Bedout Basin Exploration & Appraisal Drilling Environment Plan Summary EA-00-RI-10076.03

Level 9 100 St Georges Terrace
Perth Western Australia 6000
PO Box 5624 St Georges Tce Perth WA 6831

T +61 8 6218 7100
F +61 8 6218 7200

Quadrant Energy Pty Ltd
ABN 58 605 014 935

quadrantenergy.com.au

CONTENTS:

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

Abbreviation	Description
AFMA	Australian Fisheries Management Authority
ALARP	As low as reasonably practicable
AMOSC	Australian Marine Oil Spill Centre Pty Ltd
AMSA	Australian Marine Safety Authority
APPEA	Australian Petroleum Production & Exploration Association
AIS	Automatic Identification System
BOP	Blow-out preventer
CFA	Commonwealth Fisheries Association
CMR	Commonwealth Marine Reserve
DAH	Dissolved Aromatic Hydrocarbons
DoE	(Australian) Department of the Environment
DoF	Department of Fisheries
DPaW	Department of Parks and Wildlife
EMBA	Environment that May Be Affected
EP	Environment Plan
EPO	Environmental Performance Outcome
EPS	Environmental Performance Standard
IAP	Incident Action Plan
IMS	Invasive of Marine Species
KEF	Key Ecological Feature
LCM	Lost Circulation Materials
LMS	Listed Migratory Species
LTS	Listed Threatened Species
MC	Measurement Criteria
MMA	Marine Managed Areas
MNES	Matters of National Environmental Significance
MODU	Mobile Offshore Drilling Unit
MOU	Memorandum of Understanding
MP	Marine Park
NAF	Non-Aqueous Fluid
NEBA	Net Environmental Benefit Analysis
NOPSEMA	National Offshore Petroleum Safety and Environment Management Authority
NW Shelf	Western Australia's North West Shelf
OPEP	Oil Pollution Emergency Plan
OPGGS(E)R	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009

Abbreviation	Description
OWA	Oiled Wildlife Advisors
P&A	Plug and Abandonment
PPA	Pearl Producers Association
RACON	Radar Transponder
ROV	Remotely operated vehicle
VRASS	Vessel Risk Assessment
VSP	Vertical Seismic Profiling
WAFIC	Western Australian Fishing Industry Council
WBM	Water based mud

1. INTRODUCTION

Quadrant Energy Ltd (Quadrant Energy) plan to explore and appraise for hydrocarbons in the Bedout Basin region in Commonwealth waters within permit areas WA-435-P and WA-437-P through the drilling of a series of exploration and appraisal wells. Assuming a maximum success rate and favourable market conditions for exploration, Quadrant Energy estimate up to seven wells may be drilled in prospects within the Roc and Phoenix South fields over the period of validity (5 years) of this Environment Plan (EP), and up to three wells elsewhere within these two permits depending on market conditions and the results of drilling in the Roc and Phoenix South fields shown in **Figure 2-1.**

1.1 Titleholder

Quadrant Northwest Pty Ltd is the titleholder for petroleum activities covered under the EP within WA-437-P. For the purposes of the EP it will be referred to as Quadrant Energy.

Titleholder details are as follows:

Name: Quadrant Northwest Pty Ltd

Business address: Level 9, 100 St Georges Terrace, Perth WA 6000

Telephone number: (08) 6218-7100

Fax number: (08) 6218 7200

Email address: Info@quadrantenergy.com.au

ACN: 605 014 935

1.2 Compliance

The overall purpose of the *Bedout Basin Exploration and Appraisal Drilling Environment Plan (EA-00-RI-10076.01)* (the EP) and associated *Bedout Basin Exploration and Appraisal Drilling Oil Pollution Emergency Plan* (OPEP; EA-00-RI-10076.02) is to comply with statutory requirements of the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS (E) Regulations); and to ensure that the Activity is planned and conducted in line with Quadrant environmental policies and standards, including the corporate Environmental Policy. The EP was assessed and accepted by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) on the 30th August 2016. The EP summary has been prepared in accordance with the requirements of regulation 11 (4) of the OPGGS (E) Regulations.

1.3 Summary of Key Activity

Activities are scheduled to commence in Q3 2016. The timing of subsequent activities has not been finalised; therefore the EP assumes the activities may be undertaken at any time of year over the five year validity of the EP.

For a typical exploration or appraisal well, the Activity duration is expected to be between 60 and 125 days. It is possible that the Activity duration may increase in the case of technical difficulties and interruptions (e.g. equipment failures, weather, etc.). It is envisaged that well activities are conducted in multiple campaigns, i.e. a MODU arriving to drill one or more wells in a period between two and six months, after which the MODU leaves the Operational Area.

A summary of the Activity is provided in **Table 1-1**.

Table 1-1: Key Details of Activity

General Details	
EP Expiry Date	Five years from NOPSEMA-acceptance date
Operational Area	Area within petroleum permits WA-435-P and WA-437-P
Timing Restrictions	No
Operational activities	
MODU Type	Jack-up or semi-submersible
In-field MODU No.	One
Vessel Type	Offshore Supply and Dynamically Positioned
In-field Vessel No.	One to four
Station Keeping	Pinned or Moored
Remotely Operated Vehicles (ROV)	Yes
Helicopters	Yes
Drilling and Evaluation Activities	
No. Wells	Up to ten
Estimated Total Depth (TVDAHD)	4200m to 5900m
Estimated Operations Durations	60 to 125 days
Drilling Fluid Type	Water-based muds (WBM) or Non-Aqueous Fluids (NAFs)
Well Testing	Yes
VSP	Yes
Well re-entry	Yes
Well suspension and abandonment	Yes

2. ACTIVITY LOCATION

The Operational Area is shown in **Figure 2-1**. The MODU will be located within permit areas WA-435-P and/or WA-437-P within Commonwealth waters of the Bedout Basin (a sub-basin of the Roebuck Basin) in the NW Shelf region of Western Australia. The Operational Area is approximately 38km north from the nearest shoreline (Bedout Island), 109km from the closest mainland point (Eighty Mile Beach), 116km from Port Hedland, 232km from Karratha and 339km from Broome. The water depth over the Operational Area ranges from approximately 70m to 250m.

Co-ordinates marking the boundary of the Operational Area are shown in **Table 2-1**.

Table 2-1: Co-ordinates of Operational Area

Latitude	Longitude
18° 14' 55.126" S	119° 00' 04.671" E
19° 14' 55.145" S	119° 00' 04.702" E
19° 14' 55.157" S	118° 35' 04.705" E
19° 04' 55.153" S	118° 35' 04.700" E
19° 04' 55.163" S	118° 15' 04.703" E
18° 19' 55.148" S	118° 15' 04.680" E
18° 19' 55.144" S	118° 25' 04.679" E
18° 14' 55.142" S	118° 25' 04.676" E

The exact location of future wells are subject to further geological interpretation and detailed engineering; of the potential wells to be drilled, 7 wells are to target the Phoenix and Roc fields, and therefore can be expected to be in proximity to these reservoirs as indicated in **Figure 2-1**. A further three wells may target different reservoirs within the Operational Area.

In the event of a well requiring 're-spudded' due to operational difficulties, the MODU would shift approximately 50m from the original well location and re-drill. Typically a jack-up MODU would be jacked down and moved in this scenario prior to jacking up on the new location, whereas a semi-submersible MODU would typically 'kedge' on its mooring lines (by varying tension on opposing lines).

