of the concrete, asphalt and steel swarf discharges are not expected to result in any impacts to turtles. Any cutting and removal of pipe would be part of a larger repair operation. During such operations, marine turtles would be alert to the presence of the structures and equipment through underwater lights and sounds generated. In the event that a major repair of the GEP is required, potential impacts are

	expected to be highly localised and the potential consequence associated with discharges of concrete, asphalt, steel swarf and pipe/metal has been evaluated as insignificant.

A4:

Source of risk or impact	**Potential consequence**
Vessel atmospheric emissions.	The particular values and sensitivities identified as having the potential to be impacted by atmospheric emissions are: • listed migratory species (marine avifauna). The outer extent of a marine avifauna foraging BIA traverses Zone 1, marine avifauna breeding occurs at Browse Island and a number of migratory marine avifauna species may transit near Zone 1 during their migration via the EAA Flyway. Peak seabird foraging for the Lesser frigatebird is reported to be during April to November however, seabird foraging activity may occur throughout the year. IMR vessels will typically be transient or stationary for only short periods. 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. Acute exposure thresholds are not available for the key atmospheric emission constituents predicted to occur from 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 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, NOX, 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. Overall, the consequences of highly 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.

A5:

Source of risk or impact	**Potential consequence**
Vessel navigation light emissions.	The particular values and sensitivities identified as having the potential to be impacted are: • marine turtles • marine avifauna. Vessel activities along the GEP route are expected to be sporadic, short in duration and, in most cases, are not expected to be static. Therefore, any impacts are expected to be highly localised and temporary in nature. Light emissions from typical IMR vessels will be far lower in intensity than light

	emissions from offshore facilities. Low-intensity light spill will be generated from 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 vessels, to minimise the potential for safety and environmental hazards. Unless specifically required to support over-the-side activities (e.g. lifting or IMR activities), or for navigational purposes, lighting is directed over the work area, which helps to limit light spill to the marine environment. 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 9.5 km from the GEP route. 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, they normally maintain seaward headings by using wave propagation direction as an orientation cue. Because waves and swells generally move reliably 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 toward vessel lighting, this is considered highly unlikely given the distance of 9.5 km. Also, the vessel activity would need to coincide with turtle hatchling for this risk to occur. In addition, even if the exposure was possible, it is unlikely that there would be any significant attraction, as it has been noted that the diffuse glow from light sources can cause disorientation in hatchlings up to 4.8 km from the light source (Limpus 2006). Witherington and Martin (2003) also note that seaward orientation in adult turtles is rarely disrupted by artificial light. The GEP route, and therefore IMR vessels working in Zone 1, will be located within the East Asian–Australasian Flyway (EAA Flyway), an internationally recognised migratory 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, the potential for impact of light from vessels may be slightly elevated for six months of the year. While not an identified BIA, the closest habitat for seabirds from the GEP route 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 (Wiese et al. 2001); however, there are no threatened nocturnal migratory seabirds that use the EEA Flyway (DEWHA 2010). Significant effects of lighting associated with oil and gas infrastructure on populations of migratory birds have been found previously in the northern hemisphere (Wiese et al. 2001); however, there is no published literature of these impacts occurring on the North West 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 IMR vessels is low due to the presence of alternative habitat for resting and foraging (marine avifauna BIAs) in relatively close proximity to the GEP

	route. If any birds were attracted to a vessel 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 vessels in Zone 1, leading to a diversion from migratory behaviours, is not expected. The environmental consequence attributable to light emissions from transient, or temporarily stationary, vessels is considered to be a minor and temporary impact to individuals of a protected species.

A6:

Source of risk or impact	Potential consequence
Vessel sewage, grey water and food waste.	Particular values and sensitivities with the potential to be impacted are: • planktonic communities. Discharges associated with the activity occur in Zone 1, which is predominantly located in the open ocean and more than 12 nm from the nearest land, with the exception of a small portion in proximity to Browse Island. 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 a worst-case assumption that there are two vessels present in Zone 1, each with 50 persons on board, 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). 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 oceanic currents in Zone 1, rapid dilution and dispersion of these discharges is expected to occur. Consequently, no impact or change to productivity is expected and the consequence is considered to be ecologically insignificant.

A7:

Source of risk or impact	Potential consequence
Vessel cooling water discharges.	Particular values and sensitivities with the potential to be impacted are: • transient, EPBC-listed species • planktonic communities • whale shark foraging BIA • turtle foraging BIA • marine avifauna BIA. 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 22–26 °C). Effects of elevation in seawater surface temperatures can cause a range of behavioural responses in transient, EPBC-listed species including attraction and avoidance behaviour. There are marine avifauna, turtle and whale shark

	foraging BIAs within Zone 1 with foraging activity reported year round. As these species would be undertaking foraging activities in these areas they would generally not be exhibiting sedentary behaviour, and therefore they can be considered to be transient in nature. The vessels will be operating in an open-ocean location in water depths ranging from 30 m to 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. A marine avifauna BIA overlaps a portion of Zone 1 for lesser frigatebirds. Peak abundance is reported during April to November. Lesser frigatebirds are unique among seabirds in that they cannot settle on the sea surface due to the poor waterproofing quality of their feathers. This means that they must capture prey at or above the sea surface (e.g. flying fish); whilst their elongated bill regularly comes into contact with the water, their feathers rarely do (Clarke 2015). Therefore, impacts to this species from elevated water temperatures are considered not credible. 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.

