NEPTUNE ENERGY

Petrel-3, Petrel-4 and Tern-2 Suspended Wells: Environment Plan Summary

Document Number: GSZB-00001-PLA-HSE-006

SECURITY LEVEL

Classification	Definition	Check
Unclassified	Information which may be made public without consequences for the entity or the Neptune Energy Group.	☒
Internal	Information intended to remain within the Neptune Energy Group. Permission from a direct manager is required to disclose it outside the Group.	☐
Restricted	Information which, if disclosed outside the appropriate perimeter, may have a serious impact on the entity or Group. Access should be limited to specific individuals or groups.	☐
Confidential	Information which, if disclosed to people other than those specifically designated to receive it, would have a major impact on the entity or Group, in such cases, very strict rules apply to the information chain.	☐

DOCUMENT HISTORY

Rev	Record of Changes Made Since Previous Revision
0	Issued for use

TABLE OF CONTENTS

FIGURES

TABLES

ABBREVIATIONS AND ACRONYMS

ADIOS	Automated Data Inquiry for Oil Spills
AHS	Australasian Hydrographic Society
AIIMS	Australasian Inter-service Incident Management System
ALARP	As low as reasonably practicable
AMOSC	Australian Marine Oil Spill Centre
AMSA	Australian Maritime Safety Authority
BIA	Biologically Important Areas
BRUV	Baited Remote Underwater Video
CE	Critically Endangered (under the EPBC Act)
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAWR	Department of Aquiculture, Water and Resources
DEE	Department of Environment and Energy
DIIS	Department of Industry, Innovation and Science
DO	Dissolved Oxygen
DoE	Department of Environment
DSEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities
E	Endangered (under the EPBC Act)
EMBA	Environment that May Be Affected
EMS	Emergency Management System
EP	Environmental Plan
EPBC	Environment Protection and Biodiversity Conservation
ERM	Environmental Resource Management
ERC	Emergency Response Coordinator
ERO	Emergency Response Organisation
ESD	Ecologically Sustainable Development
f	Foraging BIA (under the EPBC Act)
GHG	Global greenhouse gas
GVI	General video inspections
HB	Handbook
HSE	Health, Safety and Environment
IAP	Incident Action Plan
IAPP	International Air Pollution Prevention
ICS	Incident Command System
IEE	International energy efficiency
IMCRA	Integrated Marine and Costal Regionalisation of Australia

IMO	International Maritime Organisation
IMP	Invasive Marine Pests
IMT	Incident Management Team
ISO	International Organisation for Standardisation
ISPP	International Sewage Pollution Prevention Certificates
JRCC	Joint Rescue Coordination Centre
KEF	Key Ecological Features
KO	Species of species habitat known to occur within the area (under the EPBC Act)
LO	Species or species habitat likely to occur within area
LOC	Loss of Control
LOR	Limit of reporting
M	Marine (under the EPBC Act)
MARPOL	International Convention for the Prevention of Pollution from Ships
MARS	Maritime Arrivals Reporting System
MDO	Marine Diesel Oil
MES	Monitoring, Evaluation and Surveillance
MO	Marine Orders
MO	Species of species habitat may occur within area (under the EPBC Act)
MOC	Management of Change
MEPC	Marine Environmental Protection Committee
MSL	Mean Sea Level
NEBA	Net Environmental Benefit Analysis
NEPM	National Centre for Environmental Prediction
NMFS	National Marine Fisheries Service
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NT	Northern Territory
OGUK	Oil and Gas UK
OPEP	Oil Pollution Emergency Plan
OPGGS	Offshore Petroleum and Greenhouse Gas Storage
OPGGS(E)R	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations
OSMP	Operational and Scientific Monitoring Plan
OSPAR	Oil Spill Prevention, Administration and Response Fund
OWR	Oiled Wildlife Response
PMS	Planned Maintenance System
PNEC	Predicted no effect concentration
PPE	Personal protective equipment

PSZ	Petroleum Safety Zone
PTS	Permanent Threshold Shift
ROV	Remotely Operated Vehicle
SEEMP	Ship Energy Efficiency Management Plan
SOPEP	Ship Oil Pollution Emergency Plan
SPL	Sound Pressure Level
STP	Sewage treatment plant
TOC	Total organic carbon
TSS	Total suspended solids
TSSC	Threatened Species Scientific Committee
UK	United Kingdom
V	Vulnerable (under the EPBC Act)
W	Wetland (under the EPBC Act)
WA	Western Australia
WOMP	Well Operations Management Plans
WOR	Well Operations Requirements

UNITS

dB	Decibel
km	Kilometres
m	Metres
m^2	Metres squared
nm	Nautical mile

1 Introduction

1.1 Activity Overview and Location

Neptune Energy Bonaparte Pty Ltd (Neptune Energy) is the operator of the Petrel and Tern gas fields in the Bonaparte Basin in North Western Australia. These fields are located in permits NT/RL-1 and WA-6-R (Petrel) and WA-27-R (Tern) (Figure 1-1).

This Environment Plan (EP) applies to a defined 'petroleum activity', as defined in the OPGGS(E). For this EP, the planned petroleum activity is defined as:

Any other petroleum-related operations or works carried out under an instrument, authority or consent granted or issued under the OPGGS Act. Specifically, the activities covered under this plan include the ongoing suspension period of the wells and periodic surveillance of the seabed equipment on these wells via a non-intrusive visual inspection using a remotely operated vehicle (ROV). The petroleum activity is limited to the wellhead and a 500 m buffer around the wellhead known from here-on-in as the operational area.

This EP includes the suspension phase and seabed equipment monitoring at the Petrel-3, Petrel-4 and Tern-2 wells undertaken by Neptune Energy under retention leases NT/RL-1 & WA-6-R and WA-27-R. The requirements for equipment surveillance surveys are in accordance with the corresponding Well Operations Management Plans (WOMP).

Activities excluded from the scope of this EP are:

- Development of the wells
- Plug and abandonment of the wells
- Vessels transiting to or from the operational area. These vessels are deemed to be operating under the Commonwealth *Navigation Act 2012* and not performing a petroleum activity.

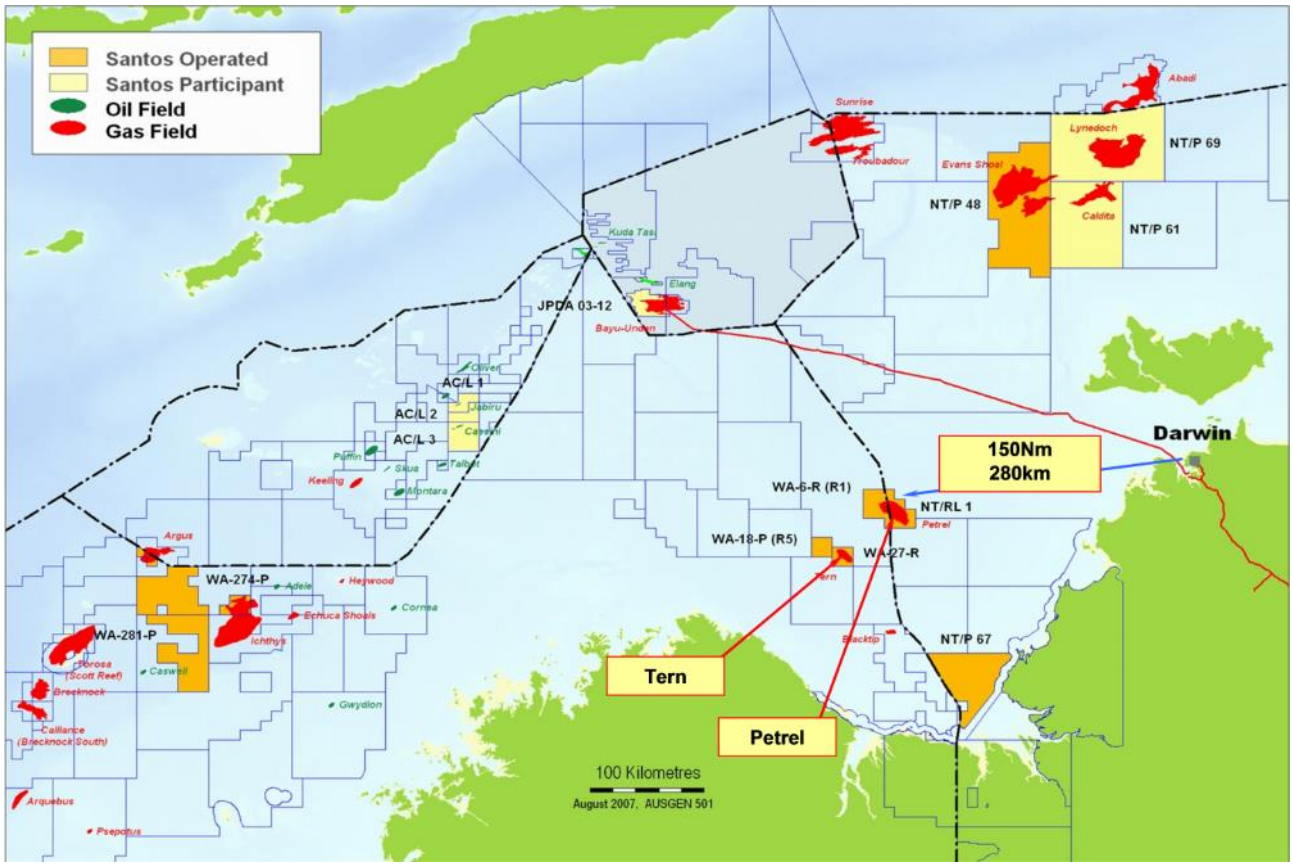


Figure 1-1 Petrel and Tern Field Locality Map

1.2 Titleholder Liaison

The nominated Neptune Energy Bonaparte liaison person for this activity is:

Janet Hann, General Manager

Level 2, 5 Mill Street

Perth. Western Australia 6000

Phone: (08) 6160 8400

Fax: (08) 6160 8401

Email: janet.hann@neptuneenergy.com

2 Description of the Activity

Within NT/RL-1 and WA-27-R permits, three wells (Petrel-3, Petrel-4 and Tern-2) have been identified as suspended since the 1980's, with wellheads remaining in-situ. The wells have been suspended to international standards and the reservoir pressure is sub-hydrostatic, meaning that the wells will not flow in their current condition.

To ensure that the condition of the seabed equipment on the wells remains unchanged during this suspended phase, general video inspections (GVI) will be undertaken as part of the Well Operations Management Plan (WOMP). These inspections will be performed within the five-year WOMP "in force" period using suitable ROV deployed from contracted vessels.

The seabed equipment surveillance is anticipated to take approximately 48 hours to complete, with active ROV operations expected to take approximately 4 hours at each well site. The survey is notionally proposed to take place on or before the end of 2020 (i.e. within the in-force period of the WOMP). Since the actual timing of the survey is dependent on a number of factors including vessel availability and weather conditions, this EP has accounted for activities potentially occurring in any season.

The monitoring is required to check the condition of seabed equipment left on the wells. The monitoring will be undertaken using ROV's deployed from a small utility vessel.

There will be no operational discharges (such as chemicals, inhibited seawater, control fluid) associated with planned activities.

All work will be undertaken during daylight hours.

No new well activities are planned in either of these permit areas, and no work on the existing wells (Petrel-3, Petrel-4 and Tern-2) is planned.

2.1 Suspended Well Information and Location

The Petrel and Tern fields lie approximately 300 km WSW of Darwin, about 200 km offshore. Table 2-1, Table 2-2 and Table 2-3 outline the locations for the suspended wells for Petrel-3, Petrel-4 and Tern-2, respectively.

Table 2-1 Petrel-3 Well Information

Well Name	Petrel-3
Permit	NT/RL-1
Water Depth	95 m (MSL)
Geographic Surface Location	Datum: GDA94
	Lat: 12º 56' 2.071" S
	Long: 128º 34' 14.671" E
	Projection: MGA 94 UTM Zone 52
	Easting: 453,438 m E
	Northing: 8,570,134 m N
Well Status	Suspended gas producer

Table 2-2 Petrel-4 Well Information

Well Name	Petrel-4
Permit	NT/RL-1
Water Depth	95 m (MSL)
Geographic Surface Location	Datum: GDA94
	Lat: 12º 53’ 13.194” S
	Long: 128º 29’ 45.557” E
	Projection: MGA 94 UTM Zone 52
	Easting: 445,319 m E
	Northing: 8,575,307 m N
Well Status	Suspended gas producer

Table 2-3 Tern-2 Well Information

Well Name	Tern-2
Permit	WA-27-R
Water Depth	83 m (MSL)
Geographic Surface Location	Datum: GDA94
	Lat: 13º 16’ 42.97” S
	Long: 128º 07’ 58.04” E
	Projection: MGA 94 UTM Zone 52
	Easting: 406,193.5 m E
	Northing: 8,532,017 m N
Well Status	Suspended gas producer

2.2 Planned Seabed Equipment Surveillance Survey

2.2.1 Vessel Operations

The activity is to be undertaken using a contracted small utility vessel. The small utility vessel will be primarily used to transport equipment and personnel to the operational area. The small utility vessel will also be used as a platform on which to undertake subsea activities including ROV operations. Small utility vessels are not likely to anchor on location during the activity but will use dynamic positioning or similar station keeping systems to maintain their position while undertaking the activities.

It is anticipated that for the planned activities, vessel operations will take place over a duration of a few days, and have been notionally scheduled to occur once during the period that the corresponding WOMPs and this EP are in force. All vessels are likely to mobilise out of Darwin Harbour in the NT. In most instances, only one vessel will be mobilised to undertake the activity.

Vessels will be fuelled by marine diesel fuel, however there is no planned vessel refuelling to take place in the operational area. All vessel fuelling is proposed to take place within the nearest suitable harbour (likely Darwin).

At this time, the small utility vessels that will be used to undertake the activity have not been identified, however they are typically less than 30 m in length and support a crew of 15 persons.

2.2.2 ROV Operations

Remotely operated (underwater) vehicle (ROV) operations are proposed to support the seabed equipment surveillance survey.

Fisheye ROV Surveys, or inspection ROV surveys, are proposed to be undertaken to provide a means to visually monitor to confirm no changes in the condition of the seabed equipment left in place when the well was suspended. For these surveys, the ROV will likely be deployed and operated from a small utility vessel.

The planned seabed equipment surveillance survey will not comprise sidescan sonar or any other geophysical survey methods that generates underwater sound.

3 Description of the Environment

3.1 Environment that may be Affected

Neptune Energy have defined the Environment that May be Affected (EMBA) based on modelling for the maximum credible hydrocarbon spill event that might occur during the petroleum activities. For the activities under this EP, the EMBA is therefore based on the accidental release of marine diesel oil (MDO) from a vessel collision.

The stochastic spill modelling was used to identify four areas based on the type of exposure predicted to occur: one screening (i.e. below impact thresholds) and three impact (i.e. social and/or ecological effects may occur) thresholds.

The environmental screening threshold represents an area that may be exposed to the presence of hydrocarbons, but at concentrations below effect thresholds. That is, hydrocarbons may be present in the water, and therefore a potential change from background water quality may occur, however the hydrocarbons are not predicted to be present at a concentration such that risks to ecological or social receptors is expected to occur. This area of exposure is predicted to occur up to 68 km away from the spill location, depending on the season (RPS, 2018). This screening category is not used further in the risk assessment process.

The social impact threshold represents areas that may have a visible sheen of hydrocarbon present, but the hydrocarbon concentration is below levels predicted to cause an impact to ecological receptors. The ecological impact thresholds are based on a time-based dosage, i.e. the hydrocarbon needs to be present in the water column above a minimum concentration over a period of time. The area of exposure to thresholds relevant for social impact is predicted to occur up to 68 km away from the spill location; up to 32.5 km away for sublethal ecological impacts; and up to 7 km away for lethal ecological impacts.

3.2 Physical Environment

The Petrel and Tern fields lie approximately 300 km west-southwest of Darwin, and approximately 110 km offshore, in 80–100 m water depth. The Petrel and Tern fields occur within the Northwest Shelf Transition IMCRA provincial bioregion, and the Bonaparte Gulf meso-scale bioregion.

3.2.1 Bathymetry and Seabed Morphology

The majority of the Northwest Shelf Transition is located on the continental shelf, with only a small area extending onto the continental slope. The Petrel and Tern fields are located on one of the prominent geomorphic features of the bioregion, the Sahul Shelf (Baker *et al.* 2008).

The seabed within the Petrel and Tern fields is generally smooth and flat, sloping down to the north-west with gradient less than 1:2,000 (0.03°). The seabed is punctuated by numerous isolated pockmarks up to 25 m in diameter and 0.5 m deep (ERM, 2011).

The distribution of seabed sediments in the Joseph Bonaparte Gulf and contained within the Sahul Shelf reflect the present-day oceanographic condition and display a distinct seaward fining pattern (Lees, 1992 in Baker *et al.,* 2008). Seabed sediments are predominantly carbonate sands mostly transported by strong tidal currents and seasonal cyclones (van Andel and Veevers, 1967). Terrigenous sediments reach the Sahul Shelf from large river systems (e.g. Victoria River System) (Lees, 1992 in Baker *et al.,* 2008).

3.2.2 Hydrography and Oceanography

The oceanographic environment of the Joseph Bonaparte Gulf region is dominated by diurnal and semi-diurnal tides, featuring some of the largest tidal energies observed anywhere in the world, with tidal sea level ranges exceeding 8 m along the western side of the Gulf during the spring tide (CSIRO, 2005). There is a well-defined spring-neap lunar cycle, with spring tides occurring two days after the new and full moon.

Superimposed on the astronomical tide are ‘meteorological’ tides resulting from changes in atmospheric pressure and strong onshore or offshore winds. Seasonal changes of mean sea level in Darwin are only ~0.15 m, and offshore the changes will be considerably less and quite insignificant (i.e. maybe ±0.05 m) (RPS 2011).

Mean monthly surface temperatures in the Joseph Bonaparte Gulf region vary between about 23°C in winter months and 33°C in summer months (RPS 2011). Monthly average sea-surface temperatures near the Petrel-1 well in the vicinity of these wells varied from a minimum of 26.3°C (August) to a maximum of 30.4°C (December) (RPS-APASA 2014).

The water column is well mixed all year round with respect to temperature, due to the large tidal range and strength of currents.

Baseline surveys carried out by the Petrel and Tern fields in 2010 and 2011 showed that seawater temperature was consistent across the area. Temperature gradients throughout the water column did not display a thermocline, instead a vertical gradient in seawater temperature was observed across all fields in which temperature decreased progressively from the surface to the bottom ranging from 32.08°C to 25.3° C. Temperature was around 2°C greater in the second survey, attributed by the warmer and calmer conditions at the end of summer, when survey two was completed (ERM, 2011).