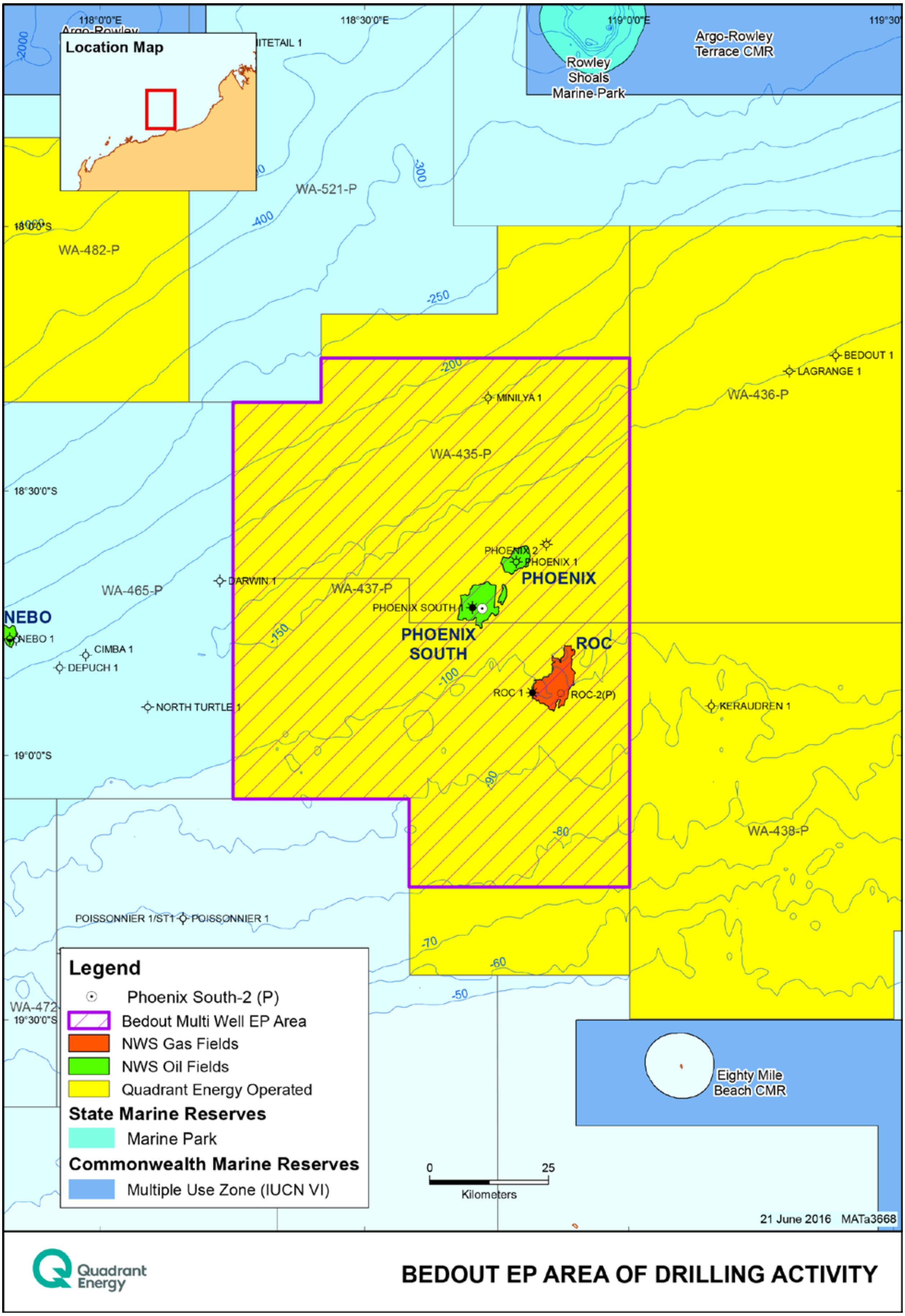

Figure 2-1: Operational Area in the Bedout Sub-Basin

3. DESCRIPTION OF THE ACTIVITY

3.1.1 Activities

The EP covers drilling, evaluating, well testing, and abandonment activities related to exploration and appraisal drilling, utilising either jack-up or semi-submersible MODUs. To conduct these activities the following may be required:

- Moving the MODU;
- MODU and vessel commissioning activities (e.g. equipment testing, tank flushing);
- Deployment and recovery of jack-up legs;
- Deployment and recovery of anchors;
- Deployment of support vessel stand-by mooring;
- Riserless drilling;
- Drilling with a close-circulating fluid system;
- Installing casing strings;
- Operation of a blow-out preventer (BOP);
- Drilling using aqueous drilling fluid systems;
- Drilling using non-aqueous drilling fluid (NAF) system;
- Use of lost circulation materials (LCM);
- Cementing;
- Use and discharge of chemicals and additives for drilling, evaluation, testing and abandonment activities;
- Well evaluation including logging-while-drilling, wireline logging, hydrocarbon sampling, vertical seismic profiling (VSP) and coring;
- Well testing (sampling, clean up, and flaring);
- Temporary abandonment activities including setting temporary mechanical or cement barriers and installing a corrosion / debris cap on the wellhead;
- Temporarily abandoning[1] wells;
- Permanent abandonment (P&A) activities including pulling casing strings, setting permanent cement barriers and removal of casings and wellhead;
- Temporary placement of equipment on the seabed;
- Re-entry of existing wells for further drilling, evaluation or testing;
- Side-track drilling, re-drilling sections and re-spud; and
- General MODU operations including the use of support vessels, helicopters and remotely operated vehicles (ROV).

[1] In the event Quadrant Energy plans to convert an exploration and appraisal well into a producing well, wells may be temporarily abandoned and additional activities to convert well to a producing well would be covered under a separate EP (i.e. Operations/Development Well EP).

3.1.2 Exclusion Zone

Within the Operational Area, activities will be undertaken over smaller areas within the MODU exclusion zone. The exclusion zone is defined as a 500 m zone around the surface of the MODU once connected to the seabed. Only one MODU will be operating in the exclusion at any point in time, however multiple support vessels and helicopters may be operating in the same area at any one time.

3.1.3 MODUs

The MODU type is dependent on the water depth of the drilling location and availability of MODU. In water depths shallower than 100m typically a jack-up MODU would be used and in waters deeper than 100m, typically a semi-submersible MODU would be used. The MODU operator is likely to vary during the period of validity of the EP.

Depending on the MODU type, the MODU will hold station at the desired well location by either;

- Pinning to the seabed and self-elevating the MODU out of the water (jack-up); or
- Anchoring to the seabed (moored semi-submersible).

Jack-up MODUs are towed into position to the drilling location by up to three support vessels. Once at the desired location and with the MODU stationary, the legs are lowered to be fully in contact with the seabed and the MODU is then raised above the sea surface.

Moored semi-submersible MODUs are towed into position to the drilling location by up to three support vessels. Once at the desired location and with the MODU stationary, the MODU ballasts down (increases its draft) to drilling draft for additional stability. Excess anchor and/or chain may be laid on the seabed for temporary storage. MODU anchors are typically deployed on arrival at location but may be pre-laid before the MODU arrives for critical operations or to save time at location. Upon departure from location anchors will be retrieved to the MODU or vessels.

Drilling will be undertaken using either a jack-up or a semi-submersible MODU which will remain at location (i.e. drilling site). The specific MODUs used may change during the 5 year duration of the EP. Although extremely unlikely, concurrent drilling of two wells is possible within the Operational Area, but the MODUs will be located at least 5nm apart to allow for the requested exclusion zone of 2.5nm around each MODU. Further the most likely scenario for concurrent drilling is the use of a semi-submersible MODU (water depths >100m) concurrent with a jack-up MODU (water depths of <100m).

In the unlikely event of concurrent drilling within the Operational Area, the EMBA from planned impacts from both activities are unlikely to overlap (and be cumulative) and no additional controls are required. The impacts and risks associated with concurrent drilling (and associated EMBA's) will be reviewed to ensure that all potential risks and impacts have been assessed adequately through the implementation of the pre-activity review process and the MoC process prior to drilling a well or multi-well campaign.

3.1.4 Drilling Discharges

Drilling discharges to sea are anticipated during the course of operations. These discharges include:

- Drilled solids or cuttings;
- Drilling fluids;
- Lost circulation materials;
- Brines;
- Cement (set or unset);
- BOP / subsea control fluids; and
- Other miscellaneous chemicals and additives (e.g. Tracer dyes, cement spacer).

3.1.5 MODU Discharges

Operational discharge streams from the MODU and support vessels are likely to include the following:

- Deck drainage / stormwater;
- Putrescible waste and sewage/grey water;
- Oily water;
- Cooling water;
- Desalination plant effluent (brine) and backwash water discharge; and
- Ballast water.

3.1.6 Waste

In addition to the drilling discharges (above), other operational waste streams from the MODU and support vessels are likely to include:

- Deck drainage;
- Putrescible waste and sewage;
- Oily water;
- Cooling water;
- Desalination plant effluent (brine) and backwash water discharge; and
- Ballast water.

3.1.7 Well evaluation and testing

Well evaluation will be performed by a combination of

- Logging-while-drilling (LWD);
- Wireline logging including VSP;
- Coring; and
- Well testing.

During well testing, hydrocarbons (oil and/or gas) and potentially formation water will be produced from the reservoir. All hydrocarbons will be flared (combusted) using burners or contained within appropriate sampling bottles or tanks. Marine discharges typically occur during well testing, such as treated recovered formation water and brine, and cooling (deluge) water. Any water recovered will be treated to remove oil prior to being discharged to the marine environment. A steam heat exchanger may be used in well testing and this results in heated water (i.e. fresh or seawater) being discharged to the marine environment.

3.1.8 Well abandonment

At the end of drilling and evaluation activities, the wells will be either temporarily or permanently abandoned. The decision on whether to temporarily or permanently abandon the well depends on the objectives and success of the well.

Temporary abandonment would be performed by setting and verifying appropriate barriers in the well, utilising either mechanical plugs or cement plugs. The wellhead and casings of a temporarily abandoned well would be preserved by installing a corrosion / debris cap on the wellhead, to allow future re-entry.

Permanent abandonment would be performed by setting and verifying appropriate barriers in the well, utilising cement plugs. The casings and wellhead would be removed at/ below the seabed.