A8:

Source of risk or impact	Potential consequence
Vessel desalination brine discharges.	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. Given the water depths in Zone 1 (ranging from 30 m to 250 m) 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. 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.

A9:

Source of risk or impact	Potential consequence
Vessel oily water / bilge discharges.	Particular values and sensitivities with the potential to be impacted are: • transient, EPBC-listed species • planktonic communities • turtle foraging BIA • marine avifauna foraging BIA

	• whale shark foraging BIA. Discharges of oily water will be treated by OWS 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. The turtle, whale shark and marine avifauna BIAs within Zone 1 are foraging areas and with these highly mobile species expected to be present throughout the year. Therefore, the potential exposure to these species 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-ocean environment, a surface expression is not anticipated; therefore; impacts are considered to be of inconsequential ecological significance to transient, EPBC-listed species and associated BIAs, and are therefore considered insignificant. Although many seabirds spend time resting on the sea surface, lesser frigatebirds are unique in that they do not settle on the sea surface due to the poor waterproofing quality of their feathers (Clarke 2015). Therefore, impacts to this species from direct contact with oily water and bilge discharges are not considered credible as they do not rest on the sea surface. However, other species of seabirds may be exposed but given the small quantities discharged and that the area is a foraging area, rather than nesting/breeding, birds are not expected to be spend a significant time on the sea surface and impacts are considered to be of inconsequential ecological significance. 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.

A10:

Source of risk or impact	Potential consequence
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 • turtle foraging BIA • marine avifauna foraging BIA • whale shark foraging BIA. 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. 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.

A11:

Source of risk or impact	Potential consequence
Accidental release from vessel or submerged IMR equipment.	Chemicals and hydrocarbons will be present on board vessels and within IMR subsea equipment during IMR activities. Although there are no planned discharges associated with these chemicals and hydrocarbons, there is the potential during handling, use and storage on board the vessels for spill events to reach the environment and create an impact within Zone 1. In addition, there is the potential for leaks to occur subsea from hydraulic systems on IMR equipment within Zone 1. The largest credible accidental release scenario is a 2 m^3 release, based on the hydraulic fluid volumes of large subsea IMR equipment. Chemical spills, such as paints/solvents, or other process chemicals, are expected to be of smaller volume, and therefore, the worst-credible scenario is defined by the hydraulic fluid spill. In the event of a small loss of containment event from a vessel or submerged IMR equipment, the particular values and sensitivities identified as having the potential to be impacted within Zone 1 are: • fish and sharks (KEFs within Zone 1) • transient EPBC-listed species • plankton • benthic communities • whale shark foraging BIA • turtle foraging BIA • marine avifauna BIA. Pelagic fish species may be able to avoid surface slicks; however, exposure may occur via entrained oil, which forms droplets in the water column. Oil in this form has the potential to impact on the various life stages of fish including the eggs, larvae, juveniles and adults (Tsvetnenko et al. 1998). Planktonic communities would be exposed to accidental releases and, given the variability of products that could accidentally be exposed, localised mortality is possible. However, due the anticipated small volumes of releases, impacts would be expected to be localised in scale, temporary in nature, and not result in any loss of productivity in the Commonwealth marine area. Benthic communities, particularly those associated with banks and shoals and KEFs, may be impacted by exposure to a subsea hydrocarbon release. Benthic communities within Zone 1 have limited environmental values and sensitivities, with 98% of the GEP route consisting of featureless, unconsolidated clay or silty sands (INPEX 2010). Whale sharks, which feed at or near the surface, could be at risk of exposure to spilled hydrocarbons and chemicals through ingestion. Potential effects include damage to the lining of the stomach and intestine, as well as effects to motility, digestion and absorption (Kirwan & Short 2003). Although a portion of Zone 1 overlaps a whale shark foraging BIA, based on the levels of whale shark abundance described in (Jenner et al. 2008; RPS 2011a), the likelihood of whale shark presence within this BIA is considered very low, with no specific seasonal pattern of migration.

	Seasonal variability with respect to the abundance of marine turtles within the turtle foraging BIA overlapping Zone 1, is poorly understood and as a basis for this assessment it has been assumed that marine turtles could be present in this BIA at any time of the year either at the surface or on the seabed. Turtles can be exposed to hydrocarbon or chemical spills as they surface, resulting in direct contact with the skin, eyes, and other membranes, as well as the inhalation of vapours or ingestion (NOAA 2010). 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). A marine avifauna BIA traverses Zone 1 with peak seabird foraging reported during April to November. Marine avifauna may be affected by the release of hydraulic fluid if a surface slick is encountered by birds resting at the water's surface and surface-plunging birds are considered particularly vulnerable to surface hydrocarbons. They may suffer from damage to external tissues, including skin and eyes, and internal tissue irritation in the lungs and stomach (Clark 1984). Impacts to seabirds that do not spend time resting on the sea surface, such as the lesser frigatebird are not expected. Subsea releases would be unlikely to result in direct impacts to marine avifauna. Other transient EPBC-Listed species, such as cetaceans may also be exposed to similar toxic effects as those described above. Given the minor volumes associated with loss of containment events, the nature and scale of exposure is expected to be limited due to the influence of physical oceanic processes, such as currents, tides and waves in Zone 1. As such, there is the potential that foraging whale sharks, turtles, marine avifauna, fish, and other transient, EPBC-listed species could be exposed to these events but only if they are present in the immediate vicinity at the time of the spill. Any potential impacts to the values and sensitivities described above are expected to be limited to individuals and not local populations because of the dispersive open-ocean environment of Zone 1. Given the minor volumes, this event has the potential to result in a local-scale event with environmental impacts that are considered to have inconsequential ecological significance; and therefore, the potential consequence is considered to be insignificant.