3.2.3 Water Quality

Surface seawater salinities in the tropics are generally 34–35 ppt and vary little between seasons (Middleton, 1995 in Shell 2009). Modelled seawater salinity profiles in the Petrel and Tern fields indicated that there is little variation in salinity through the water column, monthly or seasonally with values ranging 33.9–35.5 psu (RPS, 2011). This is supported by field data showing that salinity and specific conductivity were similar across the Petrel and Tern fields and along the pipeline route, and found to slightly increase with depth (ERM, 2011). There is a small variation in salinity and specific conductivity between seasonal surveys with a slight increase in both parameters in the dry season (ERM, 2011).

Dissolved oxygen (DO) concentration ranged from a minimum of 3.64 mg/L (49.8%) near the seabed to 7.80 mg/L (117.2%) at the sea surface. DO was found to decrease with depth consistently across all fields. Such variation is often linked to higher photosynthetic activity at the seawater surface and wave and wind generated mixing. These values are typical of unpolluted seawater (ERM, 2011).

Total suspended solids (TSS) were largely not detected across the area during the time of sampling. The samples that did report detections, had concentrations marginally above the laboratory LOR of 5 mg/L with no differences observed between surface and bottom measurements. These data represent relatively low suspended solid values as would be expected for offshore waters in the region (ERM,2011).

Surveys completed in 2010 and 2011 showed that water quality in the Petrel and Tern fields is relatively pristine with results typical of nutrient poor (oligotrophic) offshore northern Australian waters (ERM, 2011):

3.2.4 Sediment Quality

Sediments in the Petrel field were dominated by sand, with similar gravel, silt and clay proportions. The Tern seabed sediment contained approximately twice the silt, and approximately 10% higher clay content than the Petrel field (ERM, 2011).

Concentrations of analytes including metals, nutrients, TOC, and radionuclides co-varied with the particle size distribution data; e.g. the concentrations of tested analytes were higher at Tern than at Petrel; coinciding with a greater proportion of silt at Tern compared to Petrel.

3.3 Ecological Environment

3.3.1 Soft Sediment

Sediments of the Bonaparte Gulf are dominated by biogenic gravels and sands, grading to muds offshore (IMCRA Technical Group, 1998).

Benthic habitat surveys indicated that the soft sediment seabed comprised of primarily of sand, coarse shell fragment and silt. Sediments in the Petrel field were dominated by sand with similar gravel, silt and clay proportions. The Tern seabed sediment contained approximately twice the silt, and approximately 10% higher clay content than Petrel field (ERM, 2011).

3.3.2 Plankton

3.3.2.1 Phytoplankton

Phytoplankton assemblages recorded across the Petrel and Tern fields were characteristic of offshore tropical waters. Phytoplankton assemblages were dominated by cyanobacteria during the 2010 wet season survey, which comprised 99.7% of identified algal cells. During 2011 dry season survey, the phytoplankton assemblage was largely dominated by the diatoms (Bacillariophyceae).

The phytoplankton cell densities were typical of offshore oceanic waters and indicative of a classically oligotrophic (low nutrient) system as is the case across offshore Western Australia and indeed the Timor Sea which feeds the Leeuwin Circulation in the north-west Bioregion.

3.3.2.2 Zooplankton

Sampling indicated that larval fishes during both seasons were found to be dominated by the Serranidae (Cods) and Lutjanidae (Snappers), both of which are species of interest targeted by commercial fisheries in the region. Larval fish density also varied seasonally with the 2011 dry season recording highest densities of larval fishes in the zooplankton. This seasonal effect is consistent with the notion of an extended spawning season (and possibly planktonic larval duration) of the reef species dominating the larval fish assemblage in the study area at this time.

Zooplankton sampling indicated that copepods represented the most dominant group within the macro-zooplankton assemblage in both the 2010 wet season and 2011 dry season. The density of these macro-zooplankton varied significantly among seasons, with an overall greater density of these animals recorded during 2010 wet season. The greater density of macro-zooplankton may be indicative of higher primary productivity in the summer months fuelling population increases of the zooplankton (secondary productivity) at this time. Overall zooplankton density varied at the level of the assemblage with statistically distinct assemblages found within both the 2010 wet season and 2011 dry season.

3.3.3 Marine Invertebrates

A survey conducted in November 2010 recorded benthic infauna assemblages across the Petrel and Tern fields similar to the results of other studies in the bio-region in terms of the species, diversity and biomass. Infauna is documented to occur in coastal waters to depths of approximately 200 m, and are widely distributed through subtropical and tropical waters of Western Australia (Jones and Morgan, 1994).

A total of 18 benthic habitat sites were sampled in November 2011 with depths ranging from 85-99 m. Benthic habitat mapping found that generally the seabed composition was similar, with sparse sessile benthos except for an unidentified white colonial organism (presently recorded as a hydrozoa) across all sampled fields. Estimated percentage cover was low for octocorals and sponges (~2% for each) while the unidentified hydroid comprised between 11-30% at all sites.

3.3.4 Seabirds and Shorebirds

There are 11 seabird and shorebird species (or species habitat) classified as threatened and/or migratory that may occur within the EMBA (Table 3-1). The type of presence varies between species, but is predominantly may or likely to occur, with no important behaviours (e.g. foraging, roosting, breeding) recorded within the EMBA (Table 3-1). No Biologically Important Areas (BIAs) for any seabird or shorebird species intersect with the EMBA.

Given the various species distributions, habitat preferences, breeding patterns and/or foraging characteristics, any occurrence within the EMBA is likely to be of a transient nature only.

Table 3-1 Seabird and Shorebird species or species habitat that may occur within the EMBA

Species (Scientific)	Species (Common)	Threatened Species	Migratory Species	Listed Marine Species	Type of Presence	BIA
Actitis hypoluecos	Common Sandpiper		✓(W)	✓	MO	–
Anous stolidus	Common Noddy		✓(M)	✓	MO	–
Calidris acuminate	Sharp-tailed Sandpiper		✓(W)	✓	MO	–
Calidris canutus	Red Knot	E	✓(W)	✓	MO	–
Calidris ferruginea	Curlew Sandpiper	CE	✓(W)	✓	MO	–
Calidris melanotos	Pectoral Sandpiper		✓(W)	✓	MO	–
Calonectris leucomelas	Streaked Shearwater		✓(M)	✓	LO	–
Fregata ariel	Lesser Frigatebird		✓(M)	✓	LO	–
Fregata minor	Greater Frigatebird		✓(M)	✓	MO	–
Numenius madagascariensis	Eastern Curlew	CE	✓(W)	✓	MO	–
Pandion haliaetus	Osprey		✓(W)	✓	MO	–

Threatened Species:
E Endangered
CE Critically Endangered
Migratory Species:
(M) Marine
(W) Wetland
Biologically Important Area:
– No BIA Present

Type of Presence:
MO Species of species habitat may occur within area
LO Species or species habitat likely to occur within area

3.3.5 Fish

There are 11 shark and ray species (or species habitat) classified as threatened or migratory and 31 syngnathid species (or species habitat) that may occur within the EMBA (Table 3-2). The type of presence varies between species, but is predominantly may, likely or known to occur, with no important behaviours (e.g. aggregating, breeding) recorded within the EMBA (Table 3-2). No Biologically Important Areas (BIAs) for any fish species intersect with the EMBA.

3.3.5.1 Sharks and Rays

Given the various species habitat preferences, predominant range and/or migratory patterns, occurrence of these species within the EMBA is considered unlikely or of a transient nature only.

3.3.5.2 Syngnathids

Given the habitat within the EMBA is expected to be predominantly bare sediment with occasional low density of epifauna (e.g. sponges), occurrence of these species within the EMBA is considered unlikely.

3.3.5.3 Observed Fish Assemblages

Analysis of the 36 Baited Remote Underwater Video (BRUV) samples from the 2010 wet season survey recorded a total of 22 genera representing 17 families (positive identification was made for 33 species plus three unidentified records) for the deep waters of the Petrel and Tern fields as well as a proposed pipeline route, that was being planned as part of a previously scoped project. The most common families by density were Terapontidae (grunters) Nemipteridae (threadfin breams), and Lutjanidae (snappers).

The relative density of the observed species is not consistent with an aggregation or sensitive ecological community, or fish nursery grounds.

Table 3-2 Fish Species or Species Habitat that may occur within the EMBA

Species (Scientific)	Species (Common)	Threatened Species	Migratory Species	Listed Marine Species	Type of Presence	BIA
Sharks and Rays						
Anoxypristis cuspidata	Narrow Sawfish		✓		MO	–
Carcharodon carcharias	Great White Shark	V	✓		MO	–
Glyphis garricki	Northern River Shark	E			MO	–
Isurus oxyrinchus	Shortfin Mako		✓		LO	–
Isurus paucus	Longfin Mako		✓		LO	–
Manta alfredi	Reef Manta Ray		✓		LO	–
Manta birostris	Giant Manta Ray		✓		LO	–
Pristis clavate	Dwarf Sawfish	V	✓		MO	–
Pristis	Freshwater Sawfish	V	✓		KO	–
Pristis zijsron	Green Sawfish	V	✓		KO	–
Rhincodon typus	Whale Shark	V	✓		MO	–
Syngnathids						
Bhanotia fasciolata	Corrugated Pipefish			✓	MO	–
Campichthys tricarinatus	Three-keel Pipefish			✓	MO	–
Choeroichthys brachysoma	Pacific Short-bodied Pipefish			✓	MO	–
Choeroichthys suillus	Pig-snouted Pipefish			✓	MO	–
Corythoichthys amplexus	Fijian Banded Pipefish			✓	MO	–
Corythoichthys flavofasciatus	Reticulate Pipefish			✓	MO	–
Corythoichthys intestinalis	Australian Messmate Pipefish			✓	MO	–
Corythoichthys schultzi	Schultz's Pipefish			✓	MO	–
Cosmocampus banneri	Roughridge Pipefish			✓	MO	–
Doryrhamphus dactyliophorus	Banded Pipefish			✓	MO	–
Doryrhamphus excisus	Bluestripe Pipefish			✓	MO	–
Doryrhamphus janssi	Cleaner Pipefish			✓	MO	–

Species (Scientific)	Species (Common)	Threatened Species	Migratory Species	Listed Marine Species	Type of Presence	BIA
Filicampus tigris	Tiger Pipefish			✓	MO	–
Halicampus brocki	Brock's Pipefish			✓	MO	–
Halicampus dunckeri	Red-hair Pipefish			✓	MO	–
Halicampus grayi	Mud Pipefish			✓	MO	–
Halicampus spinirostris	Spiny-snout Pipefish			✓	MO	–
Haliichthys taeniophorus	Ribboned Pipehorse			✓	MO	–
Hippichthys penicillus	Beady Pipefish			✓	MO	–
Hippocampus histrix	Spiny Seahorse			✓	MO	–
Hippocampus kuda	Spotted Seahorse			✓	MO	–
Hippocampus planifrons	Flat-face Seahorse			✓	MO	–
Hippocampus spinosissimus	Hedgehog Seahorse			✓	MO	–
Micrognathus micronotopterus	Tidepool Pipefish			✓	MO	–
Solegnathus hardwickii	Pallid Pipehorse			✓	MO	–
Solegnathus lettiensis	Gunther's Pipehorse			✓	MO	–
Solenostomus cyanopterus	Robust Ghostpipefish			✓	MO	–
Solenostomus paegnius	Rough-snout Ghost Pipefish			✓	MO	–
Syngnathoides biaculeatus	Double-end Pipehorse			✓	MO	–
Trachyrhamphus bicoarctatus	Bentstick Pipefish			✓	MO	–
Trachyrhamphus longirostris	Straightstick Pipefish			✓	MO	–

Threatened Species:
V Vulnerable
E Endangered
Biologically Important Area:
– No BIA Present

Type of Presence:
MO Species of species habitat may occur within area
LO Species or species habitat likely to occur within area
KO Species or species habitat known to occur within the area

3.3.6 Marine Reptiles

There are six marine turtles, 19 sea snakes, and one crocodile species (or species habitat) classified as threatened, migratory or listed marine that may occur within the EMBA (Table 3-3). The type of presence varies between species, but is predominantly may occur, with no important behaviours (e.g. aggregating, breeding) recorded within the EMBA (Table 3-3). Foraging BIAs for four marine turtle species intersect with the EMBA (Table 3-3). No known habitat critical for the survival of marine turtles (DEE, 2017a) occurs within the EMBA (Figure 3-1).

3.3.6.1 Marine Turtles

Any occurrence within the EMBA is likely to be of a transient nature only; however, it is possible that some species (e.g. Loggerhead, Green, Olive Ridley and Flatback) may use the area for foraging.

3.3.6.2 Sea Snakes

Given their primarily nearshore and shallow water distribution, occurrence within the EMBA is considered unlikely and would likely be of a transient nature only.

3.3.6.3 Crocodiles

Given their primarily coastal distribution, occurrence within the EMBA is considered unlikely and if it did occur would likely be of a transient nature only.

Table 3-3 Marine Reptile Species or Species Habitat that may occur within the EMBA

Species (Scientific)	Species (Common)	Threatened Species	Migratory Species	Listed Marine Species	Type of Presence	BIA
Marine Turtles						
Caretta caretta	Loggerhead Turtle	E	✓	✓	LO	✓(f)
Chelonia mydas	Green Turtle	V	✓	✓	KO	✓(f)
Dermochelys coriacea	Leatherback Turtle	E	✓	✓	LO	–
Eretmochelys imbricata	Hawksbill Turtle	V	✓	✓	LO	–
Lepidochelys olivacea	Olive Ridley Turtle	E	✓	✓	LO	✓(f)
Natator depressus	Flatback Turtle	V	✓	✓	KO	✓(f)
Sea Snakes						
Acalyptophis peronii	Horned Sea Snake			✓	MO	–
Aipysurus duboisii	Dubois' Sea Snake			✓	MO	–
Aipysurus eydouxii	Spine-tailed Sea Snake			✓	MO	–
Aipysurus laevis	Olive Sea Snake			✓	MO	–
Astrotia stokesii	Stokes' Sea Snake			✓	MO	–
Disteira kingii	Spectacled Sea Snake			✓	MO	–
Disteira major	Olive-headed Sea Snake			✓	MO	–
Enhydrina schistosa	Beaked Sea Snake			✓	MO	–
Hydrelaps darwiniensis	Black-ringed Sea Snake			✓	MO	–
Hydrophis atriceps	Black-headed Sea Snake			✓	MO	–
Hydrophis coggeri	Slender-necked Sea Snake			✓	MO	–
Hydrophis elegans	Elegant Sea Snake			✓	MO	–
Hydrophis inornatus	Plain Sea Snake			✓	MO	–

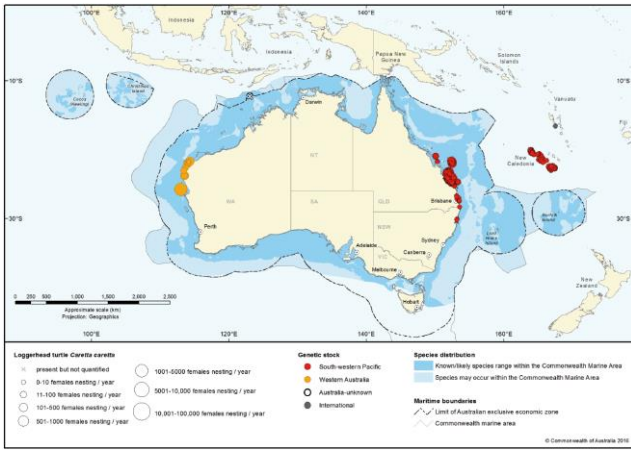
Species (Scientific)	Species (Common)	Threatened Species	Migratory Species	Listed Marine Species	Type of Presence	BIA
Hydrophis mcdowelli	Small-headed Sea Snake			✓	MO	–
Hydrophis ornatus	Spotted Sea Snake			✓	MO	–
Hydrophis paciicus	Large-headed Sea Snake			✓	MO	–
Lapemis hardwickii	Spine-bellied Sea Snake			✓	MO	–
Parahydrophis mertoni	Northern Mangrove Sea Snake			✓	MO	–
Pelamis platurus	Yellow-bellied Sea Snake			✓	MO	–
Crocodiles						
Crocodylus porosus	Saltwater Crocodile		✓	✓	LO	–

Threatened Species:
V Vulnerable
E Endangered

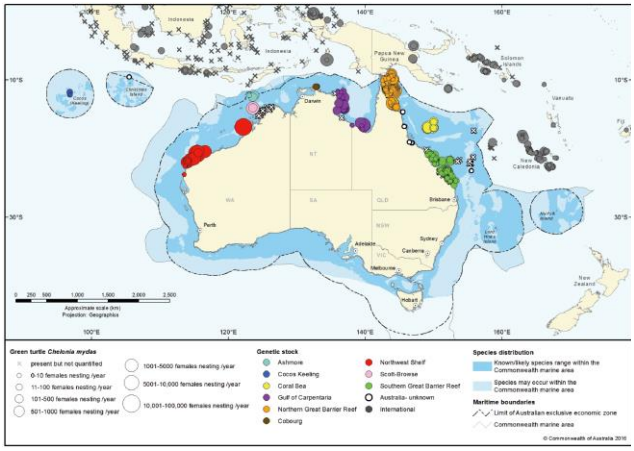
Biologically Important Area:
– No BIA Present
(f) Foraging BIA

Type of Presence:
MO Species of species habitat may occur within area
LO Species or species habitat likely to occur within area
KO Species of species habitat known to occur within area