3.1.9 Vessel Operations

The MODU will be supported by typically two to four offshore support vessels. The type of support vessel varies but are typically offshore multiple purpose or anchor handling vessels in the order of 100m in length and 18m in width. These support vessels may conduct the following activities;

- Towing the MODU;
- Holding MODU position temporarily over the drilling location;
- Running and recovering MODU anchors;
- Running and recovering vessel standby moorings, consisting of an anchor and mooring chain;
- Standing-by at close proximity to the MODU during critical operations;
- Standing-by outside the 500m exclusion zone from the MODU;
- Delivering food, potable water, drill water, fuel, dry bulk, drilling fluids, chemicals, equipment and other supplies from shore; and
- Delivering dry bulk, chemicals, equipment and waste to shore.

Transferring of items between the vessels and MODU will be conducted using the cranes or transfer hoses on-board the MODU. At least one support vessel will remain in the vicinity of the MODU at all times.

3.1.10 Helicopters

Crew changes for personnel onboard the MODU and supply of some equipment will involve transfer by helicopter. These flights will occur a minimum of three times a week dependent on operational progress and logistical constraints.

Helicopter refuelling on the MODU is not anticipated due to the close proximity of the Operational Area to the helicopter base, however, refuelling activities are provided for in the EP.

3.1.11 ROV Operations

Remotely operated vehicles (ROVs) are likely to be used to conduct visual site surveys of subsea infrastructure, monitor drilling operations and manipulate subsea equipment. An ROV is likely to be operated from the MODU, but could also be operated from a support vessel.

3.1.12 Fuel and Chemical Handling

The main engines and equipment (e.g. pumps, cranes, winches, power packs, generators) used on MODUs and support vessels require diesel for fuel, hydraulic fluid and lubricating oils for operation and maintenance of moving parts. ROV’s require hydraulic fluids for operations.

4. DESCRIPTION OF ENVIRONMENT

4.1 Environment that May Be Affected (EMBA)

Although most events and hazards associated with the activity may only affect the environment within a few hundred metres around the MODU, the worst case potential environmental impact is linked to unplanned hydrocarbon spills and may extend substantially beyond a few hundred metres. The largest predicted impact area is linked to the loss of containment scenario (**Table 4-1**) and it was used to define the Environment that May Be Affected (EMBA) (**Figure 4-1**). The combined EMBA was used to complete a search of the Matters of National Environmental Significance (MNES) database, which in turn identified the environmental values and sensitivities within the existing environment.

Table 4-1 Summary of largest credible hydrocarbon spill events considered

Scenario	Hydrocarbon Type	Maximum Credible Volume	Comment
Hydrocarbon spill (diesel) from vessel collision – MODU tank	Diesel	600m^3	Maximum credible volume based on the holding capacity of largest flank fuel tank on MODU.
Hydrocarbon spill from a loss of containment scenario – **surface** release	Crude	1,217,843m^3 (<15,816m^3/d average over 11 weeks)	Highest flow potential derived by combining the most optimistic reservoir parameters for the well design
Hydrocarbon spill from a loss of containment scenario – **seabed** release		1,187,635m^3 (<15,423m^3/d average over 11 weeks)	

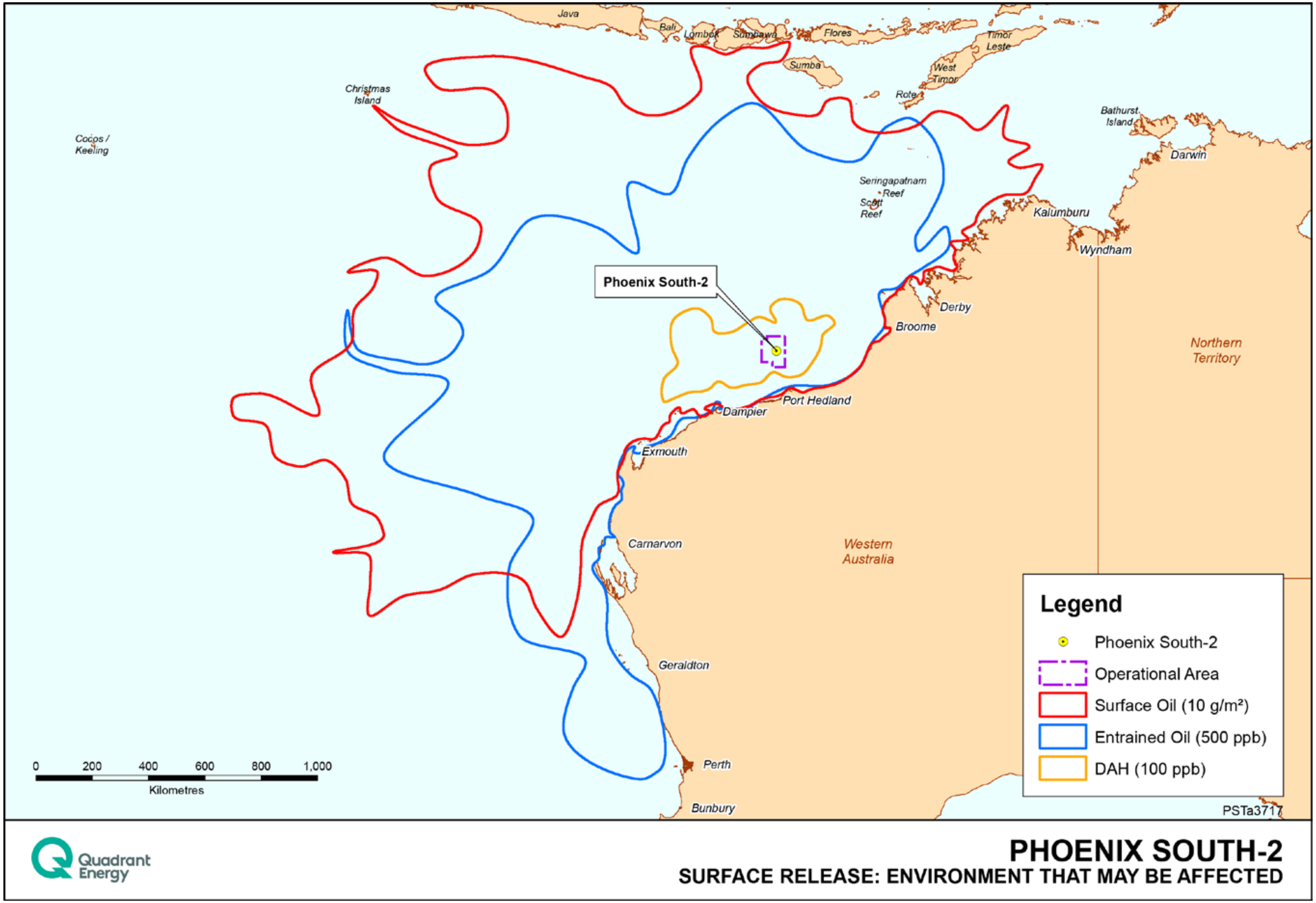

Figure 4-1: Environment that May be Affected (EMBA) from Floating oil, Entrained oil and Dissolved Aromatic Hydrocarbons (DAHs)

4.2 Physical environment and habitats

Physical environment

North West Shelf (NWS) waters are usually thermally stratified with a marked change in water density at approximately 20 m (SSE, 1993). Surface temperatures vary annually, being warmest in March (32˚C) and coolest in August (19˚C). During summer (October–March), the prevailing non-storm winds are from the southwest, west and northwest at an average speed of less than 10 knots, peak average speeds of 15–25 knots, and maximum speeds of 30 knots. Non-storm winds prevail from the north-east through to south-east at average speeds of 5–6 knots, peak average speeds of 10–15 knots, and maximum speeds of 20 knots. The wave climate is generally composed of locally generated wind waves (seas) and swells that are propagated from distant area (WNI, 1995; 1996). In the open ocean, sustained winds result in wind-forced currents of approximately 3% of the wind speed (Holloway and Nye, 1985).

Tidal and wind-forcing are the dominant contributions to local sea surface currents. The tides of the NWS have a strong semi-diurnal signal with four tide changes per day (Holloway and Nye, 1985) and a spring tidal range of 1.9 m and a highest astronomical tide of 2.9 m (Chevron Australia, 2010). The dominant sea surface offshore current (typically seaward of the 200 m isobath) is the Leeuwin Current, which carries warm tropical water south along the edge of WA's continental shelf, reaching its peak strength in winter and becoming weaker and more variable in summer. The current is described as a sea surface current, extending in depth to 150 m (BHPB, 2005; Woodside, 2005). Closer to the coast, the Ningaloo Current flows in a northerly direction, in the opposite direction to the Leeuwin Current, along the outside of the Ningaloo Reef and across the inner shelf from September to mid-April (BHPB, 2005; Woodside, 2005). The Indonesian Throughflow is the other important current influencing the upper 200 m of the outer NWS (Woodside, 2005). This current brings warm and relatively fresh water to the region from the western Pacific via the Indonesian Archipelago.

Offshore drift currents are represented as a series of interconnected eddies and connecting flows that can generate relatively fast (1–2 knots) and complex water movement. These offshore drift currents also tend to persist longer (days to weeks) than tidal current flows (hours between reversals) and thus will have greater influence upon the trajectory of slicks over time scales exceeding a few hours (APASA, 2014).