A12:

Source of risk or impact	Potential consequence
Minor loss of containment of GEP infrastructure.	The values and sensitivities with the potential to be exposed to a minor loss of containment event are: • commercial fisheries • KEFs • transient EPBC-listed species • plankton • benthic communities • whale shark BIA • turtle foraging BIA • marine avifauna BIA. The values and sensitivities associated with commercial fisheries (seafood quality and employment) could potentially be impacted from a minor loss of containment of the GEP, through the temporary closure of a commercial fishery. 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) meaning only limited impact on economic values could occur. Therefore, the impact to fisheries would be considered minor.

	Juvenile fish and larvae may experience increased toxicity if exposed to entrained/dissolved hydrocarbon plumes because of the sensitivity of these life stages. However, as plumes from a minor loss of containment are expected to be small in scale, only localised impacts are expected. Adult fish exposed to low entrained/dissolved hydrocarbon thresholds are likely to metabolise the hydrocarbons and excrete the derivatives, as studies show 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 and Figelli 1987). Several fish communities present in Zone 1 and Zone 2 (including those associated with KEFs and benthic communities), are demersal and are therefore more prevalent towards the seabed. There is the potential for increased environmental sensitivity within KEFs due to hard surface features supporting increased sessile benthic organism species diversity and abundance. These sessile benthic organisms may be susceptible to entrained/dissolved hydrocarbons. However, as the condensate droplets from a GEP gas release are expected to become entrained/dissolved as they rise through the water column and then disperse away from the release location, sessile organisms on the seabed are not expected to be significantly impacted. Also, the GEP route was selected to avoid, where possible, any areas of rocky outcropping, with 98% of it consisting of featureless, unconsolidated clay or silty sands (INPEX 2010). Therefore, although the GEP route traverses three KEFs (i.e. the ancient coastline 125 m depth contour, the carbonate bank and terrace system of the Sahul Shelf, and the pinnacles of the Bonaparte Gulf), the environmental values and sensitivities of these KEFs (i.e. rocky outcropping, high topographic relief or complexity, resulting in marine fauna aggregations) are poorly represented within Zone 1. Therefore, a minor loss of containment of the GEP infrastructure has the potential to result in a local-scale event with short-term and temporary impacts, which are not expected to affect local population viability or recruitment. Consequently, diverse fish assemblages, and commercial fisheries are not expected to be significantly impacted. Therefore, the consequence is 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). Given the minor volumes associated with a minor loss of containment event, localised short-term impacts could occur to plankton communities; however, no reduction in productivity of the Commonwealth marine area is expected. Therefore, the consequence to plankton is considered to be insignificant. Whale sharks have the potential for exposure to entrained/dissolved hydrocarbons, and potential effects include damage to the liver and lining of the stomach and intestine, 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 of a minor loss of containment of GEP gas within the whale shark BIA, there is the potential for individuals to be affected. However, given the reported low abundance in the Browse Basin (Jenner et al. 2008; RPS 2011a), population viability is not expected to be threatened, and therefore the consequence is considered minor. Seasonal variability with respect to the abundance of marine turtles within

	the turtle foraging BIA overlapping Zone 1, is poorly understood and as a basis for this assessment it has been assumed that marine turtles could be present in this BIA at any time of the year either at the surface or on the seabed. Within this BIA, there is the potential for increased environmental sensitivity, as turtle feeding areas are typically associated with hard surface features supporting increased sessile benthic organism species diversity and abundance. These sessile benthic organisms may be susceptible to entrained/dissolved hydrocarbons. However, the entrained/dissolved components of a minor loss of GEP gas at the seabed will rapidly rise through the water column (RPS APASA 2014) and disperse away from the release location. Therefore, no significant impacts to sessile benthic organisms of the turtle foraging BIA are expected. A marine avifauna BIA traverses Zone 1 with peak seabird foraging reported during April to November. Seabirds forage on planktonic and pelagic organisms, generally at or near the surface of the water column. While individual planktonic and pelagic organisms may be affected, the planktonic and pelagic communities are not expected to be significantly impacted from a minor loss of containment GEP gas at the seabed. As many transient EPBC-listed species, such as turtles, cetaceans and marine avifauna are air-breathing and do not have gills, they are less susceptible to impacts associated with entrained/dissolved hydrocarbons, but are more susceptible to surface slicks. Only limited surface slicks are possible from a minor loss of containment of the GEP. Therefore, any impacts to these EPBC-listed species within their associated BIAs are expected to be minor.