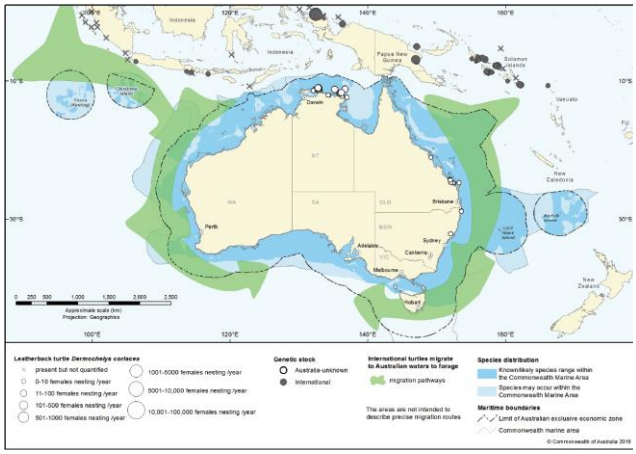
Loggerhead Turtle



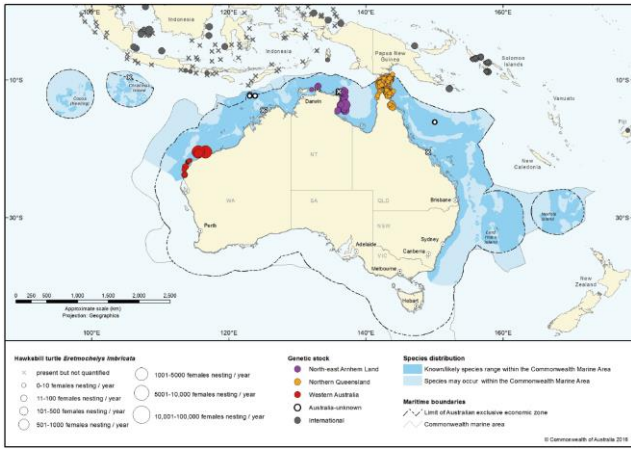
Green Turtle



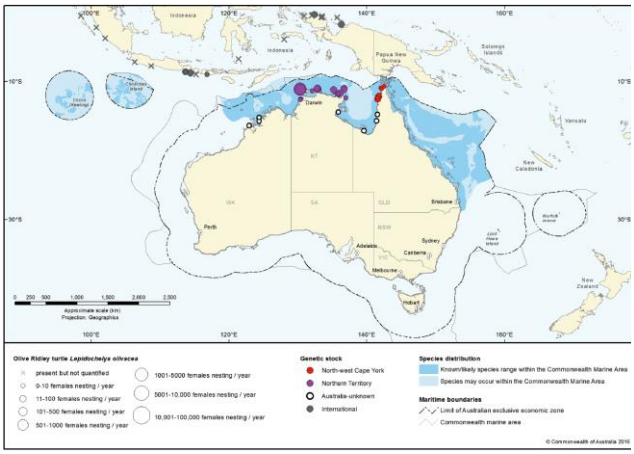
Leatherback Turtle



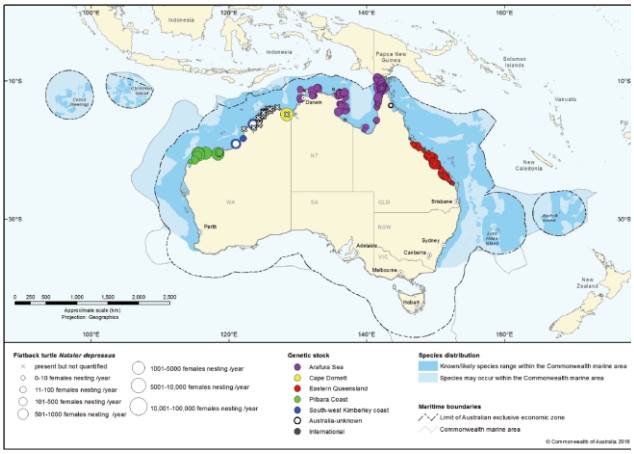
Hawksbill Turtle



Olive Ridley Turtle



Flatback Turtle



(Source: DEE, 2017a)

Figure 3-1 Marine Turtle Nesting Sites in Australia and Surrounding Regions

3.3.7 Marine Mammals

There are five whale and eight dolphin species (or species habitat) classified as threatened, migratory or a listed marine species that may occur within the EMBA (Table 3-4). The type of presence varies between species, but is predominantly may occur, with no important behaviours (e.g. aggregating, breeding) recorded within the EMBA. No BIAs for marine mammals have been identified within the EMBA (Table 3-4).

3.3.7.1 Whales

Given the various species predominant range, migratory patterns, and/or known aggregation areas, occurrence of these species within the EMBA is considered unlikely or of a transient nature only.

Analysis of six months of noise logger data (September 2010 to March 2011) did not provide evidence of any Blue Whales being present in the Project area. The noise logger data also did not provide evidence of Humpback Whale feeding, breeding or resting areas in the vicinity of the Petrel and Tern assets. During two marine surveys, November 2010 and May 2011, no Blue Whales or Humpback Whales were sighted from the survey vessel in the Project area.

3.3.7.2 Dolphins

Occurrence of some dolphins species (e.g. Spotted, Indian Ocean Bottlenose, Spotted Bottlenose) within the EMBA was considered possible, however if it did occur would likely be of a transient nature only.

Table 3-4 Marine Mammal Species or Species Habitat that may occur within the EMBA

Species (Scientific)	Species (Common)	Threatened Species	Migratory Species	Listed Marine Species	Type of Presence	BIA
Whales						
Balaenoptera borealis	Sei Whale	V	✓		MO	–
Balaenoptera edeni	Bryde's Whale		✓		MO	–
Balaenoptera musculus	Blue Whale	E	✓		LO	–
Balaenoptera physalus	Fin Whale	V	✓		MO	–
Megaptera novaeangliae	Humpback Whale	V	✓		LO	–
Dolphins						
Delphinus delphis	Common Dolphin				MO	–
Grampus griseus	Risso's Dolphin				MO	–
Orcinus orca	Killer Whale		✓		MO	–
Pseudorca crassidens	False Killer Whale				LO	–
Stenella attenuata	Spotted Dolphin				MO	–
Tursiops aduncus	Indian Ocean Bottlenose Dolphin				MO	–
Tursiops aduncus (Arafura/Timor Sea populations)	Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)		✓		MO	–
Tursiops truncatus s. str.	Bottlenose Dolphin				MO	–

Threatened Species:
V Vulnerable
E Endangered
Biologically Important Area:
– No BIA Present

Type of Presence:
MO Species of species habitat may occur within area
LO Species or species habitat likely to occur within area

3.4 Social Environment

There are no Commonwealth or State marine protected areas, wetlands of international or national importance, World, National or Commonwealth heritage properties or places, or Indigenous Protected Areas that intersect with the EMBA. Due to the distance offshore, it is also not expected that tourism and recreation activities are likely to occur within the vicinity of the EMBA.

3.4.1 Commonwealth Marine Region

Six marine regions have been identified in Commonwealth waters around Australia; the EMBA interests with two of these regions: North-west and North. Key conservation values for each of the marine regions are described online (DEE 2017b).

3.4.1.1 Key Ecological Features

Two KEFs occur within the EMBA: carbonate bank and terrace system of the Sahul Shelf; and the pinnacles of the Bonaparte Basin (Table 3-5).

Table 3-5 Key Ecological Features present within the EMBA

KEF	Values and Description
Carbonate bank and terrace system of the Sahul Shelf	• Unique seafloor feature with ecological properties of regional significance • Little is known about the bank and terrace system of the Sahul Shelf but it is regionally important because of its likely ecological role in enhancing biodiversity and local productivity relative to its surrounds. The banks are thought to support a high diversity of organisms including reef fish, sponges, soft and hard corals, gorgonians, bryozoans, ascidians and other sessile filter feeders. The banks are known to be foraging areas for loggerhead, olive ridley and flatback turtles. Cetaceans and green and freshwater sawfish are likely to occur in the area
Pinnacles of the Bonaparte Basin	• Unique seafloor feature with ecological properties of regional significance • As they provide areas of hard substrate in an otherwise relatively featureless environment, the pinnacles are likely to support a high number of species, although a better understanding of the species richness and diversity associated with these structures is required

Notes:

1. Values and description as provided in DSEWPaC, 2012.

3.4.2 Commercial Fisheries

3.4.2.1 Commonwealth Fisheries

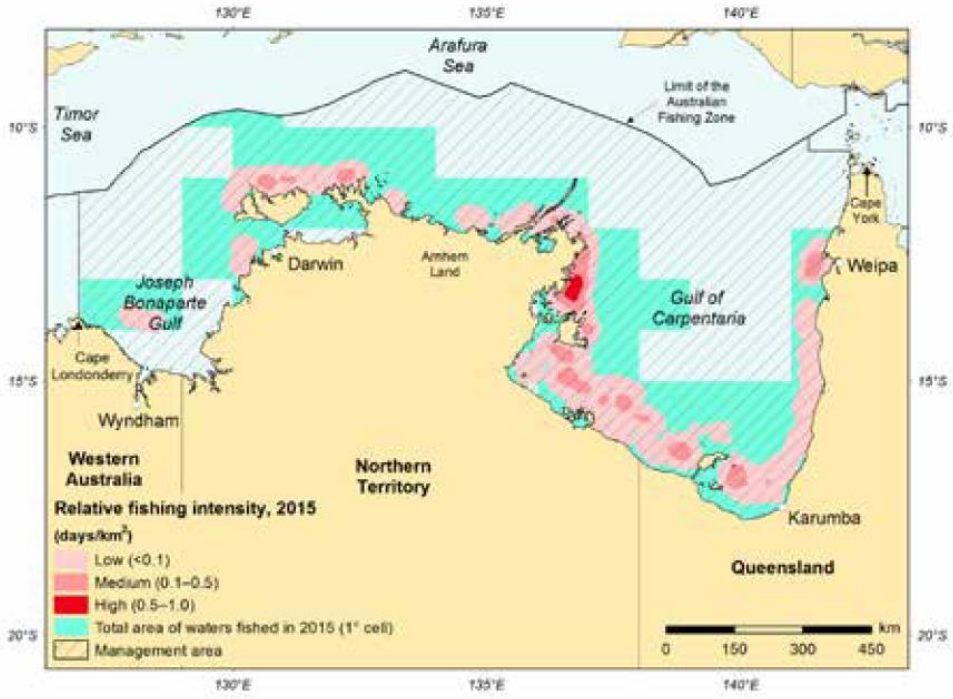
Four Commonwealth-managed commercial fisheries have management areas that intersect with the EMBA. One of these, the Skipjack Tuna Fishery, has been inactive since the 2008-2009 fishing season; and two fisheries (Southern Bluefin Tuna, and the Western Tuna and Billfish) have their catch from areas well outside the EMBA.

The Northern Prawn Fishery is the only Commonwealth-managed fishery that may have activity within the vicinity of the EMBA, however this is considered unlikely. The White Banana Prawn is mainly caught on the eastern side of the Gulf of Carpentaria, whereas Red-Legged Banana Prawn is mainly caught in Joseph Bonaparte Gulf (Figure 3-2). However, the 2015 season had very low levels of effort in Joseph Bonaparte Gulf (76 days), and corresponding very low levels of catch (30 t in Joseph Bonaparte Gulf and 56 t in total) (Patterson *et al.*, 2016).

3.4.2.2 State Fisheries

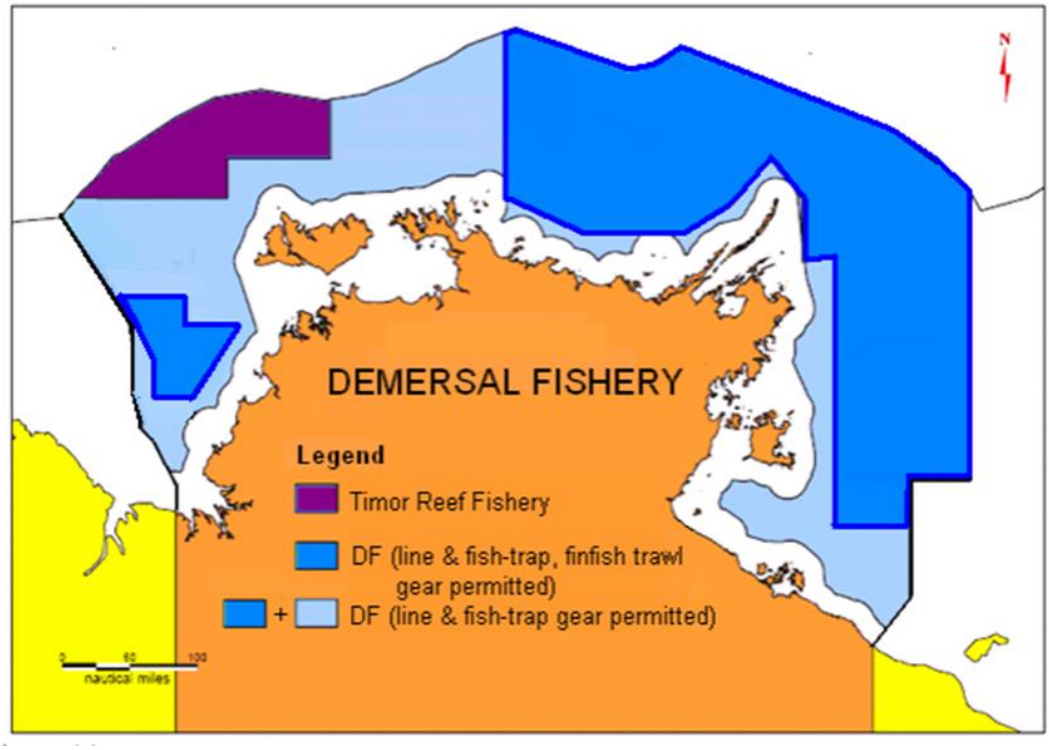
Six State-managed commercial fisheries have management areas that intersect with the EMBA. One of these, the offshore Jigging Fishery, is currently inactive. Fishing activity in the vicinity of the EMBA is expected to be low, with only one of the State-managed fisheries (the offshore Demersal Fishery and Licences) expected to

have any active fishing effort in the general region; however no trawling fishing is undertaken in the area (Figure 3-3).



(Source: Patterson *et al*., 2016)

Figure 3-2 Northern Prawn Fishery – Management Area and 2015 Fishing Intensity



(Source: DPIRD, 2012)

Figure 3-3 NT Demersal Fishery Management Arrangements

3.4.3 Industry

3.4.3.1 Shipping

There are no known recognised major shipping routes through the permit areas, however vessels may pass through the general area. The suspended wellheads have been in-situ since the 1980's, and appear on navigation charts.

3.4.3.2 Petroleum Exploration and Production

Petroleum exploration in the Bonaparte Basin commenced in the late 1940's. Gas in the Bonaparte Basin is currently produced from the Bayu-Undan and Blacktip fields; and oil is produced from the Laminaria-Corallina and greater Montara fields. The Petrel-Tern-Frigate, Barossa-Caldita and Cash-Maple, Greater Sunrise and Evans Shoals gas fields are currently being considered for development (DIIS, 2017).

3.4.3.3 Military

The Petrel and Tern fields are located within a military exercise zone named the Northern Australia Exercise Area. The zone incorporates the majority of the Northern Territories portion of the Bonaparte Basin, and is mainly utilised for activities associated with border protection including surveillance, illegal immigration and illegal fishing. Consultation with the Department of Defence indicated that unexploded ordnance may be present on and in the seafloor.

3.4.4 Heritage

3.4.4.1 Maritime

One shipwreck site does occur within the EMBA. The *Sedco Helen* was wrecked in 1970, and is located approximately four kilometres north-northwest of the Petrel-4 well in approximately 100 m of water depth. Neptune Energy has a self-imposed exclusion zone of 800 m around the wreck of the *Sedco Helen*.

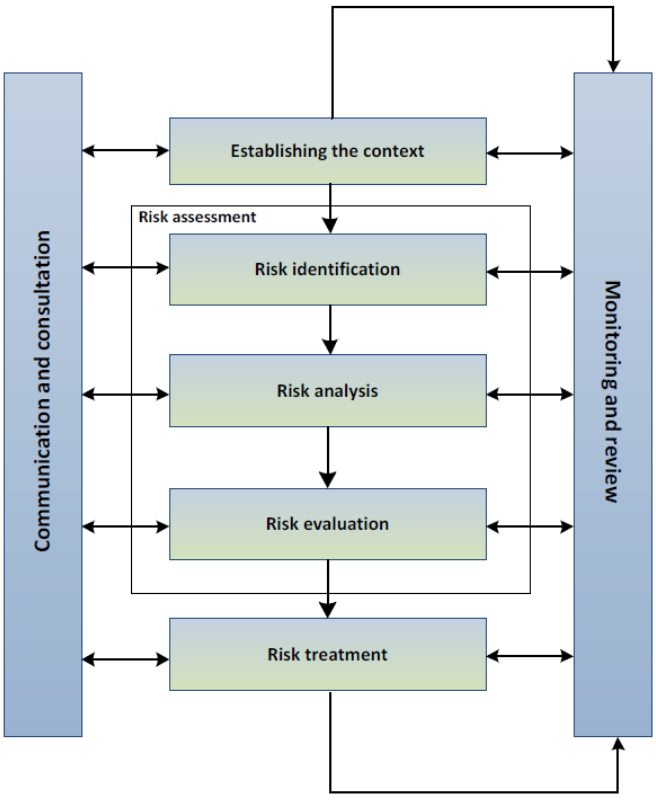
4 Environmental Risk Assessment

In accordance with Regulation 13(5) and (6) of the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009, an environmental risk assessment was undertaken to evaluate impacts and risks arising from operational activities, unplanned events and spill response strategies.

4.1 Risk Assessment Methodology

The risk assessment has been undertaken to identify the sources of risk (aspect) and potential environmental impacts associated with the activity and to assign a level of significance or risk to each impact. This assessment subsequently assists in prioritising mitigation measures to ensure that the environmental impacts are managed to as low as reasonably practicable (ALARP). Risk has been assessed in terms of likelihood and consequence, where consequence is defined as the outcome or impact of an event, and likelihood as a description of the probability or frequency of the identified consequence occurring. Following identification of practicable mitigation measures, the residual risk of each impact is reassigned and assessed for environmental acceptability.

The risk assessment methodology applied is consistent with the Australian/New Zealand Standard AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines, Handbook HB 203:2012 Managing Environment – Related Risk, and Handbook HB 89-2012 Risk Management – Guidelines on Risk Assessment Techniques. The key steps used for the risk assessment are shown in Figure 4-1.



(Source: modified from AS/NZS ISO 31000:2009 Risk management)

Figure 4-1 Risk assessment process

Risk is expressed in terms of a combination of the consequence of an impact and the likelihood of the impact occurring. Neptune Energy used a Corporate Risk Matrix (Table 4-1) to plot the consequence and likelihood to determine the level of risk. Definitions of consequence and likelihood are provided in Table 4-2 and Table 4-3, respectively.

Table 4-1 Neptune Energy Risk Matrix

		LIKELIHOOD					
		0 Remote	1 Highly Unlikely	2 Unlikely	3 Possible	4 Likely	5 Very Likely
CONSEQUENCE	A Massive	M	H	H	VH	VH	VH
	B Major	M	M	H	H	VH	VH
	C Moderate	L	M	M	H	H	VH
	D Minor	L	L	M	M	H	H
	E Slight	L	L	L	M	M	M
	F Negligible	L	L	L	L	L	L

Table 4-2 Neptune Energy Environmental Consequence Classification

Level	Environment Consequence
A	**Massive** - large scale effect, long term/permanent impact
B	**Major** - Major effect, medium term (years)
C	**Moderate** - Medium effect, short term (months)
D	**Minor** - Localised effect, short term (weeks), single breach of statutory or design limit.
E	**Slight** - Slight effect (immediate area), temporary impact (days)
F	**Negligible** - No measurable effect.