4.2.1 Habitats

The Operational Area is located in water depth ranging from 70m to 250m; depths which are unlikely to receive significant concentrations of light (Burke *et al*., 2001) and are therefore unlikely to sustain light-dependant benthic organisms such as hard corals or algae. The Operational Area is approximately 38km from the nearest shallow water environment (Bedout Island) and approximately 109km from the nearest mainland coast (Eighty Mile Beach), and therefore no coastal or shallow marine environments are included within or in close proximity to the Operational Area. The presence of marine and coastal habitats within the EMBA is summarised in **Table 4-2**.

Survey footage at the Roc-1 location in the Operational Area shows the area to be predominantly smooth and featureless with a few zones of low height sand ripples and no evidence of rock outcropping or coral reef development within the survey area. Sediment samples taken featured fine to medium sands with shell and coral fragments over cemented materials as is typical of the broader region (Fugro, 2016). This suggests that the majority of the seabed in the Operational Area is likely to be similar given that the benthic environment surrounding the Operational Area is described as a ‘featureless plain’ on the western flank of the middle NWS slope that consist of sands and gravels (Baker *et al*., 2008).

The exception to this is the key ecological feature (KEF) referred to as the ancient coastline at 125m depth contour which traverses the Operational Area and occupies approximately 4.2% of the Operational Area. The ancient coastline KEF is defined by the depth range 115m to 135m in the Northwest Shelf Province and Northwest Shelf Transition provincial bioregions (defined in IMCRA 4.0 released in 2006). Where the ancient submerged coastline provides areas of exposed hard substrate it may contribute to higher biological diversity. Little detailed knowledge is available, but the hard substrate of the escarpment is likely to support sponges, crinoids, molluscs, echinoderms (DSEWPaC 2012).

Table 4-2: Habitats within EMBA listed according to presence within the Operational Area, Provincial Bioregions of Australia and International waters

Category	Receptor	Operational Area presence	Southwest Bioregion	Central Bioregion				Northwest Bioregion					International Waters
			Southwest Shelf transition	Central Western Shelf Transition	Central Western Transition	Central Western Shelf Province	Central Western Province	Northwest Province	Northwest Transition	Northwest Shelf Province	Northwest Shelf Transition	Timor Province	
			Outer Abrolhos Islands - Shoals Abrolhos West Abrolhos Is. Wallabi Gp Abrolhos Is. Pelsaert Gp Abrolhos Is. Easter Gp Perth Canyon CMR	Ningaloo Coast Nth Ningaloo Coast Sth Outer Ningaloo Coast Nth	Outer Ningaloo Coast Nth Outer NW Ningaloo	Carnarvon - Inner Shark bay Outer Shark Bay Coast Ningaloo Coast South	Outer Abrolhos Islands - Shoals Abrolhos West Perth Canyon CMR	Outer NW Ningaloo Outer Ningaloo Coast Nth	Mermaid Reef CMR Clerke Reef MP Imperieuse Reef MP	Broome –Roebuck Eighty Mile Beach Kimberley CMR Dampier Archipelago Lowendall Is. Montebello Is. Barrow Is. Barrow- Montebello Surrounds Muiron Is. Ningaloo Nth Coast Exmouth Gulf Coast	Kimberley CMR Kimberley Coast PMZ Camden Sound Sth Coast	Ashmore Reef Outer Johnson Bank Cartier Is. CMR Scott Reef Nth Scott Reef Sth Kimberley CMR	Indonesia East
Benthic habitats	*Coral Reefs*	*Not present*	*Houtman Abrolhos Islands*	*Ningaloo Reef*	*Not Present*	• *Shark Bay* • *Bernier, Dorre and Dirk Hartog Islands*	*Not present*	*Present but no significant areas*	*Rowley Shoals (Imperieuse Reef, Clerke Reef, Mermaid Reef)*	• *Dampier Archipelago* • *Montebello, Lowendal and Barrow Islands*	• *Adele Islands* • *Long Islands* • *Heyward Islands group* • *Bonaparte archipelago* • *Cape Voltaire and Bougainville* • *Montgomery reef* • *Browse island*	• *Ashmore Reef, Cartier Island, Hibernia, Scott and Seringapatam reefs*	*Present within Indonesia East (Laut Sawu MNP)*
	Seagrasses	*Not present*	*Houtman Abrolhos Islands*	*Ningaloo Reef*	*Not Present*	*Shark Bay*	*Not present*	*Not present*	*Rowley Shoals*	• *Roebuck Bay* • *Dampier Archipelago, Regnard Islands* • *Mary Anne Reef* • *Onslow* • *Montebello and Barrow Islands*	*Southern Kimberly islands*	*Ashmore Reef, Scott Reef, Seringapatam reefs*	*Present within Indonesia East (Laut Sawu MNP)*
	Macroalgae	*Not present*	*Houtman Abrolhos Islands*	*Ningaloo Reef*	*Not Present*	*Shark Bay*	*Not present*	*Present but no significant areas*	*Present but no significant areas*	• *Shallow offshore waters of the Pilbara – Montebello, Lowendal and Barrow Islands* • *Dampier Archipelago/ Regnard Islands* • *Thevenard, Serrurier, Airlie Islands*	*Present but no significant areas*	*Ashmore Reef, Scott Reef, Seringapatam reefs*	*No significant areas*
	Non Coral Benthic Invertebrates	*Likely Present and associated with Ancient*	*Present but no significant areas*	*Present but no significant areas*	*Present but no significant areas*	*Shark Bay* *Hamelin Pool*	*Perth Canyon*	*Present but no significant areas*	*Rowley Shoals*	• *Dampier to Port Hedland* • *Barrow Island*	*Echuca Shoals*	*Ashmore Reef*	*No significant areas*

Category	Receptor	Operational Area presence	Southwest Bioregion	Central Bioregion				Northwest Bioregion					International Waters
			Southwest Shelf transition	Central Western Shelf Transition	Central Western Transition	Central Western Shelf Province	Central Western Province	Northwest Province	Northwest Transition	Northwest Shelf Province	Northwest Shelf Transition	Timor Province	
			Outer Abrolhos Islands - Shoals **Abrolhos West** **Abrolhos Is. Wallabi Gp** **Abrolhos Is. Pelsaert Gp** **Abrolhos Is. Easter Gp** **Perth Canyon CMR**	**Ningaloo Coast Nth** **Ningaloo Coast Sth** **Outer Ningaloo Coast Nth**	**Outer Ningaloo Coast Nth** **Outer NW Ningaloo**	**Carnarvon - Inner Shark bay** **Outer Shark Bay Coast** **Ningaloo Coast South**	**Outer Abrolhos Islands - Shoals** **Abrolhos West** **Perth Canyon CMR**	**Outer NW Ningaloo** **Outer Ningaloo Coast Nth**	**Mermaid Reef CMR** **Clerke Reef MP** **Imperieuse Reef MP**	**Broome –Roebuck** **Eighty Mile Beach** **Kimberley CMR** **Dampier Archipelago** **Lowendall Is.** **Montebello Is.** **Barrow Is.** **Barrow- Montebello Surrounds** **Muiron Is.** **Ningaloo Nth Coast** **Exmouth Gulf Coast**	**Kimberley CMR** **Kimberley Coast PMZ** **Camden Sound Sth Coast**	**Ashmore Reef** **Outer Johnson Bank** **Cartier Is. CMR** **Scott Reef Nth** **Scott Reef Sth** **Kimberley CMR**	**Indonesia East**
		Coastline at 125 m KEF											
Shoreline habitats	Mangroves	*Not present*	*Present but no significant areas*	*Mangrove Bay*	*None Present*	*Shark Bay*	*Not present*	*Not present*	*Present but no significant areas*	• *Exmouth Gulf* • *Montebello, Barrow and Lowendal Islands* • *Port Hedland*	• *Prince Frederick Harbour* • *Cambridge Gulf*	*None present*	*None present*
	Intertidal mud / sand flats	*Not present*	*Present but no significant areas*	*Present but no significant areas*	*None Present*	*Shark Bay*	*Not present*	*Not present*	*Not present*	• *Roebuck Bay* • *Eighty Mile Beach*	• *Colllier Bay* • *Walcott inlet* • *Prince Frederick harbour* • *Mitchell River* • *Cambridge Gulf*	*None present*	*None present*
	Intertidal platforms	*Not present*	*Present but no significant areas*	*Ningaloo Coast*	*None Present*	*Ningaloo Coast* *North-West cape*	*Not present*	*Not present*	*Present but no significant areas*	*Present but no significant areas*	*Present across region*	*None present*	*None present*
	Sandy beaches	*Not present*	*Houtman Abrolhos Islands*	*Present but no significant areas*	*None Present*	*Present but no significant areas*	*Not present*	*Not present*	*Present but no significant areas*	*Eighty Mile Beach*	*Camden Marine Park*	*None present*	*None present*
	Rocky shorelines	*Not present*	*Present but no significant areas*	*Present but no significant areas*	*None Present*	*Ningaloo Coast* *North-West Cape*	*Not present*	*Not present*	*Not present*	*Present but no significant areas*	*Present but no significant areas*	*None present*	*None present*

4.3 Protected and Significant Areas

The protected and significant areas present within the EMBA are listed in **Table 4-3.** None of these areas were identified within, or nearby, the Operational Area for the Activity, with the exception of the 125m Ancient Coastline (described below).