A13:

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: • recreational fishing (Flat Top Bank) • KEFs • benthic communities • BIAs associated with turtle foraging. Fishing charters operate along parts of the Australian mainland coast, including some regionally important areas of high diversity, such as banks and shoals within Zone 2. One such location is Flat Top Bank (close to Zone 1), identified through stakeholder engagement as a specific value for recreational fishing. The introduction of an IMP into an important habitat such as Flat Top Bank has the potential to change faunal assemblages associated with these areas resulting in decreased ecological diversity or ecosystem health. The GEP route (Zone 1) overlaps with three KEFs and one turtle foraging BIA. The environmental values and sensitivities of these KEFs and BIA include rocky outcropping and high topographic relief or complexity that may result in associated increases in diversity and marine fauna aggregations, including year round turtle foraging. The GEP route has been selected to avoid as much as possible, any areas of rocky outcropping, with 98% of the GEP route consisting of featureless, unconsolidated clay or silty sands – an environment that is common and well represented in the region (INPEX 2010). Therefore, these values and sensitivities are generally absent from Zone 1. The benthic habitats within Zone 1 are also, therefore, generally not considered to provide appropriate habitat for the establishment of IMPs. 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.

A14:

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 shark foraging BIA • turtle foraging BIA. 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 offshore, away from humpback BIA areas (migration and calving). The reaction of whales to approaching ships is reported to be quite variable. Dolman and Williams-Grey (2006) indicate that some species, such as humpback whales, can detect and change course to avoid a vessel. Humpback whales are subject to a 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. Another marine mammal with a BIA in the region (approximately 100 km to the west of Zone 1) is the blue whale, which is subject to a 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 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. 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) intersects Zone 1 however, based on the reported levels of abundance (Jenner et al. 2008; RPS 2011a) the likelihood of whale shark presence within this BIA is considered very low, with no specific seasonal pattern of migration. However whale sharks are also subject to a Conservation Advice which notes that the threat to the recovery of the species includes strikes from vessels. 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). Although a turtle foraging area is within Zone 1, large aggregations of turtles are not expected, however foraging turtles may be present at low levels throughout the year. 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. Therefore, 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 marine mammal, whale shark or turtle, it would not be expected to have a significant effect at the population level and is considered to be of minor consequence.

A15:

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 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 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 WA, NT and Commonwealth-managed fisheries overlap Zone 1 and Zone 2 and have the potential to operate within Zone 1. The GEP is marked on the Australian Hydrographic Service (AHS) navigation charts. There is no limitation or exclusion zone around the GEP that precludes fishing activities along the GEP route. Based on the relatively low levels of identified fishing activity associated with commercial fishing and the very small spatial area occupied by 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 and NT coast during certain times of the year, with the closest location to Zone 1 being Flat Top Bank in the east, and Scott Reef in the west (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 consequence associated with economic losses in the recreational fishing industry as a result of vessel presence is considered to be insignificant.

A16:

Source of risk or impact	Potential consequence
Seabed intervention activities and anchoring	The particular values and sensitivities identified as having the potential to be impacted by these activities are: • Zone 1 KEFs • benthic communities • turtle foraging BIA. 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. 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. Anchoring is not a planned aspect of IMR activities; however, it may be required in the event of a vessel emergency. Anchoring (including anchor chain scour) would result in physical disturbance of the seabed. The majority of the GEP route (>98%) is comprised of featureless, unconsolidated clay, silts and sands, with the most dominant seabed features confirmed as pockmarks and sand waves. The entire GEP route traverses three KEFs (the ancient coastline 125 m depth contour, the carbonate bank and terrace system of the Sahul Shelf, and the pinnacles of the Bonaparte Gulf), and a turtle foraging BIA. The environmental values and sensitivities of the KEFs/BIA i.e. rocky outcropping, high topographic relief or complexity, resulting in increased benthic diversity and marine fauna aggregations, represent a small proportion of the total GEP route (Zone 1). It should be noted that the GEP route is an existing disturbed site, as GEP construction activities have already occurred in Zone 1, including anchor deployments from the SEMAC-1 pipelay barge in the shallower sections of the GEP route during 2014/2015. Therefore, a single anchor deployment and recovery (in an emergency situation only) anywhere within Zone 1 would not result in a disturbance that would affect regionally significant ecological diversity or the productivity of benthic communities or KEFs. There is a potential for impacts to benthic communities from seabed intervention activities in areas of rocky outcropping with higher densities of epibenthic fauna. Such impacts may include damage from the direct placement of physical structures such as grout bags, concrete mattresses, or mud-mats if the use of the PRS is required. Physical disturbance of benthic communities may occur if these activities were undertaken in areas of increased benthic diversity such as KEFs/BIAs. Aside from the loss of physical habitat albeit limited in relation to the entire GEP route (disturbance ranging from <1 m^2 up to approximately 50 m^2), no further