Table 4-3 Neptune Energy Environmental Likelihood

Level	Definition
0	**Remote** – Unheard of in industry, once every 10,000-100,000 years at location
1	**Highly Unlikely** – Heard of, but only once or twice in the industry, once every 1,000-10,000 years at location
2	**Unlikely** – Has occurred in the industry, but not in Neptune Energy, once every 100-1,000 years at location
3	**Possible** – Has occurred multiple times in the industry and / or Neptune Energy, once every 10-100 years at location
4	**Likely** – Expected to occur once or twice during project operation life, once every 1-10 years at location
5	**Very likely** – Expected to occur multiple times during project operation life, more than once a year at location.

4.1.1 ALARP decision context

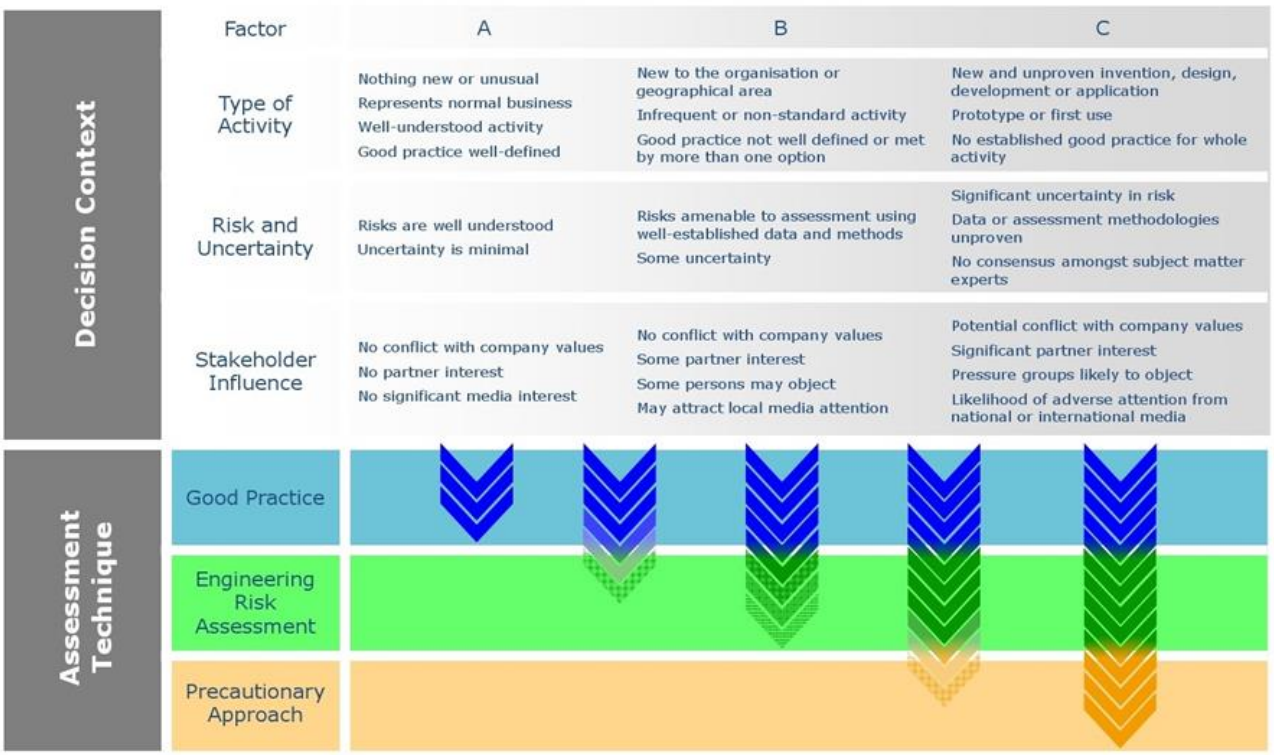
In alignment with NOPSEMA's ALARP Guidance Note (N-04300-GN0166, Rev 6, June 2015), Neptune Energy have adapted the approach developed by Oil and Gas UK (OGUK) (formerly UKOOA; OGUK, 2014) for use in an environmental context to determine the assessment technique required to demonstrate that potential impacts and risks are ALARP (Figure 4-2). Specifically, the framework considers impact severity and several guiding factors: activity type, risk and uncertainty, stakeholder influence.

A Type A decision is made if the risk is relatively well understood, the potential impacts are low, activities are well practised, and there is no significant stakeholder interest. However, if good practice is not sufficiently well-defined, additional assessment may be required.

A Type B decision is made if there is greater uncertainty or complexity around the activity and/or risk, the potential impact is moderate, and the risk generates several concerns from stakeholders. In this instance, established good practice is not considered sufficient and further assessment is required to support the decision and ensure the risk is ALARP.

A Type C decision typically involves sufficient complexity, high potential impact, uncertainty, or stakeholder interest to require a precautionary approach. In this case, relevant good practice still must be met, additional assessment is required, and the precautionary approach applied for those controls that only have a marginal cost benefit.

In accordance with the regulatory requirement to demonstrate that environmental impacts and risks are ALARP, Neptune Energy has considered the above decision contexts in determining the level of assessment required. The assessment techniques considered include: good practice, engineering risk assessment, precautionary approach.



(NOPSEMA ALARP Guidance Note. N-04300-GN0166, Rev 6, June 2015)

Figure 4-2 ALARP Decision Support Framework

4.1.2 Determination of Impact and Risk Acceptability

Neptune Energy considers a range of factors when evaluating the acceptability of environmental impacts or risks associated with its activities. This evaluation works at several levels, as outlined in Table 4-4 and is based on NOPSEMA's Guidance Notes for EP Content Requirements (N04750-GN1344, Rev 3, April 2016) and guidance issued in Decision-making – Criterion 10A(c) Acceptable Level (N-04750-GL1637, Rev 0, Nov 2016).

Table 4-4 Neptune Energy Acceptability Evaluation

Factor	Criteria / Test
Neptune Energy Risk Process	• Is the level of Risk Low and determined as ALARP decision context A (thus is inherently considered to be ALARP)? • If not, is the level of Risk Medium or High and has ALARP been demonstrated? • NOTE: Risks of Very High are not acceptable
Principles of Ecologically Sustainable Development (ESD)	• Is there the potential to affect biological diversity and ecological integrity? (Consequence Level Major [B] and Massive [A])

Factor	Criteria / Test
	• Do activities have the potential to result in serious or irreversible environmental damage? o If yes: Is there significant scientific uncertainty associated with aspect? o If yes: Has the precautionary principle been applied to the aspect?
Legislative and Other Requirements	• Confirm that all good practice control measures have been identified for the aspect including those identified in relevant EPBC listed species recovery plans or approved conservation advices.
Internal Context	• Confirm that all Neptune Energy Well Operations Requirements (WOR) manuals and policies have been identified for this aspect
External Context	• What objections and claims regarding this aspect have been made, and how have they been considered / addressed?

4.2 Summary of Environmental Impacts and Risks

The below tables summarise the impacts/risks, and associated control measures applied to reduce the risks to ALARP and an acceptable level for each environmental aspect.

Table 4-5 Physical Interaction (Collision with Marine Fauna) – Summary EIA/ERA

Cause of Aspect	The presence of moving and dynamically positioned vessels within the operational area has the potential to result in collision with marine fauna.
Impact or Risk	Interaction with fauna has the potential to result in: • injury or death of marine fauna
Consequence Evaluation	
Receptor(s)	**Description of Potential Environmental Impact**
Marine Mammals Marine Reptiles Sharks	Macrofauna comprising marine mammals, turtles and whale sharks are the species most at risk from this potential impact and thus are the focus of this evaluation. As identified in Section 3, several marine mammals (whale, dolphin), turtle species and whale sharks listed as threatened and/or migratory and/or a listed marine species under the EPBC Act have the potential to occur within the operational area. Although the majority of these species are expected to transit through, rather than aggregate, within the operational area, the operational area is located within a foraging BIA for the Loggerhead, Green, Olive Ridley and Flatback Turtle thus a higher abundance of turtles may be present during the seabed equipment surveillance survey. There is limited data regarding strikes to fauna such as turtles and Whale Sharks, possibly due to lack of collisions being noticed and lack of reporting; however, marks observed on animals show that strikes have occurred (Peel et al. (2016; cited in Commonwealth of Australia, 2016). Cetaceans were the focus of this evaluation as they provide a representative case to enable an evaluation of consequence to be undertaken. Cetaceans are naturally inquisitive marine mammals that are often attracted to offshore vessels and facilities. The reaction of whales to the approach of a vessel is quite variable. Some species remain motionless when in the vicinity of a vessel, while others are curious and often approach ships that have stopped or are slow moving, although they generally do not approach, and sometimes avoid, faster-moving ships (Richardson et al. 1995). Collisions between larger vessels with reduced manoeuvrability and large, slow-moving cetaceans occur more frequently where high vessel traffic and cetacean habitat occurs (Whale and Dolphin Conservation Society, 2006). Laist et al. (2001) identifies that larger vessels with reduced manoeuvrability moving in excess of 10 knots may cause fatal or severe injuries to cetaceans, with the most severe injuries caused by vessels travelling faster than 14 knots. Vessels typically used to undertake petroleum activities do not have the same limitations on manoeuvrability and would not be moving at these speeds when conducting activities within the scope of this EP, inside the operational area.

	Peel et al. (2016; cited in Commonwealth of Australia, 2016) reviewed vessel strike data (1997-2015) for marine species in Australian waters and identified the following: • Whales including the humpback, pygmy blue, Antarctic blue, southern right, dwarf minke, Antarctic minke, fin, bryde's, pygmy right, sperm, pygmy sperm and pilot species were identified as having interacted with vessels. The humpback whale exhibited the highest incidence of interaction followed by the southern right whale. A number of these species may migrate through the waters of the operational area. • Dolphins including the Australian humpback, common bottlenose, indo-pacific bottlenose and Risso's dolphin species were also identified as interacting with vessels. The common bottlenose dolphin exhibited the highest incidence of interaction. A number of these species may reside in or pass through the waters of the operational area. The duration of fauna exposure to vessel strike is limited to a few days per seabed equipment surveillance survey. If a fauna strike occurred and resulted in death, it is not expected that it would have a detrimental effect on the overall population. Consequently, the potential impacts and risks from fauna strike are considered to be **Slight (E)** as this type of event may result in a slight effect within the immediate vicinity of the vessel with a temporary impact given a strike resulting in death is not expected to affect the population or local ecosystem function.
ALARP Decision Context	**A**
Control Measure	**Source of good practice control measures**
• Vessel Master • Fauna observation actions • Fauna interaction management actions	EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans – The Australian Guidelines for Whale and Dolphin Watching describes strategies to ensure whales and dolphins are not harmed during offshore interactions with people. These guidelines were developed jointly by all state and territory governments through the Natural Resource Management Ministerial Council and although are more relevant for tourism activities, provide a list of good requirements that are generally adopted by the oil and gas industry to minimise the risk of fauna strike occurring. AMSA Marine Notice 15 / 2016 Minimizing the risk of collisions with cetaceans also identifies control measures for vessel operators to minimise the risk of fauna collisions (AMSA, 2016). These control measures are the same as those identified within EPBC Regulations 2000.
• Incident reporting	Vessel strikes are required to be reported under the: • Conservation Management Plan for the Blue Whale 2015–2025 (DoE, 2015) and • Conservation Advice for the Humpback Whale 2015–2020 (TSSC, 2015a); • Conservation Advice for Balaenoptera borealis (sei whale) (TSSC, 2015b); • Conservation Advice for Balaenoptera physalus (fin whale) (TSSC, 2015c).
Likelihood	**Unlikely (2)**
Residual Risk Level	**Low**

Table 4-6 Physical Interaction (Other Marine Users) – Summary EIA/ERA

Cause of Aspect	The presence of the wellheads on the seabed has the potential to result in interactions with other marine users. In addition, the presence of moving vessels within the operational area during the seabed equipment surveillance survey has the potential to result in interactions with other marine users. Note that interactions with divers and swimmers have not been considered, due to lack of appropriate sites within the operational area and distance from shore.
Impact or Risk	Interaction with other marine users has the potential to result in: • disruption to commercial activities.
Consequence Evaluation	

Receptor(s)	Description of Potential Environmental Impact
Commercial Fisheries	As identified in Section 3, several commercial fisheries have management areas that overlap the operational area associated with this EP. Fisheries which may be active within the vicinity of the operational area include the Commonwealth Northern Prawn Fishery, and the State Offshore Demersal Fishery and Licence. However, fishing activity within the area is expected to be low (e.g. Patterson et al., 2016, 2017). The wellheads protrude approximately 2-3 m above the seabed, so are ~80-92 m below the sea surface. Demersal trawling consists of towing a net across the seabed to catch fish that are generally within 2-3 m of the seabed (Baker, 2003). Protruding wellheads or other structures may potentially snag fishing nets. Based on the management framework where trawl gear is permitted in the Demersal Fishery, shown in Figure 4-12, areas where trawling is permitted does not appear to intersect with the operational area (DPIRD, 2012). Engagement with relevant stakeholders did not raise any concern or objection over the activities proposed in the EP. It is noted that the three wells have been suspended since the 1980's (with locations shown on existing navigation charts), and as such the continued presence of the wellheads is not a new aspect for marine users. Therefore, the proposed activities are not expected to result in an impact to commercial operations (via loss of catches or damage to fishing equipment) from presence of wellheads on the seabed given the long-term presence of the wellheads. The most credible impact to other marine users would be the minor deviation of commercial vessels around the seabed equipment surveillance survey small utility vessel during integrity monitoring activities. Any deviation would be minor and given the duration of the integrity monitoring, are not expected to effect travel times or fuel use of these vessels. There is no exclusion zone (Petroleum Safety Zone) currently in force around the suspended wells, and nor is one required during the seabed equipment surveillance survey. Although the well heads are expected to remain in-situ for the duration of this EP, seabed equipment surveillance survey are only expected to take a few days per well. Consequently, any impacts would be **Negligible (F)**, with no measurable little to no potential impacts to, or concerns from, affected external stakeholders.
ALARP Decision Context	**A**
Control Measure	**Source of good practice control measures**
• Pre-start notifications	Under the *Navigation Act 2012*, the Australasian Hydrographic Service (AHS) is responsible for maintaining and disseminating hydrographic and other nautical information and nautical publications including: • Notices to Mariners • AUSCOAST warnings. It is unlikely that a Notice to Mariners will be issued, given the short-term nature of the seabed equipment surveillance survey. However, this will be considered in the planning of and prior to a seabed equipment surveillance survey and should it be determined as a possible mitigation details of the vessel movements will be published in Notices to Mariners, thus enabling other marine users to plan their activities, and minimising disruption to exclusion zones. Relevant details will be provided to the Joint Rescue Coordination Centre (JRCC) to enable AUSCOAST warnings to be disseminated.
• Watch-keeping	All contracted vessels will have radar capability and 24-hour watch capability.
Likelihood	**Highly Unlikely (1)**.
Residual Risk Level	**Low**

Table 4-7 Physical Interaction (Seabed Disturbance) – Summary EIA/ERA

Cause of Aspect	During the seabed equipment surveillance survey, the ROV operates close to the seabed, and may temporarily come into direct contact with the seabed. The ROV's thrusters may also result in the suspension of seabed material. Seabed disturbance from the physical presence of the wells is not considered within the scope of this EP, as the wells were drilled in the 1980's and the wellheads have been in-situ since.
Impact or Risk	Seabed disturbance has the potential to impact on receptors, including benthic habitats and assemblages, through: • Smothering and alteration of benthic habitats; and • Localised and temporary increase in turbidity near the seabed.
Consequence Evaluation	
Receptor(s)	**Description of Potential Environmental Impact**
Soft sediment Marine invertebrates	<u>Smothering</u> The area of benthic habitat expected to be disturbed by the ROV coming into direct contact with seabed is approximately 1.5 m2. Therefore, the total disturbance area for all three wells is very small (~4.5 m2). Any impact will be limited to the immediate vicinity of each of the well locations, and thus the extent of potential impact is considered to be very localised. The benthic habitat within the Petrel and Tern fields is characterised by primarily sand, coarse shell fragments and silt; with infauna assemblages and sparse coverage of sessile epibenthic organisms. The benthic area around the individual wells is not dissimilar to the rest of the Petrel and Tern fields, and the wider Sahul Shelf. Given the lack of sensitive benthic receptors, and that damage would only occur within a small area, it is expected that any localised impacts from the ROV contacting the seabed would rapidly recolonise and recover from any disturbance. Therefore, the potential impact has been determined as **Negligible (F)**.
Soft sediment Marine invertebrates	<u>Turbidity</u> Benthic habitat may be disturbed through the temporary increase in turbidity near the seafloor when the thrusters are used to raise the ROV off the seafloor. Note, ROV activities that interact with the seabed are not constant through the activities for this EP; that is, there are three separate events that may result in individual once-off increases in local turbidity. The impact from the thrusters is not expected to cause the suspension of a large volume of material. In addition, the high settling velocity of sand (and coarser) material would ensure that the particles do not remain in suspension for an extended period of time. The location of the wells within a homogenous seabed area, and lack of sensitive benthic features, means that turbidity resulting from the described activities is expected to result in only temporary and localised impacts or disturbance, therefore the potential impact has been determined as **Negligible (F)**.
ALARP Decision Context	**A**
Control Measure	**Source of good practice control measures**
• Competence and qualifications	All ROV personnel to have relevant qualifications and/or experience to be competent to carry out survey tasks as per IMCA C005 Guidance on Competence Assurance and Assessment.
• Operating procedures	IMCA R004 Code of Practice for the Safe and Efficient Operation of Remotely Operated Vehicles refers to having operating procedures in place, that include standard procedures and any site-specific requirements. This operational procedure should be available and maintained.
Likelihood	**Remote (0)**.
Residual Risk Level	**Low**

Table 4-8 Underwater Sound Emissions – Summary EIA/ERA

Cause of Aspect	Underwater sound emissions will be generated from: • Vessel operations The noise generated from ROV operations was also considered. However, given this is considerably lower than the noise of the thrusters and propellers from a vessel, the noise from the manoeuvring of the ROV will make minimal difference to the overall noise impacts and associated impacts and as such has not been considered further.
Impact or Risk	The potential impacts of underwater sound emissions in the marine environment are: • Localised and temporary fauna behavioural disturbance that significantly affects migration or social behaviours; and • Auditory impairment, Permanent Threshold Shift (PTS).
Consequence Evaluation	
Receptor(s)	**Description of Potential Environmental Impact**
Marine Mammals	<u>Localised and Temporary Fauna Behavioural Disturbance</u> Using the National Marine Fisheries Service (NMFS) guidance for non-pulsed sound, such as vessel noise, a behavioural disturbance limit of 120 dB re 1 µPa RMS is adopted (NMFS, 2016). Richardson et al. (1995) and Southall et al. (2007) indicate that behavioural avoidance of baleen whales may onset from 140 to 160 dB re 1 µPa or possibly higher. McCauley (1998; 2004) indicates that continuous noise sources from MODU and vessel operations are expected to fall below 120 dB re 1 µPA within 4 km of the MODU / vessel. Hearing damage in marine mammals from shipping noise has not been widely reported (OSPAR, 2009). Consequently, the potential impacts and risks from noise emissions on marine mammals are considered to be Minor (D) as this type of event may result in a localised short-term effect to species of recognised conservation value.
Fish and sharks	<u>Localised and Temporary Fauna Behavioural Disturbance</u> Due to a lack of observational data on impacts to fish from continuous underwater sound sources, Popper et al. (2014) proposed qualitative indicators of relative risk of effects indicating that Peak SPL (~207 dB re 1 µPa) has the potential to result in a recoverable injury in fish that have high or medium hearing sensitivity. Temporary behavioural impacts from these sound levels may include initial startle reactions before behaviours either return to normal, or result in fish moving away from the area (Wardle et al. 2001). Thrusters from vessels have been measured to have a peak output of ~182 dB re 1 µPa (Hannay et al. 2004). As such, underwater sound levels from this activity are expected to be generated that would result in either a recoverable injury, and any impact (behavioural or other) would be temporary. Consequently, the potential impacts and risks from noise emissions on fish and sharks are considered to be Slight (E) as this type of event may result in slight effect on limited to the immediate area of the vessel which is only expected to be temporary.
Marine reptiles	<u>Localised and Temporary Fauna Behavioural Disturbance</u> Electro-physical studies have indicated that the best hearing range for marine turtles is in the range of 100-700 Hz, however no definitive thresholds are known for the sensitivity to underwater sounds or the levels required to cause pathological damage (McCauley, 1994). Using the limited information available, it has been reported that behavioural and masking changes are likely to occur at levels above 120 dB re 1 µPa (SVT Engineering Consultants 2009). Based upon (Hannay et al. 2004), there is the potential for behavioural and masking changes to occur within 4 km of the vessel during the seabed equipment surveillance survey. Consequently, the potential impacts and risks from noise emissions are considered to be Minor (D) as this type of event may result in a localised short-term effects that is expected to recover immediately upon completion of the activity.