Ancient coastline at 125m depth contour

The shelf of the North-west Marine Region contains several terraces and steps which reflect changes in sea level that occurred over the last 100,000 years. The most prominent of these features occurs at a depth of 125 m as an escarpment along the North West Shelf and Sahul Shelf (DSEWPaC 2012). Where the ancient submerged coastline provides areas of hard substrate it may contribute to higher biological diversity. Little detailed knowledge is available, but the hard substrate of the escarpment is likely to support sponges, corals, crinoids, molluscs, echinoderms (DSEWPaC 2012).

Parts of the ancient coastline are thought to provide biologically important habitats in areas otherwise dominated by soft sediments. The topographic complexity of these escarpments may also facilitate vertical mixing of the water column providing a relatively nutrient-rich environment for species present on the escarpment (DSEWPaC 2012).

Table 4-3: Distance from Operational Area boundary to Protected Areas and Key Ecological Features within the EMBA

Value/Sensitivity	Distance from Operational Area (km)	EMBA presence
Commonwealth Marine Reserves	28	Eighty Mile Beach Commonwealth Marine Reserve
	55	Argo-Rowley Terrace Commonwealth Marine Reserve
	127	Mermaid Reef Commonwealth Marine Reserve
	155	Dampier Commonwealth Marine Reserve
	253	Kimberley Commonwealth Marine Reserve
	261	Montebello Commonwealth Marine Reserve
	319	Roebuck Commonwealth Marine Reserve
	504	Gascoyne Commonwealth Marine Reserve
	508	Ningaloo Commonwealth Marine Reserve
	784	Ashmore Reef Commonwealth Marine Reserve
	785	Shark Bay Commonwealth Marine Reserve
	792	Cartier Island Commonwealth Marine Reserve
	851	Carnarvon Canyon Commonwealth Marine Reserve
	975	Oceanic Shoals Commonwealth Marine Reserve
	996	Abrolhos Commonwealth Marine Reserve
	1266	Jurien Commonwealth Marine Reserve
	1432	Perth Canyon Commonwealth Marine Reserve
State Marine Parks (MP) and Marine Management Areas (MMA)	59	Rowley Shoals MP
	92	Eighty Mile Beach MP
	186	Proposed Dampier Archipelago MP
	247	Proposed Regnard MMA
	308	Montebello Islands MP
	316	Proposed Roebuck Bay MP
	323	Barrow Island MMA
	353	Barrow Island MP

	487	Muiron Islands MMA
	507	Ningaloo MP
	537	Lalang garram/Camden Sound MP
	800	Shark Bay MP
	1253	Jurien Bay MP
World Heritage	487	The Ningaloo Coast
	800	Shark Bay
Wetlands of International Importance (Ramsar)	109	Eighty Mile Beach
	330	Roebuck Bay
	784	Ashmore Reef National Nature Reserve
National Heritage Places	205	Dampier Archipelago (including Burrup peninsula)
	287	The West Kimberley
	308	Barrow Island and the Montebello – Barrow Islands Marine Reserve (See state and commonwealth reserves)
	487	The Ningaloo Coast (see World Heritage)
	800	Shark Bay (see World Heritage)
	891	Dirk Hartog Landing Site 1616 – Cape Inscription Area
	1070	HMAS Sydney II and HSK Kormoran Shipwreck Sites
	1129	Batavia Shipwreck Site and Survivor Camps Area 1629 – Houtman Abrolhos
Commonwealth Heritage Places	136	Mermaid Reef - Rowley Shoals (see Commonwealth Marine Reserves)
	508	Ningaloo Marine Area - Commonwealth Waters (see Commonwealth Marine Reserves)
	544	Scott Reef and Surrounds
	598	Seringapatam Reef and Surrounds
	786	Ashmore Reef National Nature Reserve (see Commonwealth Marine Reserves)
	800	Subtropical and Temperate Coastal Saltmarsh
Threatened Ecological Communities	831	Monsoon vine thickets on the coastal dunes of Dampier Peninsula
Key ecological feature (KEF)	overlaps	Ancient coastline at 125 m depth contour
	50	Mermaid Reef and Commonwealth waters surrounding Rowley Shoals
	156	Glomar Shoals
	255	Continental slope demersal fish communities
	407	Exmouth Plateau
	423	Canyons linking the Argo Abyssal Plain with Scott Plateau
	462	Canyons linking the Cuvier Abyssal Plain with the Cape Range Peninsula
	508	Commonwealth waters adjacent to Ningaloo Reef
	532	Seringapatam Reef and Commonwealth waters in the Scott Reef complex
	785	Ashmore Reef and Cartier Island and surrounding Commonwealth waters

	875	Carbonate bank and terrace system of the Sahul Shelf
	943	Western Demersal slope and associated fish communities (of the Central Western Province)
	1011	Wallaby Saddle
	1042	Western rock lobster
	1077	Commonwealth marine environment within and adjacent to the west coast inshore lagoons
	1077	Ancient Coastline at 90m-120m depth
	1098	Commonwealth marine environment surrounding the Houtman Abrolhos Islands (and adjacent shelf break)
	1137	Perth Canyon and adjacent shelf break, and other west-coast canyons
Indonesia	837	Laut Sawu (Tirosa Batek Marine Area, Sumba Strait Marine Area) Marine National Park

4.3.1 Commonwealth Marine Reserves

Eighty Mile Beach Commonwealth Marine Reserve

The Eighty Mile Beach CMR (Multiple Use Zone – IUCN Category VI) covers an area of approximately 10,785km^2 and protects the following conservation values (DoE 2014):

- Foraging areas for migratory seabirds that are adjacent to important breeding grounds**;**
- Important foraging areas for marine turtles adjacent to significant nesting sites;
- Part of the migratory pathway of the protected humpback whale;
- Areas adjacent to important foraging, nursing and pupping areas for freshwater, green and dwarf sawfish;
- Protection for terrace, banks and shoal habitats on the shelf, with depths ranging from 15m to 70m; and
- Communities and seafloor habitats of the Northwest Shelf Province provincial bioregion and the Canning, Northwest Shelf, Pilbara (nearshore), Pilbara (offshore) and Eighty Mile Beach meso-scale bioregions.

Argo-Rowley Terrace Commonwealth Marine Reserve

The Argo-Rowley CMR (Multiple Use Zone – IUCN Category VI; Marine National Park Zone – IUCN Category II) covers an area of approximately 146,099km^2 and protects the following conservation values (DoE 2014):

- Foraging areas that are important for migratory seabirds as well as the endangered loggerhead turtle;
- Important habitat and foraging for sharks;
- Protection for communities and habitats of the deeper offshore waters (220m to over 5,000m) of the region;
- Seafloor features including aprons and fans, canyons, continental rise, knolls/abyssal hills and the terrace and continental slope;
- Communities and seafloor habitats of the Northwest Transition and Timor Province provincial bioregions;
- Connectivity between the existing Mermaid Reef Marine National Nature Reserve and reefs of the Western Australian Rowley Shoals Marine Park and the deeper waters of the region; and
- Two key ecological features in the reserve.

Mermaid Reef Commonwealth Marine Reserve

The Mermaid Reef CMR (Strict Nature Reserve – IUCN Category Ia) has been re-named from the previous Mermaid Reef Marine National Nature Reserve and covers an area of approximately 540km^2. During periods of high tide, Mermaid Reef is completely submerged underwater, and therefore, is under the legal jurisdiction of the Australian Commonwealth government (DSEWPaC 2012). The reef is listed on Australia's Commonwealth Heritage List and protects the following conservation values (DoE 2014):

- National and international significant habitats including, coral formations, geomorphic features and diverse marine life;
- Key area for over 200 species of hard corals and 12 classes of soft corals with coral formations in pristine condition;
- Important areas for sharks including the grey reef shark, the white tip reef shark and the silvertip whaler;
- Important foraging area for marine turtles;
- Important area for toothed whales, dolphins, tuna and billfish**;**
- Important resting and feeding sites for migratory seabirds;
- The reserve, along with nearby Rowley Shoals Marine Park, provides the best geological example of shelf atolls in Australia; and
- Examples of the seafloor habitats and communities of the Northwest Transition.

Dampier Commonwealth Marine Reserve

The Dampier CMR (Marine National Park Zone – IUCN Category II; Habitat Protection Zone – IUCN Category IV) covers an area of approximately 1,252km^2 and protects the following conservation values (DoE 2104):

- Foraging areas for migratory seabirds that are adjacent to important breeding grounds;
- Important foraging areas for marine turtles adjacent to significant nesting sites;
- Part of the migratory pathway of the protected humpback whale;
- Protection for offshore shelf habitats and shallow shelf habitats adjacent to the Dampier Archipelago; and
- Communities and seafloor habitats of the Northwest Shelf Province provincial bioregion as well as the Pilbara (nearshore) and Pilbara (offshore) meso-scale bioregions are included.