	impacts to benthic communities are anticipated particularly in relation to the broader KEFs/BIAs where large areas of similar habitat exists. In general, the seasonally naturally high turbidity (resulting from mobile sediments and strong currents) of near seabed waters along the GEP route (INPEX 2010) indicates that the benthic communities are accustomed to pulses of increased suspended sediment in the water column. Rapid dispersion of any suspended sediment plumes generated through seabed intervention activities is expected to occur naturally due to high seabed currents. Therefore, seabed intervention-generated suspended sediments are anticipated to dilute to near background levels by the outer edge of Zone 1 and not result in any overall reduction in productivity of benthic communities within Zone 1. The closest submerged banks and shoals/benthic primary producer habitat (BPPH) to the GEP route are in Zone 1 and are Flat Top Bank and Echuca Shoal located 3 km and 9 km away respectively, based on these distances they are not expected to be impacted. Overall, localised and infrequent increases in turbidity or rates of sedimentation resulting from seabed intervention activities are unlikely to affect the local benthic environment significantly, as species present in, or adjoining, unconsolidated sediments in high-current environments are well adapted to high rates of mortality and natural disturbance (Diesing et al 2013) such as increased turbidity and sedimentation. Seasonal variability with respect to the abundance of marine turtles within the turtle foraging BIA overlapping Zone 1, is poorly understood and as a basis for this assessment it has been assumed that marine turtles could be present in this BIA at any time of the year. The presence of marine turtles foraging in Zone 1 is not likely to be affected by seabed intervention activities. The placement of structures will be a slow and controlled process, to avoid damage to GEP infrastructure, with ROVs monitoring the controlled touch-down of such structures. During such operations, marine turtles would be alert to the presence of the structures and equipment through underwater lights and sounds generated. Mass-flow-excavation and jetting are techniques which eliminate the risk of entrainment of turtles, a risk commonly associated with trailing-suction-hopper-dredging and therefore, no direct impacts to turtles within the foraging BIA are expected. In addition, any permanent or temporary loss of habitat associated with seabed intervention activities would not affect the food availability for marine turtles, given the vastly larger areas of similar habitats which exist adjacent to the GEP route. Any impacts to soft sediment benthic communities are expected to be temporary with rapid rates of recovery due to the resilience of the benthic communities from natural disturbances associated with hydrodynamic process at or near the seabed. In contrast, in the small areas of hard substrate, impacts from direct placement of physical structures may result in the permanent loss of benthic habitat potentially within KEFs/BIA. This loss would be limited to the footprint of the physical structures however recolonisation is expected to occur by adjacent epifauna relatively rapidly given the presence of alternative hard substrate. In a regional context, any losses are expected to be of inconsequential ecological significance given the vastly larger areas of similar habitats which exist adjacent to the GEP route. In the event that seabed intervention is required, potential impacts are expected to be highly localised and the potential consequence associated with seabed disturbance from seabed intervention activities/emergency anchoring has been evaluated as insignificant.

A17:

Source of risk or impact	Potential consequence
Vessel collision	Oil spill modelling overview:

<table>
<tr>
<td>resulting in a Group II (250 m^3 MGO) or Group IV (100 m^3 HFO) spill.

Emergency condition</td>
<td>It is not practicable to evaluate every potential spill location along the entire GEP route due to its length. Therefore, the release locations to model potential scenarios were identified based on locations that would have the greatest potential consequence to the receiving marine environment, where values and sensitivities would be most at risk if a spill event occurred and would enable the full extent of potential environmental impacts to be assessed. Based on these considerations, five locations were identified and modelled to provide an indication of the EMBA from a vessel-based hydrocarbon spill. These locations are:

a. adjacent to a section of the GEP route closest to Browse Island
b. adjacent to a section of the GEP route that traverses closest to the Kimberley CMR
c. adjacent to a section of the GEP route that traverses the Oceanic Shoals CMR
d. adjacent to a section of the GEP route closest to Flat Top Bank
e. adjacent to a section of the GEP route closest on the three-nautical-mile Northern Territory waters boundary.

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 (largest single fuel tank). Both MGO (250 m^3) and HFO (100 m^3) vessel collision spill scenarios were modelled based on a instantaneous release at the sea surface with stochastic modelling running for 21 days at five locations along the GEP route. 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.</td>
</tr>
<tr>
<td></td>
<td>Surface hydrocarbons</td>
</tr>
<tr>
<td></td>
<td>The values and sensitivities with the potential to be affected by surface (floating) hydrocarbon exposures are:
• commercial, traditional and recreational fisheries
• emergent benthic primary producer habitat (intertidal corals, mangroves, macroalgae and seagrass, including those associated with the Ashmore Reef Ramsar wetland)
• transient, EPBC-listed species
• marine mammal BIAs
• turtle BIAs
• marine avifauna BIAs
• plankton.
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 and/or following a response would 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 Darwin (including Flat Top Bank), as well as other readily accessible coastal settlements which are generally at the edge of, or outside Zone 2, and are 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). Indonesian traditional fishing, particularly at Browse Island could be affected by impacts to fish and benthic habitats (discussed below and in the following subsections). Therefore, the socioeconomic</td>
</tr>
</table>