	Auditory impairment, Permanent Threshold Shift The criteria set by Southall et al. (2007) suggests that to cause an instantaneous injury to cetaceans (including porpoises) resulting in a permanent loss in hearing, the sound must exceed 230 dB re 1 µPa (Peak SPL). Popper et al. (2014) propose qualitative indicators of relative risk of effects indicating that Peak SPL (~207 dB re 1 µPa) has the potential to result in a recoverable injury in fish that have high or medium hearing sensitivity; thus, peak levels would need to be above this to result in auditory impairment. Using the limited information available, it has been reported that physical injury and/or instantaneous permanent hearing damage to adult turtles is likely to occur at 240 dB re 1 µPa (SVT Engineering Consultants 2009). No supporting literature is available to determine levels of continuous underwater noise generated from vessel operations would be above those required to cause auditory impairment or PTS impacts on marine mammals, whales and sharks or marine turtles. As such, no further assessment of this impact has been made.
ALARP Decision Context	**A**
Control Measure	**Source of good practice control measures**
• Planned maintenance system (PMS)	It is industry good practice that a PMS is in place to ensure that the generators and thrusters are working efficiently to the required standard.
• Vessel Master • Fauna observation actions • Fauna interaction management actions	EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans – The Australian Guidelines for Whale and Dolphin Watching, describes strategies to ensure whales and dolphins are not harmed during offshore interactions with people. These guidelines were developed jointly by all state and territory governments through the Natural Resource Management Ministerial Council and although are more relevant for tourism activities, provide a list of good requirements that are generally adopted by the oil and gas industry to minimise the risk of fauna strike occurring; this also has the effect of ensuring distance from vessel propellers and so on that cause underwater sound. AMSA marine notice 15/2016 Minimizing the risk of collisions with cetaceans; also identifies control measures for vessel operators to minimise interactions with marine fauna which by proxy reduce the potential impact of underwater sound species such as marine mammals and marine turtles. These control measures are the same as those identified within EPBC Regulations 2000 and thus have not been discussed further.
Likelihood	**Unlikely (2).**
Residual Risk Level	**Low**

Table 4-9 Atmospheric Emissions – Summary EIA/ERA

Cause of Aspect	The following activities were identified as having the potential to result in air emissions: • Use of fuel by vessels.
Impact or Risk	Generation of atmospheric emissions has the potential to result in: • chronic effects to sensitive receptors from localised and temporary decrease in air quality from diesel combustion. Given the short duration and minimal fuel usage of vessel(s), the contribution of atmospheric emissions to the global greenhouse gas (GHG) effect is expected to be insignificant and has not been assessed further.
Consequence Evaluation	

Receptor(s)	Description of Potential Environmental Impact
Seabirds and Shorebirds Marine Reptiles Marine Mammals	The use of fuel (specifically marine-grade diesel) to power engines, generators and mobile and fixed plant (e.g., ROV, back-deck crane, generator), will result in gaseous emissions of greenhouse gases (GHG) such as carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O), along with non-GHG such as sulphur oxides (SOX) and nitrous oxides (NOX). The quantities of atmospheric emissions and related impacts will be similar to other vessels operating in the region for both petroleum and non-petroleum activities. Emissions from engines, generators and deck equipment may be toxic, odoriferous or aesthetically unpleasing, and will result in a localised, temporary reduction in air quality. Modelling was undertaken by BP (BP, 2013) for a large offshore project (that comprised a MODU, support vessels, helicopters, tug boats etc) to understand the extent of potential impacts associated with offshore atmospheric emissions. NO2 is the focus of the modelling as it is considered the main (non-greenhouse) atmospheric pollutant of concern, with larger predicted emission volumes compared to other pollutants, and the potential for NO2 to impact on human health (as a proxy for environmental receptors). Results of this modelling indicate that on an hourly average, there is the potential for an increase in ambient NO2 concentrations of 0.0005 ppm within 10 km of the source and an increase of less than 0.1 µg/m3 (0.00005 ppm) in ambient NO2 concentrations more than 40 km away. The Australian Ambient Air Quality National Environmental Protection (Air Quality) Measures (NEPM) recommends that hourly exposure to NO2 is <0.12 ppm and annual average exposure is <0.03 ppm. As this modelling was based upon emissions from a number of different sources including a MODU that generates a significantly higher amount of emissions due to higher diesel consumption, this modelling is very conservative and indicates that exposures above NEPM would not be expected from this activity too distant from the source of emission. Potential receptors above the sea surface within the operational area that may be exposed to reduced air quality include seabirds and marine megafauna that surface for air (e.g. marine mammal and marine turtles). Emissions will be small in quantity and will dissipate quickly into the surrounding atmosphere, therefore any reduction in air quality is not expected to result in any measurable effect and consequently, the potential impacts and risks from atmospheric emissions are evaluated as **Negligible (F)**.
ALARP Decision Context	**A**
Control Measure	**Source of good practice control measures**
• Reduced sulphur content fuel	Sulphur content of diesel/fuel oil complies with Marine Order Part 97 and Regulation 14 of MARPOL 73/78 Annex VI (fuel oil with sulphur content less than 3.50% mass/mass)
• Compliance with Marine Orders – Part 97: Marine Pollution Prevention – Air Pollution	• All vessels will comply with Marine Orders – Part 97: Marine Pollution Prevention – Air Pollution (appropriate to vessel class) for emissions from combustion of fuel including: • vessels will hold a valid International Air Pollution Prevention (IAPP) certificate and a current international energy efficiency (IEE) certificate. • All vessels (as appropriate to vessel class) will have a Ship Energy Efficiency Management Plan (SEEMP) as per MARPOL 73/78 Annex VI. • operation of engines, generators and deck equipment in accordance with manufacturer's instructions and ongoing maintenance to ensure efficient operation.
Likelihood	**Remote (0)**
Residual Risk Level	**Low**

Table 4-10 Planned Liquid Discharges – Summary EIA/ERA

Cause of Aspect	During the seabed equipment surveillance survey, the vessel will make the following planned liquid discharges: • Sewage • Grey water • Food / putrescible waste • Brine (from water treatment plant) • Cooling water • Deck drainage and bilge water. As the Operational Area is located more than 300 km from the nearest landfall at Darwin, all of these liquid wastes will be discharged to the marine environment as permitted under MARPOL Annex IV and V.
Impact or Risk	Planned liquid discharges to the marine environment could affect water quality and marine fauna in surface waters. Changes to water quality may include: • increased water temperature • increased water salinity • potential chemical toxicity in the water column. Impacts associated with the planned discharge of food waste, sewage and greywater, including changes to water and sediment quality, are presented in detail in the Reference Case [2017:1001] and have not been discussed further here. No additional impacts from the planned discharge of food waste, sewage and greywater associated with this activity are expected.
Consequence Evaluation	
Receptor(s)	**Description of Potential Environmental Impact**
Fish and sharks Marine reptiles Marine mammals	<u>Increased temperature</u> Changes in water temperature can result from discharges of cooling water. Modelling of continuous wastewater discharges (including cooling water) undertaken by Woodside for its Torosa South-1 drilling program in the Scott Reef complex found that discharge water temperature decreases quickly as it mixes with the receiving waters, with the discharge water temperature being <1 °C above ambient within 100 m (horizontally) of the discharge point, and 10 m vertically (WEL, 2014). Sensitive environmental receptors with the potential to be exposed to an increase in temperature are transient marine fauna, including whales, sharks, fish, and reptiles. Marine mammals and fish passing through the area will be able to actively avoid entrainment in any heated plume (Langford, 1990), and reptiles and sharks would be expected to behave similarly. Acclimation of test organisms at 15, 20 and 25°C allowed them to tolerate temperature increments of 8-9°C without damage (UNEP, 1985). Given the open nature of the receiving environment, the short duration of the activity, and the lack of sensitive environmental receptors, the impact of increased temperature is expected to be **Negligible (F)**.
Fish and sharks Marine reptiles Marine mammals	<u>Increased salinity</u> Changes in salinity can result from discharges of brine. Brine water will sink through the water column where it will be rapidly mixed with receiving waters and dispersed by ocean currents. As such, any potential impacts are expected to be limited to the source of the discharge where concentrations are highest. This is confirmed by studies that indicate effects from increased salinity on planktonic communities in areas of high mixing and dispersion are generally limited to the point of discharge only (Azis et al., 2003). Changes in salinity can affect the ecophysiology of marine organisms. Most marine species are able to tolerate short-term fluctuations in salinity in the order of 20% to 30% (Walker and McComb, 1990). However, larval stages, which are very crucial transition periods for marine species, are known to be more susceptible to impacts of increased salinity (Neuparth, Costa & Costa 2002). Pelagic species are mobile, it is expected that at worst, they would be subjected

	to slightly elevated salinity levels (~10-15% higher than seawater) for a very short time which they are expected to be able to tolerate. As such, transient species are not expected to experience chronic or acute effects. Given the open nature of the receiving environment, the short duration of the activity, and the lack of sensitive environmental receptors, the impact of increased salinity is expected to be **Negligible (F)**.
Plankton	Potential chemical toxicity Potential chemical toxicity can result from scale inhibitors and biocides used in the heat exchange and desalination process, and treatment of bilge and deck drainage. Scale inhibitors are typically low molecular weight phosphorous compounds that are water-soluble, and only have acute toxicity to marine organisms about two orders of magnitude higher than typically used in the water phase (Black et al., 1994). The biocides typically used in the industry are highly reactive and degrade rapidly (Black et al., 1994). Scale inhibitors and biocide used in the heat exchange and desalination process to avoid fouling of pipework are inherently safe at the low dosages used; they are usually consumed in the inhibition process, so there is little or no residual chemical concentration remaining upon discharge. Bilge and deck water may contain small volumes of hydrocarbons. OSPAR (2014) indicates that the predicted no effect concentration (PNEC) for marine organisms exposed to dispersed oil is 70.5 ppb. It should be noted that this PNEC is based upon NOECs after exposure to certain concentrations for an extended period that was greater than 7 days (OSPAR 2014). A discharge of treated bilge is non-continuous and infrequent. Modelling by Shell (2009) indicates that upon discharge, hydrocarbon and other chemical concentrations are rapidly diluted and expected to be below PNEC within a relatively short period of time. Given the nature of this discharge, marine fauna most susceptible to toxic impacts from chemical discharges are mainly limited to less mobile fish embryo, larvae, and other plankton. There is potential for short-term impacts to species that rely on plankton as a food source. Any impact to prey species would be temporary as the duration of exposure would be limited, and fish larvae and other plankton are expected to rapidly recover as they are known to have high levels of natural mortality and a rapid replacement rate (UNEP, 1985). Consequently, the potential impacts and risks from planned discharge of treated bilge and other chemicals are considered to be **Slight (E)** as this type of event may result in a slight effect to the immediate area to a species of conservation value (blue whales) through impacting their foraging habitat but only temporary as rapid recovery is expected upon completion of the seabed equipment surveillance survey.
ALARP Decision Context	**A**
Control Measure	**Source of good practice control measures**
• MARPOL-approved oil water separator • Criteria for approved discharge	AMSA Marine Order Part 91 (Marine Pollution Prevention - Oil) gives effect to parts of MARPOL Annex I. MARPOL is the International Convention for the Prevention of Pollution from Ships and is aimed at preventing both accidental pollution and pollution from routine operations.
• Planned maintenance system (PMS)	• It is industry good practice that a PMS is in place to ensure that the oil water separator continue to operate at the required standard. • Engines and associated equipment that require cooling by water will be maintained to accordance with the PMS. • It is industry good practice that a PMS is in place to ensure that the food macerator and MARPOL-approved sewage system continue to operate at the required standard.
• Sewage discharge	• Where appropriate for class, requirements in accordance with Marine Order 96 (Marine pollution prevention – sewage) 2013. This includes: • No discharge of treated or untreated sewage <3 nm from nearest land

	• Sewage discharged between 3 NM and 12 NM to be treated via an on-board sewage treatment plant (STP) approved by the International Maritime Organisation (IMO) (MARPOL MEPC.2 (IV), or MEPC.159 (55), or MEPC.227 (64)). • Sewage (treated or untreated) originating from holding tanks is discharged at a moderate rate* while the ship is proceeding enroute at a speed not less than 4 knots • *The rate of discharge shall be approved by the Administration based upon standards approved by the Organisation (MEPC.157 (55)). Recommended standards for the rate of discharge of sewage from ships can be found in Marine Order 96 • Where appropriate for class, vessels/facilities will have valid International Sewage Pollution Prevention Certificates (ISPP) • STP must be in good working order • Personnel must be appropriately trained in tasks and aware of requirements
• Putrescible waste discharge	• Where appropriate for class, requirements in accordance with Marine Order 95 (Marine pollution prevention – garbage) 2013. This includes: • All food wastes discharged >3 NM and <12 NM will be macerated to <25mm • Food waste to be discharged >12 NM but within 500 m of a stationary facility, will be macerated to <25 mm • Processing equipment must be capable of macerating to <25 mm, and be in good working order • Personnel must be appropriately trained in tasks and aware of requirements • Records of food waste disposal to be maintained in a Garbage Record Book • Vessels will maintain a Garbage Management Plan which addresses the requirements for food wastes • Vessels of 12 metres in length or over are required to display placards notifying passengers and crew of the disposal requirements, including for food wastes
Likelihood	**Unlikely (2)**
Residual Risk Level	**Low**

Table 4-11 Introduction of Marine Pests – Summary EIA/ERA

Cause of Aspect	Vessel operations have the potential to result in: • discharge of ballast water within the operational area • biofouling Both these aspects have the potential to result in the introduction of marine pests, therefore they have been assessed together.
Impact or Risk	The known and potential impacts of Invasive Marine Pests (IMPs) introduction (assuming their survival, colonisation and spread) include: • Reduction in native marine species diversity and abundance; • Displacement of native marine species; • Socio-economic impacts on commercial fisheries; and • Changes to conservation values of protected areas. No ballast water discharge or exchange is expected to occur within the territorial sea boundary. Open-ocean ballast water discharge or exchange is considered the best compromise in regard to efficacy, environmental safety and economic practicality to manage the potential risk if IMPs (DoF, 2009). The two key assumptions underpinning this are: • Changes in biological condition (including salinity) of source and recipient waters; i.e. coastal or estuarine IMPs are presumed unlikely to survive in ocean waters, and vice versa. • The transport of viable released non-indigenous organisms from open-ocean to coastal and estuarine waters, by ocean currents, is considered extremely unlikely.

Consequence Evaluation	
Receptor(s)	**Description of Potential Environmental Impact**
Soft sediment Marine invertebrates Commercial fisheries	Successful IMP invasion requires the following three steps: • Colonisation and establishment of the marine pest on a vector (e.g., vessel hull) in a donor region (e.g., home port). • Survival of the settled marine species on the vector during the voyage from the donor to the recipient region (e.g., project area). • Colonisation (e.g., dislodgement or reproduction) of the marine species in the recipient region, followed by successful establishment of a viable new local population. IMP are likely to have little or no natural competition or predators, thus potentially outcompeting native species for food or space, preying on native species, or changing the nature of the environment. It is estimated that Australia has more than 250 established marine pests, and it is estimated that approximately one in six introduced marine species becomes pests (Department of the Environment, 2015). Marine pest species can also deplete fishing grounds and aquaculture stock, with between 10% and 40% of Australia's fishing industry being potentially vulnerable to marine pest incursion. Marine pests can also damage marine and industrial infrastructure, such as encrusting jetties and marinas or blocking industrial water intake pipes. By building up on vessel hulls, they can slow the vessels down and increase fuel consumption. The benthic habitat within the operational area is expected to comprise soft sediment with the occasional hard substrate outcrop, infauna communities, and sparse epibiotic communities. Areas of higher value or sensitivity are not located within the operational area. Once established, some pests can be difficult to eradicate (Hewitt et al., 2002) and therefore there is the potential for a long-term or persistent change in habitat structure. It has been found that highly disturbed environments (such as marinas) are more susceptible to colonisation than open-water environments, where the number of dilutions and the degree of dispersal are high (Paulay et al, 2002). Successful colonisation in the recipient region would be difficult given the nature of the benthic habitats within the operational area (i.e. predominantly bare sands with patchy occurrences of hard substrate), and lack of light due to deep waters (i.e. approximately 80-100 m). If an IMP was introduced, and if it did colonise an area, it is expected that any colony would remain fragmented and isolated, and only within the vicinity of the wells (i.e. it would not be able to propagate to nearshore environments, and protected marine areas present in the wider region). Given the lack of sensitivities in the operational area, there is the potential for the introduction of an IMP to result in a medium effect to benthic habitats and as such has been evaluated as a **Moderate (C)** consequence.
ALARP Decision Context	**B**
Control Measure	**Source of good practice control measures**
• Maritime Arrivals Reporting System (MARS)	Under the *Biosecurity Act 2015*, pre-arrival information must be reported through MARS before arriving in Australian waters.
• Exchange of vessel ballast water outside Australian waters • Report ballast water discharges	The Australian Ballast Water Management Requirements (DAWR, 2017) describes the management requirements for ballast water exchange. These also require that if a vessel is mobilised from outside Australian waters; its ballast water will be exchanged before it enters Australian waters.