Kimberley Commonwealth Marine Reserve

The Kimberley CMR (Multiple Use Zone – IUCN Category VI; Habitat Protection Zone – IUCN Category IV; Marine National Park Zone – IUCN Category II) covers an area of approximately 74,469km^2 and protects the following conservation values (DoE 2014):

- Important foraging areas for migratory seabirds, migratory dugongs, dolphins and threatened and migratory marine turtles;
- Important migration pathway and nursery areas for the protected humpback whale;
- Adjacent to important foraging and pupping areas for sawfish and important nesting sites for green turtles;
- Protection for communities and habitats of waters offshore of the Kimberley coastline (ranging in depth from less than 15m to 800m);
- Representation of continental shelf, slope, plateau, pinnacle, terrace, banks and shoals and deep hole/valley seafloor features; and

- Communities and seafloor habitats of the Northwest Shelf Transition, Northwest Shelf Province and Timor Province provincial bioregions along with the Kimberley, Canning, Northwest Shelf and Oceanic Shoals meso-scale bioregions.

Two key ecological features included in the reserve are:

- Ancient coastline (an area of enhanced productivity attracting baitfish which, in turn, supplies food for migrating species); and
- Continental slope demersal fish communities (the second richest area for demersal fish species in Australia).

Montebello Commonwealth Marine Reserve

The Montebello CMR (Multiple Use Zone - IUCN Category VI) covers an area of approximately 3,413km^2 and protects the following conservation values (DoE 2014):

- Foraging areas for migratory seabirds that are adjacent to important breeding areas;
- Areas used by vulnerable and migratory whale sharks for foraging;
- Foraging areas for marine turtles which are adjacent to important nesting sites;
- Section of the north and south bound migratory pathway of the humpback whale;
- Shallow shelf environments with depths ranging from 15m to 150m which provides protection for shelf and slope habitats, as well as pinnacle and terrace seafloor features;
- Seafloor habitats and communities of the Northwest Shelf Province provincial bioregions as well as the Pilbara (offshore) meso-scale bioregion; and
- One key ecological feature.

Roebuck Commonwealth Marine Reserve

The Roebuck CMR (Multiple Use Zone – IUCN Category VI) covers an area of approximately 304km^2 and protects the following conservation values (DoE 2014):

- Foraging habitat area for migratory seabirds adjacent to important breeding areas;
- Foraging area adjacent to important nesting sites for flatback turtles;
- Parts of the migratory pathway of the protected humpback whale;
- Habitat adjacent to important foraging, nursing and pupping areas for freshwater, green and dwarf sawfish;
- Foraging and calving areas for Australian snubfin, Indo-Pacific humpback and Indo-Pacific bottlenose dolphins;
- Protection for shallow shelf habitats ranging in depth from 15m to 70m; and
- Ecosystems example of the Northwest Shelf Province provincial bioregion and the Canning meso-scale bioregion.

Gascoyne Commonwealth Marine Reserve

The Gascoyne Commonwealth Marine Reserve (Multiple Use Zone – IUCN Category VI; Habitat Protection Zone – IUCN Category IV-9272 km^2; Marine National Park Zone – IUCN Category II) covers an area of approximately 81,766 km2 and protects the following conservation values (DoE 2014):

- Important foraging areas for: migratory seabirds threatened and migratory hawksbills and flatback turtles; and vulnerable and migratory whale shark;
- A continuous connectivity corridor from shallow depths around 15 m out to deep offshore waters on the abyssal plain at over 5,000m in depth;

- Seafloor features including canyon, terrace, ridge, knolls, deep hole/valley and continental rise. It also provides protection for sponge gardens in the south of the reserve adjacent to Western Australian coastal waters;
- Ecosystems examples from the Central Western Shelf Transition, the Central Western Transition and the Northwest province provincial bioregions as well as the Ningaloo meso-scale bioregion;

Three key ecological features for the region:

  - Canyons on the slope between the Cuvier Abyssal Plain and the Cape Range Peninsula (enhanced productivity, aggregations of marine life and unique sea-floor feature);
  - Exmouth Plateau (unique sea-floor feature associated with internal wave generation); and
  - Continental slope demersal fish communities (high species diversity and endemism – the most diverse slope bioregion in Australia with over 500 species found with over 64 of those species occurring nowhere else).

- The canyons in this reserve are believed to be associated with the movement of nutrients from deep water over the Cuvier Abyssal Plain onto the slope where mixing with overlying water layers occurs at the canyon heads. These canyon heads, including that of Cloates Canyon, are sites of species aggregation and are thought to play a significant role in maintaining the ecosystems and biodiversity associated with the adjacent Ningaloo Reef; and
- The reserve therefore provides connectivity between the inshore waters of the existing Ningaloo Commonwealth marine park and the deeper waters of the area.

Ningaloo Commonwealth Marine Reserve

Ningaloo Commonwealth Marine Reserve was previously named the Ningaloo Marine Park (Commonwealth Waters) and is approximately 300 km along the west coast of the Cape Range Peninsula near Exmouth, Western Australia (DSEWPaC 2012). Ningaloo Reef is the longest fringing barrier reef in Australia forming a discontinuous barrier that encloses a lagoon that varies in width from 200m to 7 km. Gaps that regularly intercept the main reef line provide channels for water exchange with deeper, cooler waters (CALM 2005). It is the only example in the world of extensive fringing coral reef on the west coast of a continent. It is included in the adjacent Western Australian Ningaloo Marine Park (State Waters), which lies between the Ningaloo Commonwealth Marine Reserve and the Western Australian coast (DSEWPaC 2012).

The Ningaloo Commonwealth Marine Reserve (Recreational Use Zone – IUCN Category II) covers an area of approximately 2,435 km^2 and protects the following conservation values (DoE 2014):

- Important habitat (foraging areas) for vulnerable and migratory whale sharks;
- Areas used for foraging by marine turtles adjacent to important nesting sites;
- Part of the migratory pathway of the protected humpback whale;
- Shallow shelf environments which provides protection for shelf and slope habitats, as well as pinnacle and terrace seafloor features; and
- Seafloor habitats and communities of the Central Western Shelf Transition.

Ashmore Reef Commonwealth Marine Reserve

The Ashmore Reef Commonwealth Marine Reserve (Sanctuary Zone – IUCN Category Ia; Recreational Use Zone – IUCN Category II) was re-named from Ashmore Reef National Nature Reserve and covers an area of approximately 583 km^2 (DoE 2014). It forms part of the North-west Commonwealth Marine Reserves Network. Interim management arrangements apply until the management plan for the North-west Commonwealth Marine Reserves Network comes into effect. As the only oceanic reef in the north-east Indian Ocean with vegetated islands (East, Middle and West Islands), Ashmore is also the largest of three emergent, oceanic reefs in the region (DSEWPaC 2012). Both the Ashmore and Cartier Islands fall under the legal memorandum of understanding between Indonesia and Australia, as both areas are located within Australia's external territory (DSEWPaC 2012).

Ashmore Reef Commonwealth Marine Reserve is located on Australia's North-West Shelf in the Indian Ocean, about 450 nautical miles (840 km) west of Darwin and 330 nautical miles (610 km) north of Broome. The reserve covers 583 km² and includes two extensive lagoons, shifting sand flats and cays, seagrass meadows, a large reef flat covering an area of 239 km2. Within the reserve are three small islands known as East, Middle and West Islands (DoE, 2002).

Ashmore was designated a Ramsar Wetland of International Importance in 2003 due to the importance of its islands providing a resting place for migratory shorebirds and supporting large seabird breeding colonies.

The proclaimed marine reserve will protect the following conservation values (DoE, 2014):

- Ecosystems, habitats and communities associated with; the North West Shelf; Timor Province; and emergent oceanic reefs;
- The island and reef habitats:
    - Contains critical nesting and internesting habitat for green turtles (including one of three genetically distinct breeding populations in the North-west Marine Region). Low level nesting activity by loggerhead turtles has also been recorded;
    - Large and significant feeding populations of green, hawksbill and loggerhead turtles occur around the reefs (it is estimated that approximately 11,000 marine turtles feed in the area throughout the year);
    - Supports a small dugong population of less than 50 individuals that breed and feed around the reef. This population is thought to be genetically distinct from other Australian populations;
    - Support some of the most important seabird rookeries on the North West Shelf including colonies of bridled terns, common noddies, brown boobies, eastern reef egrets, frigatebirds, tropicbirds, red-footed boobies, roseate terns, crested terns and lesser crested terns;
    - Is an important staging points/feeding areas for many migratory seabirds; and
    - Is internationally significant for its abundance and diversity of sea snakes.
- The cultural and heritage sites include;
- Indonesian artefacts; and
- Grave sites.