	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 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. This can have 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 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. 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 Group II spill. Impacts are expected to be on a local scale, with short-to-medium term effects; 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 a 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). Given the range of turtle BIAs (nesting/breeding/foraging) there is a potential for turtles to be present in Zone 1 and 2 throughout the year, peak nesting occurs on the NT coastline and Kimberley coast between March and October. 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. Peak seabird foraging in Zone 1 occurs during April to November. 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 whereas impacts to seabirds that do not spend time resting on the sea surface, such as the lesser frigatebird are not expected. If exposed, 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 EPBC-listed species, such as marine mammals, turtles and seabirds) and emergent benthic habitats, such as coral reefs and mangroves. The potential consequence associated with surface expression of hydrocarbons from the identified spill events is considered to be significant.
	Entrained/dissolved hydrocarbons
	Values and sensitivities with the potential to be exposed to entrained/ dissolved hydrocarbons are: • commercial, traditional and recreational fisheries • BPPH (corals, seagrass, macroalgae and mangroves) • fish communities (KEFs shallower than –30 m LAT) • turtle foraging BIA • whale shark foraging BIA • benthic communities (submerged coral reefs, filter-feeding communities shallower than –30 m LAT). • plankton. 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. Flat Top Bank, a recreational fishing site may, however, be affected. 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 (shallower than –30 m LAT), including benthic primary producers, such as coral reefs, seagrass and mangroves, and filter-feeding communities, would be exposed to entrained/dissolved hydrocarbons from an MGO spill. 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 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 and 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). 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). A single spill and entrained plume could potentially affect a bank or shoal, such as Echuca Shoal or Browse Island submerged coral reefs, resulting in a local-to-medium scale event with short-to-medium term impacts, before the reef could recover. Therefore, the potential consequence for impacts to coral reefs is considered moderate. Several filter-feeding communities are close to, or within Zone 1, such as the 125 m ancient coastline KEF, the pinnacles of the Bonaparte Basin KEF, Echuca Shoal, Heyward Shoal, Oceanic Shoals CMR. However, due to the shallow depth of entrainment of an MGO surface spill, impacts to deeper seabed features will not occur. Therefore, only the shallow benthic communities, such as shallow banks, shoals and islands closer to the GEP route, such as Browse Island, Echuca Shoal, Heyward Shoal, Van Cloon Shoals and Flat Top Bank would be impacted through exposure to entrained/dissolved hydrocarbons from a surface MGO spill. More significant coral reef structures, such as Scott Reef, Ashmore Reef and Cartier Island are less likely to be significantly impacted due to their distance from the release location and lower concentrations of entrained/dissolved hydrocarbon exposure (RPS APASA 2015a). Exposure of filter-feeding communities from a surface MGO spill is expected to result in a local-to-medium scale event, with short-to-medium term impacts, and therefore the potential consequence is considered to be moderate. 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 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. Based on the above impact assessment, the consequence is considered to be minor. Mangrove communities within Zone 2, present along the Kimberley and NT coastlines, are also susceptible to entrained oil exposure, with potential impacts including defoliation and mortality. Therefore, potential impacts are considered to be minor. 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 & Figelli 1987). Several fish communities present in Zone 1 and Zone 2 are demersal and, therefore, more prevalent at the seabed. As an entrained/dissolved plume from a surface MGO spill will become entrained/dissolved in the top 30 m of the water column, deeper demersal fish communities, such as those associated with KEFs (i.e. the 25 m ancient coastline, the pinnacles of the Joseph Bonaparte Gulf, and the carbonate bank and terrace system of the Sahul Shelf), will not be exposed to entrained hydrocarbons from a surface MGO spill. Therefore, impacts to demersal fish would be expected to occur only at shallower benthic habitats closer to the GEP route, such as Flat Top Bank, Browse Island, Echuca Shoal and Van Cloon Shoal. Based on the above the potential consequence of an MGO entrained hydrocarbon plume on fish and sharks is considered minor. Whale sharks (including those in the whale shark BIA) have the potential for exposure to entrained and dissolved hydrocarbons. Potential effects include damage to the liver and lining of the stomach and intestine, 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 MGO surface spill occurred during whale shark foraging activities, there is the potential for a proportion of the local population to be affected; however, given the reported low abundance in the Browse Basin (Jenner et al. 2008; RPS 2011a) and the distance to the closest whale shark aggregation (1,000 km to the Ningaloo Reef aggregation), the overall population viability is not expected to be threatened. Therefore, the consequence is considered to be minor. Marine mammals, reptiles and avifauna could also be impacted through entrained hydrocarbons, primarily through ingestion, including through foraging activities (AMSA 2015a). Therefore, due to the potential for medium-scale contamination of food sources, the impact to marine megafauna, including EPBC-listed species, is considered to be moderate. 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. 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. In summary, the potential extent of entrained/dissolved hydrocarbon with a concentration >500 ppb may result in local-to-medium scale exposure to marine fauna (including EPBC-listed species, such as marine mammals, turtles and seabirds) and shallow benthic habitats, such as coral reefs, seagrass, mangroves and shallow filter-feeding communities. There would likely also be cumulative impacts through bioaccumulation up the food chain. Fish and fishing activities would also be affected. On this basis, the potential consequence associated with entrained/dissolved plumes from the identified spill events is considered to be moderate.
	Shoreline hydrocarbons
	Intertidal habitats and marine fauna known to use shorelines are most at risk from these exposures as these concentrations have the potential to smother intertidal habitats (such as emergent coral reefs) and coat marine fauna. Consequently, the particular values and sensitivities with the potential to be exposed to shoreline hydrocarbons are: • BPPH (intertidal habitats, including coral reefs and mangroves) • turtle BIAs • marine avifauna BIAs. Intertidal BPPH communities exposed at spring low tides, such as the coral reef platforms of Browse Island and Vernon Islands, 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 varying degrees of tissue decomposition and death. 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). 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. Peak nesting time on the NT coastline and Kimberley coast occurs between March and October for olive ridley and flatback turtles; and for Green turtles at Browse Island, Cartier Island, Scott Reef and NT coastline nesting occurs between December and April, with a peak in March. 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 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 turtles with the potential to be exposed to shoreline accumulation, there is the potential to impact on nesting populations, which has the potential to affect species recruitment at a local population level. The oil spill model predicted the fastest time for shoreline