• Maintain a ballast water record system	
• Anti-fouling certificate	The *Protection of the Sea (Harmful Anti-fouling Systems) Act 2006* enacts the Marine Order Part 98 (Marine pollution – anti-fouling systems). This marine order requires that an anti-fouling certificate is in place for vessels.
• Biofouling management plan • Biofouling record book	The guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species (Biofouling Guidelines) MEPC.207(62)) 2011 (IMO, 2011) specifically requires a biofouling management plan and record book to be available and maintained.
Likelihood	**Highly Unlikely (1)**
Residual Risk Level	**Medium**

Table 4-12 Accident Release (Waste) – Summary EIA/ERA

Cause of Aspect	The handling and storage of materials and waste on board the vessel(s) has the potential for accidental over-boarding of hazardous/non-hazardous materials and waste. The following non-hazardous materials and wastes will be disposed of to shore, but have the potential to be accidentally dropped or disposed overboard due to overfull bins or crane operator error: • Paper and cardboard; • Aluminium, cans; • Glass; and • Plastics. The following hazardous materials may be used and waste generated using consumable products and will be disposed to shore, but may be accidentally dropped or disposed overboard: • Hydrocarbon-contaminated materials (e.g., oily rags); • Batteries, empty paint cans, aerosol cans, fluorescent tubes, printer cartridges; • Contaminated personal protective equipment (PPE); and
Impact or Risk	The potential environmental impacts associated with the accidental release of waste are: • Marine pollution (litter and a temporary and localised reduction in water quality); • Injury and entanglement of marine fauna and seabirds; and • Smothering or pollution of benthic habitats.
Consequence Evaluation	
Receptor(s)	**Description of Potential Environmental Impact**
Soft sediment Plankton Marine invertebrates Fish and sharks Commercial fisheries	<u>Hazardous Materials and Waste</u> Hazardous materials and wastes are defined as a substance or object that exhibits hazardous characteristics and are no longer fit for its intended use and requires disposal. Some of these hazardous characteristics (as outlined in Annex III to the Basel Convention) include being toxic, flammable, explosive and poisonous. Hazardous materials and wastes released to the sea cause pollution and contamination, with either direct or indirect effects on marine organisms. For example, chemical spills can impact on marine life from plankton to pelagic fish communities, causing physiological damage through ingestion or absorption through the skin. Impacts from an accidental release would be limited to the immediate area surrounding the release, prior to the dilution of the chemical with the surrounding seawater. In an open ocean environment such as the operational area, it is

	expected that any minor release would be rapidly diluted and dispersed, and thus temporary and localised. Solid hazardous materials, such as paint cans containing paint residue, batteries and so forth, would settle on the seabed if dropped overboard. Over time, this may result in the leaching of hazardous materials to the seabed, which is likely to result in a small area of substrate becoming toxic and unsuitable for colonisation by benthic fauna. Given the size of materials release it is expected that only localised impacts to benthic habitats within the operational area would be affected and unlikely to contribute to a significant loss of benthic habitat or species diversity. Given the restricted exposures and limited quantity of waste generated from this activity, it is expected that any impacts from marine pollution may have a **Slight (E**) impact to the immediate expected to recover within a number of days.
Soft sediment Plankton Marine invertebrates Fish and sharks Commercial fisheries	<u>Non-hazardous Materials and Waste</u> Non-hazardous wastes released overboard can cause smothering of benthic habitats as well as injury or death to marine fauna or seabirds through ingestion or entanglement (e.g., plastics caught around the necks of seals or ingested by seabirds and fish). For example, the TSSC (2015a) reports that there have been 104 records of cetaceans in Australian waters impacted by plastic debris through entanglement or ingestion since 1998 (humpback whales being the main species). If dropped objects such as bins are not retrievable by ROV, these items may permanently smother small areas of seabed, resulting in the loss of benthic habitat. However, as with most subsea infrastructure, the items themselves are likely to become colonised by benthic fauna over time (e.g., sponges) and become a focal area for sea life, so the net environmental impact is likely to be neutral. This would affect small areas of seabed and is not expected to contribute to the loss of benthic habitat or species diversity. Given the restricted exposures and limited quantity of waste generated from this activity, it is expected that any impacts from marine pollution may have a **Slight (E)** impact to the immediate expected to recover within a number of days.
ALARP Decision Context	**A**
Control Measure	**Source of good practice control measures**
• Garbage / waste management plan • Garbage record book	AMSA Marine Order Part 95 (Marine pollution prevention — garbage) and Marine Order Part 94, (Packaged harmful substance) gives effect to MARPOL Annex V. MARPOL is the International Convention for the Prevention of Pollution from Ships and is aimed at preventing both accidental pollution, and pollution from routine operations. Specifically, MARPOL Annex V requires that a garbage / waste management plan and garbage record book is in place and implemented.
• Waste management training / induction	The Protection of the Sea (Prevention of Pollution from Ships) Act 1983 – Part IIIC (Prevention of pollution by garbage) requires garbage to minimised, collected and stored appropriately in accordance with the Garbage Management Plan. Inductions for all Vessel crew provide an opportunity to make personnel aware of the requirements of the Garbage Management Plan during the implementation of the activity.
Likelihood	**Unlikely (2)**
Residual Risk Level	**Low**

Table 4-13 Accidental Release (LOC Vessel Collision) – Summary EIA / ERA

Cause of Aspect	The following activities have the potential to result in a spill of marine diesel oil (MDO): • A collision between a vessel and a third-party vessel that results in tank rupture and MDO loss. Vessel drift or powered grounding is not considered credible given the distance from shore and the lack of emergent features in the operational area.

Impact or Risk	The LOC (vessel collision) event has the potential to expose the environment to hydrocarbon with the potential to directly or indirectly result in: • Toxicity or physical oiling to marine habitats or fauna; • Reduction in intrinsic value / visual aesthetics; • Damage to commercial businesses. Results of stochastic oil spill modelling for the surface release of MDO have predicted: • Surface exposure above the social impact threshold was predicted to extend a maximum distance of up to 68 km from the release site, depending on the season. • Surface exposure above the sublethal ecological impact threshold was predicted to extend a maximum distance up to 32.5 km from the release site, depending on the season. • Surface exposure above the lethal ecological impact threshold was predicted to extend a maximum distance up to 7 km from the release site, depending on the season • No in-water entrained exposure above the ecological impact thresholds was predicted for any season. • No in-water dissolved exposure above the ecological impact thresholds was predicted during the summer and transitional seasons. During winter, there was a low probability (1%) that the sub-lethal ecological impact threshold would be met in a single isolated cell in the immediate vicinity of the release site. • No shoreline contact was predicted for any season. Therefore, the below consequence evaluation is focused on surface exposure only.
Consequence Evaluation	
Receptor(s)	**Description of Potential Environmental Impact**
Seabirds and Shorebirds	When first released, the MDO has higher toxicity due to the presence of volatile components. Individual birds making contact close to the spill source at the time of the spill (i.e. out to 32.5 km for potential sublethal toxicity, and 7 km for potential lethal toxicity) may suffer impacts however it is unlikely that a large number of birds will be affected given the rapid natural evaporation and dispersion that is expected to occur. Seabirds rafting, resting, diving or feeding at sea have the potential to come into contact with localised areas of sheen, however the time-based exposure requirement for toxicity effects (i.e. 48 hrs) may not occur. It is also noted that the area of exposure is localised and temporary (1-2 days following the release). As such, acute or chronic toxicity impacts (death or long-term poor health) to small numbers of birds are possible, however this is not considered significant at a population level. Consequently, the potential impacts and risks to seabirds from a vessel collision event are considered to be **Minor (D)**, as they could be expected to result in localised short-term impacts to species/habitats of recognised conservation value for a short duration but not expected to affect species populations or general ecosystem functioning.
Marine Reptiles	The number of sea snakes that may be exposed is expected to be low due to the offshore location and the extent of exposure above the threshold, before the hydrocarbon weathered further. Therefore, potential impact would be limited to individuals, with population impacts not anticipated. Marine turtles are vulnerable to the effects of oil at all life stages. Marine turtles can be exposed to surface oil externally (i.e. swimming through oil slicks) or internally (i.e. swallowing the oil). Ingested oil can harm internal organs and digestive function. Oil on their bodies can cause skin irritation and affect breathing. Marine turtles have the potential to come into contact with localised areas of MDO, however the time-based exposure requirement for toxicity effects (i.e. 48 hrs) may not occur. It is also noted the area of contact is localised and temporary (1-2 days following the release). Therefore, potential impact would be limited to individuals, with population impacts not anticipated. Consequently, the potential impacts and risks to seabirds from a vessel collision event are considered to be **Minor (D)**, as they could be expected to result in localised short-term impacts to species/habitats of recognised conservation value for a short duration but not expected to affect species populations or general ecosystem functioning.

Marine Mammals	Physical contact by individual whales or dolphins of MDO is unlikely to lead to any long-term impacts. Given the mobility of whales, only a small proportion of the migrating population would surface in the affected areas, resulting in short-term and localised consequences, with no long-term population viability effects. Consequently, the potential impacts and risks to cetaceans are considered to be **Slight (E)**, as they could be expected to result in temporary impacts (days).
ALARP Decision Context	**A**
Control Measure	**Source of good practice control measures**
• Vessel crew	AMSA Marine Order Part 3 [Seagoing qualifications] requires that crew meet the minimum standards for safely operating a vessel, including watchkeeping requirements.
• Navigational equipment	AMSA Marine Order Part 30 [Prevention of collisions] requires that onboard navigation, radar equipment, and lighting meets industry standards
• Vessel SOPEP/ emergency management plan	In accordance with MARPOL Annex I and AMSA's Marine Order Part 91, Marine Pollution Prevention – oil, a SOPEP is required to be developed based upon the Guidelines for the Development of Shipboard Oil Pollution Emergency Plans, adopted by IMO as Resolution MEPC.54(32) and approved by AMSA. To prepare for a spill event, the SOPEP details: • response equipment available to control a spill event • review cycle to ensure that the SOPEP is kept up to date • testing requirements, including the frequency and nature of these tests. In the event of a spill, the SOPEP details: • reporting requirements and a list of authorities to be contacted • activities to be undertaken to control the discharge of oil • procedures for coordinating with local officials. AMSA's Marine Order Part 21 [Safety and emergency arrangements] requires vessels to have an emergency management plan which includes recommended actions for dealing with emergencies, including damage to the vessel and pollution from the vessel. The emergency management plan/s must include: • damage control procedures; • a decision support system for emergency management; Marine Order Part 21 [Safety and emergency arrangements] also requires that the Vessel Master must: • assign the crew duties relating to emergencies that may occur on the vessel; and provide instructions on those duties. • ensure each crewmember is trained in the operation and application of all emergency appliances and equipment of the vessel.
• OPEP	Under the OPGGS(E)R, NOPSEMA require that the petroleum activity have an accepted OPEP in place before commencing the activity. In the event of a vessel collision the OPEP will be implemented.
• OSMP	Neptune Energy's OSMP details the arrangements and capability in place for: • operational monitoring of a hydrocarbon spill to inform response activities • scientific monitoring of environmental impacts of the spill and response activities. Operational monitoring will allow adequate information to be provided to aid decision making to ensure response activities are timely, safe, and appropriate. Scientific monitoring will identify if potential longer-term remediation activities may be required.
• Pre-start notifications	It is unlikely that a Notice to Mariners will be issued, given the short-term nature of the activity. However, this will be considered in the planning of and prior to a seabed equipment surveillance survey and should it be determined as a possible mitigation details of the vessel movements will be published in Notices to Mariners, thus enabling other marine users to plan their activities, and minimising disruption to exclusion zones.

	Relevant details will be provided to the JRCC to enable AUSCOAST warnings to be disseminated.
Likelihood	**Unlikely (2)**
Residual Risk Level	**Low**

5 Emergency Response Overview

5.1 Emergency Management

5.1.1 Emergency Management Arrangements

The emergency management arrangements outline a systematic approach for preventing, planning, responding to, and recovering from emergency events and is intended to provide a standardised corporate management and response structure that details emergency management documentation, Emergency Response Organisation (ERO), facilities and equipment, and training and exercises.

The ERO provides a standardised management and response structure for any emergency. Personnel filling roles within this structure may include full-time professionals, but most will be part-time volunteers drawn from across the workforce.

The system used to organise the Neptune Energy Incident Management Team (IMT) is based on the Incident Command System (ICS) and is compatible with the Australasian Inter-service Incident Management System (AIIMS). This system is compatible with the National Plan for Maritime Environmental Emergencies, with an incident management system consistent with the AIIMS.

A well-delineated IMT chain of command has been established for emergency response. As incidents grow in size or complexity, command may transfer several times. For a major incident, incident command may transfer to a designated Control Agency or to the Perth IMT, if required.

Throughout an incident, a formal handover will be conducted whenever any command or control position is transferred from one person to another.

In the event of an emergency of any type the Vessel Master will assume overall onsite command and act as the Emergency Response Coordinator (ERC). All persons aboard the vessel/s will be required to act under the ERC's directions. Emergency response support can be provided by Neptune Energy if requested by the ERC.

To establish emergency response arrangements that can be scaled up or down depending on the nature of the incident by integrating with other local, regional, national, and industry plans and resources, Neptune Energy has adopted a tiered approach in its response system. This tiered-response model scales the number of resources mobilised for a response, and the emergency team activated, according to the severity of the incident. This approach is consistent with the International Convention on Oil Pollution Preparedness, Response and Cooperation.

5.1.2 Emergency Response Plan

The Emergency Response Plan provides organisational structures, management processes, and the tools necessary to:

- respond to emergencies and prevent or mitigate emergency and/or crisis situations
- respond to incidents in a safe, rapid, and effective fashion
- restore or resume affected operations of strategic importance.

The OPEP acts as an operational document to ensure an appropriate response to the emergency events described in this EP.

Smaller spills are monitored, evaluated, and cleaned up as part of routine duties, where relevant and appropriate to the nature and scale of the spill, and will not require activation of the OPEP.

5.1.3 Net Environmental Benefit Analysis (NEBA)

A key component of emergency management is the collation of relevant data and information (including inputs from MES activities and operational monitoring), which then contributes to an assessment of the net environmental benefit of the selected response options and tactics.

Net Environmental Benefit Analysis (NEBA) is the process of considering advantages and disadvantages of different spill response options (including no response) to arrive at a spill response decision resulting in the

lowest overall environmental and social impacts. NEBA is undertaken at a strategic level to identify pre-determined recommended response strategies, and an operational NEBA is undertaken throughout the emergency response. The process requires the identification of sensitive environmental receptors and the prioritisation of those receptors for protection so that the strategic objectives of the response can be established.

5.1.4 Incident Actions Planning

For emergencies which are less complex and protracted, with response and/or recovery operations completed within a single operational period, a detailed written Incident Action Plan (IAP) is not required. For response operations expected to continue for a prolonged period, an IAP may be developed by the IMT; however, this is not expected with the vessel failure scenario.

The IAP ensures that the IMTs work towards the objectives set during the operational period, ensuring a coordinated response. Generally, an IAP will be developed if these criteria are met:

- the response requires shift changes of personnel and/or equipment
- the response, clean-up, and recovery is expected to last more than one or two days
- more than one facility, company, or a third party is involved in the management or response operations
- response resources from contractors, mutual aid, or external parties are used.

Incident action planning is an evolving, cyclical process and continues throughout response and recovery operations.

5.1.5 Operational and Scientific Monitoring

The Operational and Scientific Monitoring Plan (OSMP) provides a flexible framework for defining environmental monitoring requirements and implementation. The OSMP allows monitoring to be adapted to the nature and scale of any emergency event identified under this EP.

The OSMP provides clear initiation triggers for the individual components for the operational or scientific monitoring scopes based upon activation of the IMT and/or results from MES tactics and operational monitoring, where appropriate. Activation of the IMT and MES tactics are described within the OPEP.

5.1.6 Testing Arrangements

Response arrangements as detailed in this EP and the OPEP shall be tested:

- when they are introduced
- when they are significantly amended
- not later than 12 months after the most recent test
- if a new location for the activity is added to this EP after the response arrangements have been tested, and before the next test is conducted: test the response arrangements in relation to the new location as soon as practicable after it is added to this EP
- if a facility becomes operational after the response arrangements have been tested and before the next test is conducted: test the response arrangements in relation to the facility when it becomes operational.

The arrangements for testing the response arrangements should include:

- a statement of the objectives of testing;
- proposed schedule of tests;
- mechanisms to examine the effectiveness of response arrangements against the objectives of testing; and
- mechanisms to address recommendations arising from tests.

Neptune Energy runs desktop exercises annually to test:

- the notification, activation and/or mobilisation of the IMT
- efficiency and effectiveness of equipment and/or personnel deployment

- Neptune's ability to effectively operate and response to an emergency response.

The exercise scenario varies each year to cover a number of potential emergency situations (e.g. man overboard, spills etc.). Neptune Energy commits to simulating an oil spill scenario as the exercise prior to undertaking the monitoring survey for this EP.

Records of all exercises are kept, including event logs and action registers. Any lessons learnt, requiring changes to emergency management procedures are recorded, and changes implemented as per the Neptune Energy MoC process (Section 7.6).

5.2 Spill Response Strategies

The Petrel-3, Petrel-4 and Tern-2 OPEP outlines specific emergency response options and tactics to respond effectively to an oil spill, if a spill occurs during petroleum activities under this EP.

5.2.1 Response Option Selection

Not all response options and tactics are appropriate for every oil spill. NEBA is undertaken at a strategic level to identify pre-determined recommended response strategies, and an operational NEBA is undertaken throughout the emergency response.

Table 5-1 provides an assessment of the available oil spill response options, their suitability to MDO and their recommended adoption for the identified events. As there is no shoreline contact predicted for the spill scenario, nearshore and shoreline response is not required. The response techniques considered appropriate for this EP include:

- Natural Recovery
- Monitoring, Evaluation, and Surveillance (MES)
- Vessel Source Control

Table 5-1 Suitability of Response Options for MDO

Response Option	Viable Response	Strategic Net Benefit?
Natural Recovery	✓	✓
Monitor & Evaluate	✓	✓
Vessel Source Control	✓	✓
Dispersant Application	X	X
Contain & Recover	X	X
Protect & Deflect	X	X
Shoreline Clean-up	X	X
Oiled wildlife Response (OWR)	X	X

5.2.2 Monitoring, Evaluation, and Surveillance

Monitor and evaluate will apply to all marine spills. Higher levels of surveillance such as vessel/aerial surveillance, and oil spill trajectory modelling will only be undertaken for Level 2/3 spills given the nature and scale of the spill risk.