Shark Bay Commonwealth Marine Reserve

The Shark Bay Commonwealth Marine Reserve (Multiple Use Zone – IUCN Category VI) covers an area of approximately 7,443 km^2 and protects the following conservation values (DoE 2014):

- Foraging areas adjacent to important breeding areas for several species of migratory seabirds;
- Part of the migratory pathway of protected humpback whales;
- Waters that are adjacent to the largest nesting area for loggerhead turtles in Australia;
- Protection to shelf and slope habitats as well as a terrace feature;
- Examples of the shallower ecosystems of the Central Western Shelf Province and Central Western Transition provincial bioregions including the Zutydorp meso-scale bioregion; and
- Connectivity between the inshore waters of the Shark Bay World Heritage Area and the deeper waters of the area.

Cartier Island Commonwealth Marine Reserve

The Cartier Island Commonwealth Marine Reserve (Sanctuary Zone – IUCN Category Ia) was previously named the Cartier Island Marine Reserve. Similar to Ashmore Reef, the legal jurisdiction of Cartier Island is a memorandum of understanding between Indonesia and Australia, as the island is located in Australia's external territory (DSEWPaC 2012). The reserve covers an area of approximately 172 km^2, which contains an unvegetated island, mature reef, a submerged pinnacle and two shallow pools (DSWEPaC 202). The marine reserve protects the following conservation values (DoE 2014):

- Ecosystems, habitats and communities associated with; the North West Shelf; Timor Province; and emergent oceanic reefs;
- Cartier Island is an important area for protected species including large and significant feeding populations of green, hawksbill and loggerhead turtles;
- Important seabird rookeries on the North West Shelf including colonies of bridled terns, common noddies, brown boobies, eastern reef egrets, frigatebirds, tropicbirds, red-footed boobies, roseate terns, crested terns and lesser crested terns;
- Important staging points/feeding areas for many migratory seabirds;
- internationally significant abundance and diversity of sea snakes; and
- Ann Millicent historic shipwreck is an important cultural and heritage site.

Carnarvon Canyon Commonwealth Marine Reserve

The Carnarvon Canyon Commonwealth Marine Reserve (Habitat Protection Zone – IUCN Category IV) covers an area of approximately 6,177 km^2 and protects the following conservation values (DoE 2014):

- The Carnarvon Canyon a single channel canyon with seabed features that include slope, continental rise and deep holes and valleys;
- The Carnarvon Canyon ranges in depth from 1500m to over 5,000m, thereby providing habitat diversity for benthic and demersal species; and
- Central Western Transition provincial bioregion ecosystem examples are found here, which are characteristic of the biogeographic faunal transition between tropical and temperate species.

Oceanic Shoals Commonwealth Marine Reserve

The Oceanic Shoals Commonwealth Marine Reserve (Sanctuary Zone IUCN Category VI) covers an area of approximately 71, 744 km^2.

The marine reserve protects the following conservation values (DoE 2014):

- Important resting area for turtles between egg laying (internesting area) for the threatened flatback turtle and olive ridley turtle;
- Important foraging area for the threatened loggerhead turtle and olive ridley turtle;
- Examples of the ecosystems of two provincial bioregions: the Northwest Shelf Transition Province (which includes the Bonaparte, Oceanic Shoals, and Tiwi meso-scale bioregions) and the Timor Transition Province; and
- Key ecological features represented in the reserve are:
    - carbonate bank and terrace system of the Van Diemen Rise (unique sea-floor feature);
    - carbonate banks of the Joseph Bonaparte Gulf (enhanced productivity, high biodiversity, unique sea-floor feature);
    - pinnacles of the Bonaparte Basin (enhanced productivity, unique sea-floor feature); and
    - shelf break and slope of the Arafura Shelf (unique sea-floor feature).

Abrolhos Commonwealth Marine Reserve

The Abrolhos Commonwealth Marine Reserve [Marine National Park Zone – IUCN Category II-2,54 km^2; Habitat Protection Zone – IUCN Category VI-23,239 km^2; Multiple Use Zone – IUCN Category VI-56,612 km^2;

Special Purpose Zone – IUCN Category VI-5,727 km^2] covers an area of approximately 88,126 km^2 and protects the following conservation values (DoE, 2014):

- Important foraging areas for the:
  - Threatened Australian lesser noddy;
  - Northernmost breeding colony of the threatened Australian sea lion; and
  - Migratory common noddy, wedge-tailed shearwater, bridled tern, Caspian tern and roseate tern.
- Important migration habitat for the protected humpback whale;
- The second largest canyon on the west coast, the Houtman Canyon;
- Examples of the northernmost ecosystems of the Central Western Province and South-west Shelf Transition (including the Central West Coast meso-scale bioregion);
- Examples of the deeper ecosystems of the Abrolhos Islands meso-scale bioregion;
- Examples of the shallower, southernmost ecosystems of the Central Western Shelf Province provincial bioregion including the Zuytdorp meso-scale bioregion;
- Examples of the deeper ecosystems of the Central Western Transition provincial bioregion;
- Examples of diversity of seafloor features including: southern most banks and shoals of the North-west region; deep holes and valleys; slope habitats; terrace and shelf environments; and
- Six key ecological features

Jurien Commonwealth Marine Reserve

The Jurien Commonwealth Marine Reserve [Marine National Park Zone (IUCN Category II) – 31 km^2 Special Purpose Zone (IUCN Category VI) – 1,820 km^2] covers an area of approximately 1,851 km^2 and protects the following conservation values (DoE 2014):

- Important foraging areas for the:
  - Threatened soft-plumaged petrel;
  - Threatened Australian sea lion;
  - Threatened white shark; and
  - Migratory roseate tern, bridled tern, wedge-tailed shearwater, and common noddy.
- Important migration habitat for the protected humpback whale;
- Examples of the ecosystems of two provincial bioregions: the central part of the South-west Shelf Transition (which includes the Central West Coast meso-scale bioregion) and small parts of the Central Western Province;
- One key ecological feature; and
- Heritage values represented by the SS Cambewarra historic shipwreck

Perth Canyon Commonwealth Marine Reserve

Perth Canyon Commonwealth Marine Reserve (Marine National Park Zone – IUCN Category II – 1,107 km^2; Habitat Protection Zone – IUCN Category IV – 2,569 km^2; Multiple Use Zone – IUCN Category VI – 3,733 km^2) covers an area of approximately 7,409 km2 and protects the following conservation values (DoE 2014):

- Globally important seasonal feeding aggregation for the threatened blue whale;
- Important foraging areas for the:
  - Threatened soft-plumaged petrel;

  - Migratory sperm whale; and
  - Migratory wedge-tailed shearwater.
- Important migratory areas for protected humpback whales;
- Examples of the ecosystems of the southernmost parts of the Central Western Province and South-west Shelf Transition (including the Central West Coast meso-scale bioregion), and the northernmost parts of the South-west Transition and Southwest Shelf Province (including the Leeuwin-Naturaliste meso-scale bioregion); and
- Three key ecological features.

4.3.2 State Marine Parks and Management Areas

Rowley Shoals Marine Park

Lying approximately 300km north-north-west of Broome, the Rowley Shoals comprise three oceanic reef systems approximately 30–40km apart, namely Mermaid Reef, Clerke Reef and Imperieuse Reef. The Rowley Shoals Marine Park comprises the Clerke and Imperieuse Reefs which lie in State Waters. DPaW has lead management responsibility for the Marine Park, in accordance with the Rowley Shoals Management Plan (DEC 2007b).

The Rowley Shoals Marine Park was originally gazetted on 25 May 1990 as a Class A reserve and on 10 December 2004 the boundary was amended to extend the Park to the State Waters limit. The Park now covers approximately 87,632ha (DEC 2007b). Mermaid Reef lies in Commonwealth waters and comprises the Mermaid Reef Marine National Nature Reserve managed by the Commonwealth Department of Environment (DEWHA 2008).

The Rowley Shoals Marine Park is characterised by spectacular intertidal and subtidal coral reefs, exceptionally rich and diverse marine fauna and high water quality. These attributes and the low level of use of the area contribute to the Park’s unique wilderness qualities, which are a significant drawcard for visitors. Lying in the headwaters of the Leeuwin Current, the Shoals are thought to provide a source of invertebrate and fish recruits for reefs further south and as such are regionally significant. The remoteness of the Shoals and low use have ensured that the marine environment of the Shoals is in a near natural state, particularly relative to other reefs in the Indo-West Pacific region which are subject to intense ongoing human pressures and destructive fishing practices. The Rowley Shoals are of national and international significance and provide an important global benchmark for Indo-West Pacific reefs (DEC 2007b).

Eighty Mile Beach Marine Park

The Eighty Mile Beach Marine Park, located between Port Hedland and Broome, was gazetted on 29 January 2013. It covers an area of approximately 200,000ha stretching for some 220km from Cape Missiessy to Cape Keraudren, and includes sanctuary, recreation, general use and special purpose zones. The park is managed under the Eighty Mile Beach Marine Park Management Plan 2014-20124 (DPaW, 2014).