	contact to occur at Browse Island. For this to occur, high wind speeds would be required, resulting in significant emulsification of the Group IV oil, leaving a persistent layer of oil on the shoreline. Overall, it is considered that there is the potential for a local-to-medium-scale event with short-to-medium-term effects and no threat to overall turtle population viability. 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, as birds attempt to preen their feathers (Jenssen 1994). Shorebirds foraging and feeding in intertidal zones are at potential risk of exposure to shoreline hydrocarbons, potentially causing acute affects to numerous marine avifauna BIAs. While numerous birds may be exposed, based on the small volumes predicted to accumulate on shorelines, impacts to bird population viability are not predicted. It is also possible that birds exposed to MGO from a surface (floating) slick may be displaced (i.e. fly away) and use nearby shorelines to recover, thereby, potentially increasing their exposure to shoreline 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 a spill of this magnitude would threaten overall population viability for any protected species. Therefore, the potential consequence associated with shoreline hydrocarbon exposure is considered to be moderate.

A18:

Source of risk or impact	Potential consequence
Major loss of containment of GEP infrastructure (GEP rupture). Emergency condition.	Oil spill modelling overview: the worst-credible spill event associated with a GEP rupture would eventuate from a rupture in the deepest water depth (approximately 250 m). However, a rupture could occur at any location along the GEP route. Therefore, modelling (RPS APASA 2014) was conducted at 200 locations along the GEP route, in water depths ranging from 70 m to 235 m. It should be noted that at shallower locations, higher proportions of the GEP gas release will rapidly enter the atmosphere and not become entrained. Therefore, the EMBA towards the onshore end (i.e. shallower water) of the GEP route is considered highly conservative.
	Entrained/dissolved hydrocarbons
	A major loss of containment/rupture of the GEP infrastructure has the potential to result in changes to water quality, predominantly through entrained and dissolved hydrocarbon exposure. The particular values and sensitivities with the potential to be exposed to entrained and dissolved hydrocarbons from a major loss of containment of the GEP infrastructure includes: • commercial, recreational and traditional fisheries • BPPH (corals, seagrass, macroalgae and mangroves) • KEFs • Ramsar wetland (Ashmore reef) • transient, EPBC-listed species • plankton • benthic habitats • marine mammal BIAs • whale shark BIA

	• turtle foraging BIAs • marine avifauna BIAs. RPS APASA (2014) modelling predicts that during a GEP rupture, droplets of condensate will be lifted vertically by a plume of sea water and expanding gas. Under all GEP rupture scenarios, limited deepwater entrainment is likely to occur because the majority of gas and associated condensate droplets are expected to rise to the surface, where the condensate droplets will evaporate, or become entrained in the top of the water column, leaving a limited surface slick. 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, Wyndham and Darwin, 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. Flat Top Bank, a recreational fishing site may, however, be affected. 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, could be exposed to entrained/dissolved hydrocarbons in the event of a GEP rupture. 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). 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). Browse Island and Echuca Shoal, the closest coral reef / BPPH receptors to Zone 1, were predicted to receive worst-case concentrations of entrained/dissolved hydrocarbons, and several other coral reef / BPPH receptors were predicted to receive above the 100 ppb threshold. Several filter-feeding communities are close to, or within Zone 1 (e.g. the 125 m ancient coastline KEF, the pinnacles of the Joseph Bonaparte Gulf KEF, Echuca Shoal, Heyward Shoal, and the Oceanic Shoals CMR). However, due to the buoyant nature of the plume, impacts to deeper seabed features will potentially be less severe than impacts to shallow benthic primary producer habitats. Therefore, benthic communities, particularly shallow banks, shoals and islands closer to the GEP route, such as Browse Island,

	Echuca Shoal, Heyward Shoal, the Van Cloon Shoals and Flat Top Bank may be significantly impacted through exposure to entrained/dissolved hydrocarbons from a GEP rupture. More significant coral reef structures, such as Scott Reef, Ashmore Reef and Cartier Island are less likely to be significantly impacted due to their distance from the release location and lower concentrations of entrained/dissolved hydrocarbon exposure (RPS APASA 2014). However, as a single rupture scenario could impact several receptors, including deeper filter-feeding communities and shallower benthic primary producer habitats, resulting in a medium-to-large scale event, with medium-term impacts, the potential consequence 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 molecules allows them to concentrate in membranes of aquatic plants 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 so the associated received concentrations will be lower; however, still potentially above the threshold 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 and NT coastlines, are also susceptible to entrained oil exposure, with potential impacts including defoliation and mortality. Therefore, potential impacts are considered to be minor. Due to the potential for entrained/dissolved hydrocarbons to be present at all depths of the water column from a GEP rupture, 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 ancient coastline KEF), and site-attached fish on coral reefs, such as those at 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 & Figelli 1987). Several fish communities present in Zone 1 and Zone 2 are demersal and, therefore, more prevalent at the seabed. As the majority of condensate will become entrained/dissolved near the surface, deeper demersal fish communities, such as those associated with KEFs (i.e. the 125 m ancient coastline, the pinnacles of the Joseph Bonaparte Gulf and the carbonate bank and terrace system of the Sahul Shelf), are less likely to be affected. Therefore, the more significant, medium-term impacts to demersal fish