MES should be conducted throughout the response duration, potentially along with other response options.

It is the responsibility of the Control Agency to undertake operational monitoring during the spill event to inform the operational response. Operational monitoring includes the following:

- Aerial observation;
- Vessel-based observation;

- Computer-based tools:
- Oil spill trajectory modelling;
- Automated Data Inquiry for Oil Spills (ADIOS) (a spill weathering model).
- Utilisation of satellite tracking buoys.

For vessel-based spills, the responsibility for operational monitoring lies with AMSA (Commonwealth waters).

5.2.2.1 Capability

Neptune Energy have access to service and/or resource providers, including:

- Contracts with oil spill trajectory modelling providers.
- Suitable aircraft is available for hire in NT.
- Access to vessels or aircraft (for either MES or OSMP components).
- Third-party environmental support, including for OSMP implementation.

As the control agency, AMSA also provides support tools including:

- Trajectory modelling
- Response phase monitoring
- GIS mapping

Neptune Energy considers that the existing capability is appropriate, and there are no other practicable controls, appropriate to the nature and scale of the oil spill risk, which could be implemented to affect more timely response activities.

5.2.3 Vessel Source Control

Source control arrangements for an accidental release from vessel failures includes:

- closing water tight doors;
- checking bulkheads;
- determining whether vessel separation will increase spillage;
- isolating penetrated tanks;
- tank lightening, etc.

Implementation of source control for vessels is detailed within the below documents:

- SOPEP/Vessel emergency management plan/s (as required by AMSA Marine Orders Part 21 and/or 91)
- National Plan for Maritime Environmental Emergencies (NatPlan).

5.2.3.1 Capability

Source control for vessel failure does not rely on additional capability, resources or equipment to be mobilised to the spill location; rather it is actions taken onboard the vessel to minimise the loss of MDO and make the vessel safe.

5.3 Risk Assessment of Response Strategies

Typically, environmental risks that arise from conducting emergency response activities are similar to those already described; specifically, aspects generated by using offshore vessels are not included here as they are considered to be appropriately covered under various impact and risk evaluations in Section 4.2.

Source control for vessels is implemented onboard the vessels, by closing valves, transferring fuel between tanks, patching and so on. These activities don't present any different risks to those of vessel operations (Section 4.2), therefore are not additional risk assessment is necessary. Table 5-2 provides a summary of the environmental risk assessment associated with the MES response strategy.

Table 5-2 Monitoring, Evaluation, and Surveillance – Summary EIA/ERA

Cause of Aspect	The following hazards associated with operational monitoring have the potential to interfere with marine fauna: • Additional vessel activity (over a greater area); and • Aircraft use for aerial surveillance (fixed wing or helicopter). The potential impacts associated with vessel activities have been evaluated in Section 4.2. Based upon the nature and scale of the activities, the evaluation is considered appropriate for any marine surveillance undertaken and thus has not been considered further. As aircraft operations have not been evaluated previously, they are the focus of the following evaluation. Sound emitted from aircraft operations is typically below 500 Hz (Richardson et al. 1995). The peak-received level diminishes with increasing aircraft altitude, but the duration of audibility often increases with increasing altitude. For example, Richardson et al. (1995) reports that helicopter sound was audible in air for four minutes before it passed over underwater hydrophones, but detectable underwater for only 38 seconds at 3 m depth, and 11 seconds at 18 m depth.
Impact or Risk	The potential impacts of underwater sound emissions in the marine environment are: • Localised and temporary fauna behavioural disturbance that significantly affects migration or social behaviours; and • Auditory impairment, Permanent Threshold Shift (PTS).
Consequence Evaluation	
Receptor(s)	**Description of Potential Environmental Impact**
Fish and sharks Marine reptiles Marine mammals	Underwater sound emissions literature has been used previously (Table 4-8) to determine the impact thresholds for fauna behavioural disturbance to be 120 dB re 1 µPa for marine turtles, 140 to 160 dB re 1 µPa for marine mammals and ~207 dB re 1 µPa for fish. Helicopter flyover at 305m was measured at 108 dB re 1 µPa at 45 to 70000 Hz (Simmonds et al. 2004). Under calm sea conditions, airborne sound is totally reflected and does not enter the water; however rough seas may provide suitable angles for airborne sound to penetrate the water surface (Richardson et al. 1985). Consequently, the potential impacts and risks from noise emissions on marine mammals, turtles fish and sharks are considered to be **Slight (E)** as this type of event may result in temporary localised impact or disturbance to animals. Similar to Section 4.2 (Table 4-8), no auditory impairment (PTS) is expected from aircraft activities, and no further assessment of this impact has been made.
ALARP Decision Context	**A**
Control Measure	**Source of good practice control measures**
• Fauna observation actions • Fauna interaction management actions	EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans – The Australian Guidelines for Whale and Dolphin Watching, describes strategies to ensure whales and dolphins are not harmed during offshore interactions with people. These guidelines were developed jointly by all state and territory governments through the Natural Resource Management Ministerial Council and although are more relevant for tourism activities, provide a list of good requirements that are generally adopted by the oil and gas industry to minimise the risk of fauna strike occurring; this also has the effect of ensuring distance from aircraft and so on that cause underwater sound.
Likelihood	**Unlikely (2)**
Residual Risk Level	**Low**

6 Stakeholder Consultation

In support of the activity, Neptune Energy conducted a stakeholder assessment and engaged with relevant stakeholders to inform decision-making and planning for this petroleum activity in accordance with the requirements of Regulation 11A and 14(9) of the Environment Regulations.

The principal objectives of the Neptune Energy consultation strategy were to:

- Identify stakeholders;
- Initiate and maintain open communications between stakeholders and Neptune Energy relevant to their interests; and
- Proactively work with stakeholders on recommended strategies to minimise impacts.

At each stage, Neptune Energy:

- Complied with regulatory requirements; and
- Recorded consultation and tracked commitments made by Neptune Energy.

6.1 Consultation Management System

To achieve these objectives, the Neptune Energy consultation approach followed methodology framed around four steps:

Step	Aim/Outcome
Scoping	Identification of relevant persons or entities through mapping of impacts to stakeholder functions, interests and activities.
Making sufficient information available	Identification and sufficient availability of relevant information for stakeholders Visible point of contact of stakeholders Stakeholder notification of changes or updates to the proposed activities
Addressing merits of claims and objections	Assessment of merits must be recorded and included in the EP. Assessment of merits must involve a balanced use of research material
Closing the feedback loop	Follow up on non-response Respond to stakeholders in a timely manner Demonstrate a balance use of research material to support assessments

Where activities have been identified as likely to have an impact requiring stakeholder consultation, the relevant stakeholder group has been identified (Table 9-3).

Neptune Energy expects some additional stakeholders may be identified through on-going engagement and consultation carried forward. Recognising that there may be additional stakeholders with an interest in our activities, we have also invited interested stakeholders to indicate interest via email to the General Manager.

Table 6-1: Stakeholders for the Neptune Energy Seabed Equipment Surveillance Survey

Department or agency of the Commonwealth to which the activities to be carried out under the EP may be relevant	
Australian Fisheries Management Authority (AFMA)	Australian Hydrological Service (AHS)
Department of Defence (DoD)	Australian Maritime Safety Authority (AMSA)
Director of National Parks	
Each Department or agency of a State or the Northern Territory to which the activities to be carried out under the EP may be relevant	

Department of Primary Industry and Resources	
A person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the EP	
Fisheries:	
Northern Territory Seafood Council	Amateur Fisherman's Association of the Northern Territory
Offshore Demersal Fishery and Licences	Northern Prawn Fishery
Commonwealth Fisheries Association	Western Australian Fishing Industry Council Inc (WAFIC)
Oil spill preparedness and response agencies:	
Australian Marine Oil Spill Centre (AMOSC)	Department of Transport - WA
Any other person or organisation that the Titleholder considers relevant	
Community interests: None identified given the location of the activity	

6.2 Summary of Stakeholder Consultation

Stakeholder engagement has involved distribution of and activity information flyer in October 2017 and a series of follow up phone calls. No meetings have been requested by stakeholders.

Neptune Energy believes that the low rate of feedback and the low level of concern from stakeholders expressed to date is due to the nature and scale of the activity and low level of impacts, in a remote offshore location.

A summary of stakeholder responses, Neptune Energy's assessment of any objections or claims and response or proposed response, are provided in Table 6-2. Full copies of all stakeholder responses are provided in Appendix E.

It is acknowledged that stakeholders may still respond to information disseminated and that consultation is ongoing. All stakeholder responses shall be assessed and dealt with as per Section 6.1.

Table 6-2: Stakeholder Feedback and Assessment of Claims/Objections

Stakeholder and relevance	Relevance to Activity	Information provided (Date, Method, Record, Number)	Summary of Response	Assessment of Merits to Adverse Claim / Objection	Operators Response to each Claim / Objection	Full text response - record number
Australian Fisheries Management Authority	Management of Commonwealth Commercial Fisheries from 3nm to 200nm (EEZ)	October 2017, emailed Activity Information Flyer	Requested that all correspondence be via the generic petroleum@afma.gov.au address and it will then be disseminated to relevant managers.	No claims or objection to be assessed. All emails to only go via generic petroleum email address.	Neptune Energy confirmed that the information was sent to the appropriate fishing industry contacts as outlined in the link. requested confirmation then that any information about upcoming activities only be emailed to the 'petroleum' address and not to individual Fishery Managers.	ENG-0001
Australian Maritime Safety Authority	Safety Regulator for Marine Safety and Vessel-based Oil Spill Response in Commonwealth Waters Impacts on Shipping Routes & Navigation Warnings Marine Pollution Controller in Commonwealth Waters for Vessels	October 2017, emailed Activity Information Flyer	Requested JRCC be contacted 24-48 hours before activity commences with vessel details etc to promulgate AUSCOAST warning. Requested AHS be contacted at least 4 weeks prior to activities for NtM (vis hyrdo email) and to update charts (via datacentre email). Further response confirmed that following review of the stakeholder flyer, it is assessed that these activities will have a minimal impact upon navigational safety of vessels. When final details on the ROV inspections, including timings and duration of activities is known, please be in touch for updated advice including whether there is a requirement for the promulgation of navigational safety warnings.	When final details on the ROV inspections, including timings and duration of activities is known, titleholder will be in touch to seek updated advice including whether there is a requirement for the promulgation of navigational safety warnings. Titleholder has identified this in the EP ongoing consultation requirements.	Neptune Energy will contact AMSA at least 3 weeks prior to activities commencing to see whether there are any updated requirements for navigational safely warnings.	ENG-0002

Stakeholder and relevance	Relevance to Activity	Information provided (Date, Method, Record, Number)	Summary of Response	Assessment of Merits to Adverse Claim / Objection	Operators Response to each Claim / Objection	Full text response - record number
Australian Hydrographic Office	Commonwealth Agency responsible for Hydrographic Services such as Notice to Mariners Details of infrastructure placed on Navigation Charts Charting and Information Management	October 2017, emailed Activity Information Flyer	Response requested to provide finalised information at least three weeks prior to commencement of any works to allow for publication of notices to mariners.	Commitment made to notify 3 weeks prior. Reflected in the EP. No other claims or objections to be assessed.	Neptune Energy confirmed information would be provided to AHS at least 3 weeks prior to activities commencing	ENG-0003
Department of Defence	Potential for interaction between vessels and DoD activities	October 2017, emailed Activity Information Flyer. Response to Defence letter required, noting requirement for notification prior to activity commencing.	Response received on the 30th November. Noting that: 1. No objection to the proposed activity. 2. Due to potential presence of unexploded ordnance in the area, Neptune Energy must undertake exploration activities at its own risk. 3. Such that activities do not conflict with Defence training, Neptune Energy must notify Defence a minimum of 14 days prior to commencing activities.	Neptune Energy consider that the potential risk from unexploded ordnances is negligible given the nature of the activities, and noting that this is not an exploration activity. Notification to the Department of Defence of the activity will be undertaken 2 weeks prior to the activity commencing.	Neptune Energy confirmed notification would be provided to Defence at least 2 weeks prior to activities commencing	ENG-0004
NT Department of Primary Industry and Resources	Petroleum activity regulation	October 2017, emailed Activity Information Flyer Email resent on the 18th January 2018	No response received	No claims or objections to be assessed.	No response required	ENG-0005

Stakeholder and relevance	Relevance to Activity	Information provided (Date, Method, Record, Number)	Summary of Response	Assessment of Merits to Adverse Claim / Objection	Operators Response to each Claim / Objection	Full text response - record number
Australian Marine Oil Spill Centre (AMOSC)	Oil Spill Response Organisation	October 2017, emailed Activity Information Flyer January 2018, OPEP (Rev 0) submitted for information	No response received however, AMOSC interested in receiving a draft copy of the OPEP.	No claims or objections to be assessed.	OPEP (Rev 0) supplied to AMOSC for their information.	ENG-0006
Commonwealth Fisheries Association	Peak body for commercial fisheries. Relevant based on potential for coexistence.	October 2017, emailed Activity Information Flyer Called office on the 18th January 2018 and resent information via email same day.	No further response received	No claims or objections to be assessed. The Northern Prawn Fishery is the only Commonwealth managed fishery that may have activity in the area, however this is considered unlikely given recent years low fishing efforts within the Joseph Bonaparte Gulf. Given modelling does not predict exposure in deeper waters where this fishery is focussed, impacts are unlikely.	No response required	ENG-0007

Stakeholder and relevance	Relevance to Activity	Information provided (Date, Method, Record, Number)	Summary of Response	Assessment of Merits to Adverse Claim / Objection	Operators Response to each Claim / Objection	Full text response - record number
Northern Territory Seafood Council	Relevance due to for coexistence with commercial fisheries	October 2017, emailed Activity Information Flyer Called office on the 18th January 2018, and resent information via email same day.	No response received	No claims or objections to be assessed. The Northern Prawn Fishery is the only Commonwealth managed fishery that may have activity in the area, however this is considered unlikely given recent years low fishing efforts within the Joseph Bonaparte Gulf. Given modelling does not predict exposure in deeper waters where this fishery is focussed, impacts are unlikely The NT Demersal Fishery may have activity in the area. The two areas where trawl gear is permitted do not appear to intersect with the operational area.	No response required	ENG-0008
Amateur Fisherman's Association of the Northern Territory (AFANT)	Unlikely to be relevant due to location of activity offshore, flyer was provided for information	October 2017, emailed Activity Information Flyer	No response received. No further contact or information provided given that the interests were not likely to be impacted by the activity (based on the remote offshore location of the activity.	No claims or objections to be assessed.	No response required.	ENG-0009

Stakeholder and relevance	Relevance to Activity	Information provided (Date, Method, Record, Number)	Summary of Response	Assessment of Merits to Adverse Claim / Objection	Operators Response to each Claim / Objection	Full text response - record number
Department of Transport (DoT) WA	While oil spill response in state waters is not predicted to be required, DoT were informed.	Fact sheet emailed 14 November 17 with email noting that a LOWC event would not result in the activation of DoT as a CA.	Further information was requested on the 21st November re the potential LOWC scenario. Neptune Energy provided additional information including details of the activity and the scenario given the status of the wells as suspended. This information was acknowledged by DoT on the 8th December with a request for confirmation of the 'visual impact' distance from state waters. Additional information was provided on the 13th December which showed the area where oil may be visible as outside of state waters, excepting a small area of overlap at the limits of state waters. There is no visual impacts at or near the shoreline.	While further information was requested, there were no claims or objections to be assessed.	OPEP (Rev 0) and DoT Supporting Information document (to meet consultation requirements) was supplied to DOT on 24 February 2018. If any comments received, these will be incorporated as appropriate. No further response required. Following an Opportunity to Modify and Resubmit received from NOPSEMA in April 2018, the OPEP and DoT Supporting Information comments were revised, and provided to DoT for review on 28 May 2018.	ENG-0010

Stakeholder and relevance	Relevance to Activity	Information provided (Date, Method, Record, Number)	Summary of Response	Assessment of Merits to Adverse Claim / Objection	Operators Response to each Claim / Objection	Full text response - record number
		Following an Opportunity to Modify and Resubmit received from NOPSEMA in April 2018, the OPEP and DoT Supporting Information comments were revised, and provided to DoT for review on 28 May 2018.	Response from DoT received on 6 July 2018, specifically: • Confirm document title • DoT notes while it is not expected that there would be any impact to State waters above the actionable threshold, there could be impacts over the visual threshold. However, there are no references to notifying DoT of a spill entering State waters. Please note that DoT is the Controlling Agency for any Level 2/3 spill that enters State waters, regardless of the spill source location. • Provide some detail around the definitions of each Level of spill.	Neptune Energy considers DoT's comments to have merit, and they have been addressed in Revision 1 of the OPEP.	DoT's comments were addressed in Revision 1 of the OPEP; specifically: • Confirmed title of document • WestPlan-MOP added to Section 5.2.1; and State Waters and DoT have been added to Table 5-3 as a Control Agency; and to Table 5-4 External Notifications. • A new Table 2-2 has been added describing Neptune Energy's spill classification s, in alignment with the WestPlan-MOP and NatPlan. These proposed responses were emailed to DoT on 13 August 2018. DoT responded on 21 September 2018, stating while they have not seen the revised OPEP, DoT trusts that Neptune have included the information (as detailed in 18 Aug email) in accordance with WestPlan – MOP and the National Plan.	
		12 December 2018, emailed DoT to advise that risk profile of the activities under this EP had changed such no potential impacts expected within State waters.	No response is required.	N/A	N/A	

Stakeholder and relevance	Relevance to Activity	Information provided (Date, Method, Record, Number)	Summary of Response	Assessment of Merits to Adverse Claim / Objection	Operators Response to each Claim / Objection	Full text response - record number
Western Australian Fishing Industry Council Inc (WAFIC)	Relevant based on potential for coexistence.	21 May 2018, emailed Activity Information Flyer Rev 2, which had been revised to include an image of the suspended wells and further information on their history and future.	Further information was requested on 22 May by email and phone; specifically: • Coordinates • Water depth • Exclusion zone clarification • Distances to closest landfall	While further information was requested, there were no claims or objections to be assessed.	Requested information was included in the flyer, and provided to WAFIC on 23 May 2018. No further response has been received.	ENG-0011
Director of National Parks	Unlikely to be relevant due to location of activity offshore, flyer was provided for information	21 May 2018, emailed Activity Information Flyer Rev 2, which had been revised to include an image of the suspended wells and further information on their history and future. 3 August 2018, follow up email sent to DNP regarding no response received.	No response received.	No claims or objections to be assessed.	No response required.	ENG-0012
		11 December 2018, emailed DNP to advise that risk profile of the activities under this EP had changed such no potential impacts expected within Australian Marine Parks.	No response is required.	N/A	N/A	

Stakeholder and relevance	Relevance to Activity	Information provided (Date, Method, Record, Number)	Summary of Response	Assessment of Merits to Adverse Claim / Objection	Operators Response to each Claim / Objection	Full text response - record number
Demersal Fishery and Licences	Relevant based on potential for coexistence.	24 May 2018, posted Activity Information Flyer Rev 3, which had been revised to include an image of the suspended wells and further information on their history and future. Provided to all 18 licence holders by express post.	Response from Australia Bay Seafoods: • They see no issue with the proposed activity • Request to be kept updated if there is any change • Would like to be contacted for any future development in the area or Demersal Fishery.	The NT Demersal Fishery may have activity in the area. The two areas where trawl gear is permitted do not appear to intersect with the operational area.	Australia Bay Seafood: • Acknowledgement.	ENG-0013
Northern Prawn Fishery	Relevant based on potential for coexistence.	2 July 2018, emailed Activity Information Flyer Rev 3, which had been revised to include an image of the suspended wells and further information on their history and future. Provided to CEO.	No response received.	No claims or objections to be assessed.	No response required.	ENG-0014

6.3 Ongoing Consultation

Ongoing consultation activities for the activities will be built upon Neptune Energy's broader stakeholder consultation for offshore petroleum activities in this area. Feedback received through community engagement and consultation will be captured in Neptune's stakeholder database and actioned where appropriate.

From the stakeholder consultation undertaken, the notifications and ongoing consultation required for this activity is captured in Table 6-3.

Table 6-3 Summary of Notifications and Ongoing Consultation

Stakeholder	Notification / Ongoing Consultation Requirement	Timing	Objective	Frequency
DoD	Advanced notification of the activity	Two weeks before commencing seabed equipment surveillance survey	Location, start and finish dates	Once
AHS	Advanced notification of the activity for: • Notice to Mariners	Three weeks before commencing seabed equipment surveillance survey	Notice to Mariners	Once
AMSA JRCC	Advanced notification of the activity for: • AUSCOAST Warnings	24–48 hours before commencing seabed equipment surveillance survey	AUSCOAST Warning	Once
NOPSEMA	Notifying start of an activity	10 days before commencing activity	Official notification of commencement of the activities under OPGGS(E) Regulation 29	Once
	Notifying end of an activity	10 days after completing activity	Official notification of cessation of the activities under OPGGS(E) Regulation 29	Once
Interested parties Potentially affected parties Government agencies	Advise of any new or significant changes to activities or impacts/risks within the scope of this EP, following an evaluation; that may potentially impact marine users.	Prior to new or significant changes to activities or impacts/risks occurring	Location, start and finish dates	As required

7 Environmental Performance

Neptune Energy retains full and ultimate responsibility as the Titleholder of the activity and is responsible for ensuring that the monitoring activities at Petrel-3, Petrel-4 and Tern-2 are implemented in accordance with the performance outcomes outlined in this EP.

7.1 Neptune Energy Management System

Neptune Energy Bonaparte is an Affiliate office of Neptune Energy, headquartered in London UK. Neptune Energy's Drilling Functional Assurance Team (FAT) is based in Aberdeen UK. The objective of FAT is to provide Engineering and Operational assistance and support to the Neptune Energy Group Affiliates and parent companies. In this role, FAT develops and administers the Neptune Energy Well Operations Requirements that is used by all Neptune Energy offices. This system underpins the management of the seabed equipment surveillance survey, and the activities that would be undertaken in the event of a vessel collision.

7.1.1 Environmental Management System

The Neptune Energy Environmental Management System (EMS) for this EP is consistent with the Australian/New Zealand Standard As/NZS ISO 14001 Environmental Management Systems – Requirements for guidance with use.

7.2 Environmental Performance Monitoring

Environmental performance of the seabed equipment surveillance survey will be evaluated and reviewed to:

- Ensure all significant environmental hazards of the activity are covered (and continue to be covered) by the EP.
- Ensure that environmental management measures to achieve commitments of the EP are being implemented, reviewed and where necessary amended.
- Identify potential non-conformances and opportunities for improvement.

The following arrangements will be established to evaluate environmental performance of the activity:

- An inspection of any contracted vessels will be carried out before the activity to ensure that procedures and equipment for managing routine discharges and emissions are in place to enable compliance with the EP.
- An inspection of the vessels will be carried out by Neptune Energy during each campaign to ensure commitments outlined in the EP are complied with.
- A summary of the key information, commitments, EPO, EPS and MC for the activity will be distributed aboard the vessels, and implementation of the environmental performance outcomes and commitments will be monitored on a regular basis.

Should any inadequacies or improvements be found, the EP will be amended via a Management of Change (see Section 7.6) to ensure environmental impacts and risks of the activity are continually identified and reduced to a level that is ALARP.

7.3 Management of Non-conformance

Neptune Energy employees and contractors are required to report all environmental incidents and non-conformance with performance objectives detailed in the EP. Incidents are reported using an Incident and Hazard Report Form that includes details of the event, immediate action taken to control the situation, and corrective actions to prevent reoccurrence. Detailed investigations will be undertaken by Neptune Energy for all high potential environmental incidents.

7.4 Monitoring and Record Keeping

The following environmental and other information will be monitored and recorded during the survey (Table 7-1).

Table 7-1: Monitoring and Record Keeping Requirements

Environmental Hazard	Monitoring	Record keeping	Reporting
Treated Bilge	Volume Location Vessel Speed	Daily	EP Performance Report
Sewage Discharge	Volume Location	Daily	EP Performance Report
Food-scraps	Volume Location	Daily	EP Performance Report
Fuel Use	Volume	Daily	EP Performance Report
Incinerator (waste)	Volume Flue Temperature	Daily	EP Performance Report
Ballast Water Discharge	Volume	Daily	EP Performance Report
Chemical Inventory	Chemical Type	Weekly	EP Performance Report
Spill	Volume Chemical / Oil Type	By incident Event	Incident Report EP Performance Report

7.5 Audit and Review of the EP

Environmental performance of the activities will be audited and reviewed. These reviews are undertaken to ensure that:

- Environmental performance standards to achieve the EPOs are being implemented, reviewed and where necessary amended;
- Potential non-compliances and opportunities for continuous improvement are identified; and
- All environmental monitoring requirements are being met.

The following arrangements review the environmental performance of the activity:

- Due-diligence pre-activity inspection/audit of the vessel may be carried out prior to the work commencing (and after contract award) to verify that procedures and equipment for managing routine discharges and emissions are in place (as described in prequalification material) to enable compliance with the EP;

A summary of the EP commitments for the activity will be distributed aboard the vessel.

Independent of vessel-based inspection/audit activities, Neptune Energy shall undertake a compliance audit of the commitments contained in this EP and assess the effectiveness of the implementation strategy, during the in-force period. An audit will be conducted prior to, and following the seabed equipment surveillance survey. The pre-mobilisation inspection and compliance audits will be undertaken by independent consultants, and in line with industry accepted / best practice standards where relevant (e.g. IMCA or equivalent for vessel-based inspections).

Any opportunities for improvement or non-compliances noted will be communicated to all relevant personnel at the time of the audit to ensure adequate time to implement corrective actions. The findings and recommendations of inspections and audits will be documented and distributed to relevant personnel for comments, and any actions tracked until closed out.

Results from the environmental inspections and audits will be summarised in the annual EP performance report submitted to NOPSEMA, annually from the start of activities. This report is due within three months following the end of the reporting period.

7.6 Management of Change

The key steps (initiate, evaluate, approve, implement and close-out) in Neptune Energy's management of change (MOC) are detailed in their corporate MOC Standard.

Hazards and risks arising as a result of proposed changes to the approved plan, procedure or programme shall be assessed using the Neptune Energy Risk Assessment Matrix (**Error! Reference source not found.**).

Changes to the approved seabed equipment surveillance survey will be managed by the MoC process and it is the responsibility of the Operations Superintendent to check that any changes are assessed against the approved EP and notify the Environmental Advisor if the changes are not covered by the EP. The Environmental Advisor will then assess the impact of the proposed change on the environmental risks, as identified and described in Section 7. In the event that the proposed change introduces a significant new environmental impact or risk, results in a significant increase to an existing risk, or as a cumulative effect of a series of changes results in an increase in environmental risk, this EP will be revised for resubmission.

The risk assessment will also consider the impact of the proposed change on the environmental performance objectives defined in this EP. Where the proposed change can be managed such that the environmental performance objectives are met, this will be documented as such without the requirement for a formal revision to this EP. In the event that the proposed change has an impact such that compliance with the environmental performance objectives cannot be achieved, this EP will be revised for resubmission.

Changes to the Programme(s) (via MoC or Document Control procedures) will be referred to the Drilling Manager for approval. The Drilling Manager is responsible for ensuring any changes do not compromise well objectives agreed with sub-surface or other project areas unless agreed to by these parties.

Changes to approved drilling programmes, well designs and operations procedures will be controlled to the level that they were approved in the preceding processes. To deviate without appropriate levels of checking and confirmation has the potential to introduce unacceptable risk.

Environmentally relevant changes, such as changes to State/Commonwealth management plans or recovery plans, EPBC listed status, or availability of new literature, will be reviewed against the current content of the EP (e.g. description of the environment, risk assessments etc.). Any change required from this review will be subject to the Neptune Energy MoC process; this includes the requirement for resubmission of the EP if a proposed change will result in a significant change to environmental impact or risk assessments.

If stakeholder responses are received in future that may impact the EP (e.g. description of environment, risk assessment, ongoing consultation), any suggested changes arising from this review will be subject to the MoC process.

8 References

AMSA. 2016. Minimising the risk of collisions with cetaceans. Marine Notice 15/2016. Available online at: https://apps.amsa.gov.au/MOReview/MarineNotice/IssuedIndex [Accessed October 2017]

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 J.H.A. 2003. *Development of the 'Cocoon' Subsea Fishing Protection System*. Journal of the Society for Underwater Technology, Vol. 25, No. 2, pp.135-142.

Baker C, Potter A, Tran M, Heap AD. 2008. Sedimentology and Geomorphology of the Northwest Marine Region of Australia. Geoscience Australia, Record 2008/07. Geoscience Australia, Canberra. 220pp.

Black, K.P., Brand, G.W., Grynberg, H., Gwyther, D., Hammond, L.S., Mourtikas, S., Richardson, B.J. and Wardrop, J.A. 1994. Production facilities. In: Environmental implications of offshore oil and gas development in Australia – the findings of an independent scientific review. Swan, J.M., Neff, J.M. and Young, P.C. (eds) Australian Petroleum Exploration Association. Sydney. pp 209–407

BP. 2013. Shah Deniz Stage 2 Project. Environmental & Socio-Economic Impact Assessment. BP Development Pty Ltd.

Commonwealth of Australia. 2016. Draft National Strategy for Mitigating Vessel Strike of Marine Mega-fauna. Department of the Environment and Energy, Commonwealth of Australia.

CSIRO 2005. Collation and Analysis of Oceanographic Datasets for National Marine Bioregionalisation: The Northern Large Marine Domain. A report to the Australian Government, National Oceans Office

DAWR. 2017. Australian Ballast Water Requirements. Versions 7. Department of Agriculture and Water Resources. Available from: http://www.agriculture.gov.au/SiteCollectionDocuments/biosecurity/avm/vessels/ballast/australian-ballast-water-management-requirements.pdf [Accessed November 2017]

DEE. 2017a. Recovery Plan for Marine Turtles in Australia. Department of the Environment and Energy, Commonwealth of Australia

DEE. 2017b. Australian Marine Parks (Commonwealth Marine Reserves). Department of the Environment and Energy, Australian Government. Available from: http://www.environment.gov.au/topics/marine/marine-reserves. Accessed 10 Oct 2017.

DIIS. 2017. Offshore Petroleum Exploration Acreage Release – Australia 2017. Department of Industry, Innovation and Science. Geoscience Australia. Australian Government. Available from: http://www.petroleum-acreage.gov.au/2017/welcome-2017-offshore-petroleum-exploration-acreage-release. Accessed 31 Oct 2017.

DoE. 2015. Conservation Management Plan for the Blue Whale, 2015-2025 — A Recovery Plan under the Environmental Protection and Biodiversity Conservation Act 1999. Department of the Environment. Commonwealth of Australia.

DoF. 2009. *A Review: Biosecurity Risks Posed by Vessels and Mitigation Options*. Fisheries Occasional Publication No. 55. Department of Fisheries. Government of Western Australia.

DSEWPaC. 2012. Marine Bioreional Plan for the North-west Marine Region. Department of Sustainability, Environmental, Water, Population and Communities. Australian Government.

ERM. 2011. GDF SUEZ – Marine Baseline Survey and Ecological Assessment. Report prepared for GDF SUEZ LNG, Perth, Western Australia

Hannay, D., MacGillivray, A., Laurinolli, M. & Racca, R. 2004. Source Level Measurements from 2004 Acoustics Programme, Sakhalin Energy, pp. 66.

Hewitt, C.L., Martin, R.B., Sliwa, C., McEnnulty, F.R., Murphy, N.E., Jones, T. and Cooper, S. (eds). 2002. National introduced marine pest information system. Available online http://www.marinepests.gov.au/Pages/default.aspx Accessed 04 May 2017

IMCRA Technical Group. 1998. Interim Marine and Coastal Regionalisation for Australia: an ecosystem-based classification for marine and coastal environments. Version 3.3. Interim Marine and Coastal Regionalisation for Australia Technical Group. Environment Australia, Commonwealth Department of the Environment. Australia.

IMO. 2011. Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species (Biofouling Guidelines) MPEC.207(62)). International Maritime Organization.

Jones, D. and Morgan, G. 1994. A Field Guide to Crustaceans of Australian Waters. Reed Books, Australia.

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

Langford, T.E.L. 1990. Ecological effects of thermal discharges, xi, 468p. Elsevier.

McCauley RD 1998. Radiated underwater noise measured from the drilling rig Ocean General, rig tenders Pacific Arki and Pacific Frontier, fishing vessel Reef Venture and natural sources in the Timor Sea. Report produced for Shell Australia. 54pp.

McCauley, R.D. 2004. Underwater sea noise in the Otway Basin – drilling, seismic and blue whales. Report prepared by Centre for Marine Science and Technology, Curtin University, for Santos Ltd

Middleton, J.H. 1995. The oceanography of Australian seas. In: State of the Marine Environment Report for Australia. Department of the Environment, Sport and Territories, Canberra.

Neuparth, T., Costa, F. O., and Costa, M. H. 2002. Effects of temperature and salinity on life history of the marine amphipod Gammarus locusta. Implications for ecotoxicological testing. Ecotoxicology, 11, 61–73.

NMFS. 2016. Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Threshold Levels for Onset Permanent and Temporary Threshold Shifts. National Marine Fisheries Service. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-55. 178 pp. http://www.nmfs.noaa.gov/pr/acoustics/Acoustic%20Guidance%20Files/opr-55_acoustic_guidance_tech_memo.pdf.

OGUK. 2014. Guidance on Risk Related Decision Making. Available at: http://oilandgasuk.co.uk/product/guidance-on-risk-related-decision-making-issue-2-july-2014/ [Accessed 7 January 2017]

OSPAR. 2009. Overview of the impacts of anthropogenic underwater sound in the marine environment. OSPAR Commission.

OSPAR. 2014. Establishment of a list of Predicted No Effect Concentrations (PNECs) for naturally occurring substances in produced water. OSPAR Commission. OSPAR Agreement: 2014–05.

Patterson, H., Noriega, R., Georgeson, L., Stobutzki, I. and Curtotti, R. 2016. Fishery Status Report 2016. Australian Bureau of Agricultural and Resource Economics and Sciences, Department of Agriculture and Water Resources. Australia.

Patterson, H., Noriega R., Georgeson, L., Larcombe, J. and Curtotti, R. 2017, Fishery status reports 2017, Australian Bureau of Agricultural and Resource Economics and Sciences, Department of Agriculture and Water Resources. Australia.

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

Peel, D., Smith, J.N. and Childerhouse, S. 2016. Historical data on Australian whale vessel strikes. Presented to the IWC Scientific Committee. SC/66b/HIM/05

Popper, A.N., Hawkins, A.D., Fay, R.R., Mann, D., Bartol, S., Carlson, Th., Coombs, S., Ellison, W.T., Gentry, R., Halvorsen, M.B., Lokkeborg, S., Rogers, P., Southall, B.L., Zeddies, D.G., Tavolga, W.N. 2014. Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-

Accredited Standards Committee S3/ SC1 and registered with ANSI. Acoustical Society of America and Springer.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. Marine Mammals and Noise. Academic Press, San Diego, California. 576.

RPS 2011. Bonaparte LNG Preliminary Metocean Study. Report prepared for GDF SUEX Bonaparte LNG, Perth, Western Australia.

RPS. 2018. Petrel-4 Oil Spill Modelling. Prepared for Neptune Energy Bonaparte Pty Ltd, by RPS Australia West Pty Ltd. Report No. MAQ0747J.

RPS-APASA. 2014. Petrel Field, Bonaparte Basin: Condensate and Gas Spill Modelling. Report No. Q0327. RPS APASA Pty Ltd. Australia.

Shell. 2009. Prelude Floating LNG Project Draft Environmental Impact Statement.

Simmonds M, Dolman S, and Weilgart L (eds) 2004. Oceans of noise. A whale and Dolphin Sociaety Science Report, Chipperham, UK. 169pp.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene, C.R., Kastak, Jr., D., Ketten D.R. and Miller J.H. 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. Aquatic Mammals 33(4): 411–521.

TSSC. 2015a. Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale). Threatened Species Scientific Committee. Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/38-conservation-advice-10102015.pdf. Accessed 2 Aug 2017.

TSSC. 2015b. Approved Conservation Advice for *Balaenoptera borealis* (sei whale). Threatened Species Scientific Committee. Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/34-conservation-advice-01102015.pdf. Accessed 8 Sept 2017.

TSSC. 2015c. Approved Conservation Advice for *Balaenoptera physalus* (fin whale). Threatened Species Scientific Committee. Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/37-conservation-advice-01102015.pdf. Accessed 8 Sept 2017.

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

van Andel TH and Veevers JJ. 1967. Morphology and sediments of the Timor Sea. Bureau of Mineral Resources, Geology and Geophysics, Bulletin 83.

Walker, D.I. and McComb, A.J. 1990 Salinity Response of the Seagrass Amphibolus antartica: An Experimental Validation of Field Results. Aquatic Botany 36: 359–366.

Wardle, C.S., Carter, T.J., Urquhart, G,G, Johnstone, A.D.F., Ziolkowsko, A.M., Hampson, G. and Mackie, D. 2001. Effects of seismic air guns on marine fish. Continental Shelf Research 21 (2001) 1005–1027

WEL. 2014. Browse FLNG Development, Draft Environmental Impact Statement. EPBC 2013/7079. Woodside Energy Ltd, Perth WA.