	would be expected to occur at shallower benthic habitats closer to the GEP route, such as Flat Top Bank, Browse Island, Echuca Shoal and Van Cloon Shoal. Pelagic fish may be at risk if transiting the entrained/dissolved hydrocarbon plume and they may also ingest smaller/juvenile fish affected by the entrained/dissolved plume. Although pelagic fish typically swim at depth (Burns et al. 2011), given the potential for deeper trapping depths of the entrained/dissolved plume during later duration of the release (especially for deeper water releases), there is the potential for acute impacts. However, due to their mobile nature, they may avoid the entrained plume. Based on the above risk assessment, the potential consequence of an entrained hydrocarbon plume on fish and sharks is considered moderate. Whale sharks (including those in the whale shark BIA) have the potential for exposure to entrained/dissolved hydrocarbons. Potential effects include damage to the liver and lining of the stomach and intestine, 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 GEP rupture occurred during whale shark foraging activities, there is the potential for a proportion of the local population to be affected; given the reported low abundance in the Browse Basin (Jenner et al. 2008; RPS 2011a) and the distance to the closest whale shark aggregation (1,000 km to the Ningaloo Reef aggregation), the overall population viability is not expected to be threatened. Therefore, the consequence is considered to be minor. All air-breathing mammals, reptiles and birds (including EPBC-listed species) would likely be affected through the inhalation of hydrocarbon vapours from the gas cloud associated with a GEP rupture (RPS Group 2015). One turtle foraging BIA and one marina avifauna foraging BIA which traverse Zone 1 are exposed to this risk. Impacts, however, would likely be limited to individuals or small groups of a local population, and not affect regional population viability. The lack of any significant surface slick and the very light (non-sticky) nature of the GEP gas hydrocarbons will significantly limit surface slick-associated impacts for air-breathing EPBC-listed species. Marine mammals, reptiles and avifauna could also be impacted through entrained hydrocarbons, primarily through ingestion, including through foraging activities (AMSA 2015a). Therefore, due to the potential for medium-scale contamination of food sources, the impact to marine megafauna including EPBC-listed species is considered to be moderate. 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. In summary, the potential extent of entrained/dissolved hydrocarbon with a

	concentration >100 ppb may result in widespread exposure to marine fauna (including EPBC-listed species, such as marine mammals, turtles and seabirds); benthic habitats, such as coral reefs, seagrass and mangroves; and deeper filter-feeding communities, such as the continental slope demersal fish community KEF, the 125 m ancient coastline KEF and the Oceanic Shoals CMR. There would likely also be cumulative impacts through bioaccumulation up the food chain. Fish and fishing activities would also be affected. On this basis, the potential consequence associated with entrained/dissolved plumes from the identified spill events is considered to be significant.

A19:

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, and higher currents around nearshore waters of the WA and NT coastlines, any temporary changes to water quality that may occur are expected to be short-term and localised, and are therefore considered to be insignificant.

A20:

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: • commercial, recreational and traditional fisheries • benthic communities (including BPPH and shallow submerged reefs and shoals) • transient, EPBC-listed species (marine fauna) • plankton • BIAs associated with turtle and marine avifauna nesting. Dispersant applications can reduce the amount of hydrocarbon present on the surface of the water column; thereby, 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. As dispersant results in increased concentrations of hydrocarbons entrained in the top layers of the water column, plankton, pelagic fish and sharks (including whale sharks) may be exposed to increased hydrocarbon concentrations. Therefore, associated shallow-water commercial, recreational and traditional fisheries may be impacted. In the context of dispersant use, individuals or small groups of animals may be affected; however, overall population viability of EPBC-listed species is not expected to be threatened through dispersant use. 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 and potentially impacting subtidal values and sensitivities, particularly in shallow-water environments. Monitoring undertaken after the Montara spill confirmed entrained/dispersed 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 (2014a) 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 report remodelled the identified worst-case stochastic model runs, with various dispersant treatments (vessel-based, 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 to, 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 (2014a), 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. The closest submerged shoals to Zone 1 are Echuca Shoals, Van Cloon Shoals and Flat Top Bank. They have depths shallower than –30 m LAT and therefore can be exposed to dispersed hydrocarbons. Browse Island has submerged and intertidal habitat (with corals 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.

A21:

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 with a minor consequence. Protect and deflect/contain and recover response activities would generate a significant quantity of hydrocarbon-contaminated solid and liquid waste. Contaminated solids would include personal protective equipment (PPE), oil-coated booms and skimmers etc., and the oil-contaminated liquids and sediments collected during the response activity. Contaminated liquids would include oil-contaminated seawater. Inappropriate management of oil-contaminated waste could result in localised contamination of the marine environment and shoreline sediments, resulting in harm to individuals of protected species with a minor consequence.

A22:

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). A wildlife response strategy 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 increased stress to wildlife individuals subjected to 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.

A23:

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 and is therefore insignificant.

A24:

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.

A25:

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