The listed ecological values of the Eighty Mile Beach Marine Park include the high sediment and water quality, the juxtaposition of the beach, coastal topography and seabed and the diverse and ecologically important habitats and marine/coastal flora and fauna. The listed habitat values of the marine park are as follows:

- The intertidal sand and mudflat communities supporting a high abundance and diversity of invertebrate life and providing a valuable food source for shorebirds (including migratory species) and other fauna;
- The diverse subtidal filter-feeding communities;
- Macroalgal and seagrass communities providing habitat and feeding opportunities for fish, invertebrates and dugongs;

- High diversity intertidal and subtidal coral reef communities; and
- Mangrove communities and adjacent saltmarshes provide nutrients to the surrounding waters and habitat for fish and invertebrates.

The listed marine and coastal fauna values are as follows:

- A high diversity and abundance of nationally and internationally important shorebirds and waders (including migratory species) are found in the marine park;
- Flatback turtles are endemic to northern Australia and nest at Eighty Mile Beach;
- Dugongs and several whale and dolphin species inhabit or migrate through the marine park;
- A highly diverse marine invertebrate fauna provides an important food source for a variety of animals, including birds, fish and turtles, along with recreational and commercial fishing opportunities;
- A diversity of fish species provide recreational and commercial fishing opportunities; and
- A diversity of sharks and rays, including several protected species, are found in the park.

In addition to these natural values, the marine park contains land and sea important to traditional indigenous owners through identity and place, family networks, spiritual practice and resource gathering. The marine park also has a history of European activity including exploration, pastoralism and commercial fishing (e.g. the pearl oyster fishery). The park contains a historical WWII plane wreck (*Dornier Do-24 X-36*) and shipwrecks (two pearl luggers). The marine park provides tourism opportunity and recreational value through its remoteness, diversity and abundance of habitats and marine fauna and the pristine nature of the marine and coastal environment.

The marine park contains vast intertidal sand and mudflats that extend up to 4km wide at low tide and provide a rich source of food for many species. Eighty Mile Beach Marine Park is one of the world's most important feeding grounds for small wading birds that migrate to the area each summer, travelling from countries thousands of kilometres away (DPaW 2014).

Montebello Islands Marine Park

The Montebello Islands MP is an ‘A’ Class Reserve (DEC 2007a) and its northern and western boundaries follow the seaward extent of Western Australian state waters (DEC 2007a). Zoning within the Montebello Islands MP is a combination of sanctuary, recreation, special purpose (benthic protection), special purpose (pearling), and general use (DEC 2007a).

The Montebello Islands comprise over 100 islands, the majority of which are rocky outcrops; rocky shore accounts for 81% of shoreline habitat (DEC 2007a). Other marine habitats within the marine park include coral reefs, mangroves, intertidal flats, extensive sheltered lagoonal waters, and shallow algal and seagrass reef platform extending to the south of the Montebello Islands to the Rowley Shelf.

Ecologically, the marine park’s values include important turtle nesting sites, feeding and resting areas for migrating shorebirds, seabird nesting areas, dugong foraging areas, globally-unique mangrove communities, and highly diverse fish and invertebrate assemblages (DEC 2007a). Also, the sediment and water quality of the marine park are considered pristine (DEC 2007a) and are essential to the maintenance of the marine ecosystems and associated biota.

Economic values within the Montebello Islands MP include commercial pearl culture, commercial line and trap fishing, and an increasing recreational usage (DEC 2007a). Special purpose zones for pearling are established for the existing leaseholder to allow pearling to be the priority use of these areas (DEC 2007a). Commercial fishing includes a trap fishery for reef fishes, mainly in water depths of 30–100 m, and wet lining for reef fish and mackerel. Fish trawling also occurs in the waters near to the Montebello Islands. A tourist houseboat operates out of Claret Bay, at the southern end of Hermite Island, during the winter months. The Montebello Islands are becoming more frequently used by recreational boaters for camping, fishing and diving activities.

Barrow Island Marine Management Area

The Barrow Island MMA is the largest reserve within the Montebello/Barrow Islands marine conservation reserves (DEC 2007a) and includes most of the waters around Barrow Island, the Lowendal Islands and the Barrow Island Marine Park, with the exclusion of the port areas of Barrow Island and Varanus Island.

The MMA is not zoned apart from one specific management zone: the Bandicoot Bay Conservation Area. This conservation area is on the southern coast of Barrow Island and has been created to protect benthic fauna and seabirds. It includes the largest intertidal sand/mudflat community in the reserves, is known to be high in invertebrate diversity and is an important feeding area for migratory birds.

As for the other reserves in the Montebello/Barrow Islands marine conservation reserves, the Barrow Island MMA includes significant breeding and nesting areas for marine turtles and the waters support a diversity of tropical marine fauna, important coral reefs and unique mangrove communities (DEC 2007a). Green, hawksbill and flatback turtles regularly use the island's beaches for breeding, and loggerhead turtles are also occasionally sighted.

Barrow Island Marine Park

The Barrow Island MP covers 4,169 ha, all of which is zoned as sanctuary zone (the Western Barrow Island Sanctuary Zone) (DEC 2007a). It includes Biggada Reef, an ecologically significant fringing reef, and Turtle Bay, an important turtle aggregation and breeding area (DEC 2007a). Representative areas of seagrass, macroalgal and deep water habitat are also represented within the marine park (DEC 2007a). Passive recreational activities (such as snorkelling, diving and boating) are permitted but extractive activities such as fishing and hunting are not.

Muiron Islands Marine Management Area

The Ningaloo Marine Park Management Plan (CALM 2005) created a MMA for the Muiron Islands, immediately adjacent to the northern end of the Park. This is managed as an integrated area together with the Ningaloo Marine Park, but its status as a MMA means that some activities, including oil and gas exploration, are still permitted under a strict environmental assessment process involving both the DMP and NOPSEMA.

The Muiron Islands, located 15 km northeast of the North West Cape comprise the North and South Muiron Islands and cover an area of 1,400 ha (AHC 2006). They are low limestone islands (maximum height of 18m above sea level (ASL)) with some areas of sandy beaches, macroalgae and seagrass beds in the shallow waters (particularly on the eastern sides) and coral reef up to depths of 5m, which surrounds both sides of South Muiron Island and the eastern side of North Muiron Island. The Muiron Islands MMA was WA's first MMA, gazetted in November 2004. It covers an area of 28,616 ha and occurs entirely within state waters (CALM 2005).

Ningaloo Marine Park

The Ningaloo Marine Park was declared in May 1987 under the National Parks and Wildlife Conservation Act 1975 (Cmlth). The Ningaloo Coast, incorporating both key marine and terrestrial values was later granted World Heritage Status in June 2011. In November 2012, the Ningaloo Marine Park (Commonwealth Waters) was renamed to be incorporated in the North-west Commonwealth Marine Reserves Network. The park covers an area of 263,343 km^2, including both State and Commonwealth waters, extending 25 km offshore. It is vested in the Marine Parks and Reserves Authority (MPRA) and managed by the WA Department of Parks and Wildlife (DPaW) on behalf of the Commonwealth.

The park protects a large portion of Ningaloo Reef, which stretches over 300 km from North West Cape south to Red Bluff. It is the largest fringing coral reef in Australia, forming a discontinuous barrier that encloses a lagoon that varies in width from 200m to 7 km. Gaps that regularly intercept the main reef line provide channels for water exchange with deeper, cooler waters (CALM 2005). The Ningaloo Marine Park forms the backbone of the nature-based tourism industry, and recreational activities in the Exmouth region. Seasonal aggregations of whale sharks, manta rays, sea turtles and whales, as well as the annual mass spawning of coral attract large numbers of visitors to Ningaloo each year (CALM 2005).

The reef is composed of partially dissected basement platform of Pleistocene marine or Aeolian sediments or tertiary limestone, covered by a thin layer of living or dead coral or macroalgae. Key features that characterise the Ningaloo Reef include (CALM 2005):

- Over 217 species of coral (representing 54 genera);
- Over 600 species of mollusc (clams, oysters, octopus, cuttlefish, snails);
- Over 460 species of fish;
- Ninety-seven species of echinoderms (sea stars, sea urchins, sea cucumbers);
- Habitat for numerous threatened species, including whales, dugong, whale sharks and turtles; and
- Habitat for over 25 species of migratory wading birds listed in CAMBA and JAMBA.

Lalang garram / Camden Sound Marine Park

The Lalang-garram / Camden Sound Marine Park was created on 19 June 2012 under Section 13 of the Conservation and Land Management Act 1984 (CALM Act). It is a multiple zone marine park that includes; Sanctuary, Special Purpose, and General Use zones (DPaW 2013). The marine park falls within the west Kimberley, which was recently added to the Australian National Heritage List because of its natural, Indigenous and historic values to the nation.

The marine park is located about 150 km north of Derby (or 300 km north of Broome) and lies within the traditional country of three Aboriginal native title groups. The Dambimangari people's determination overlies the majority of the marine park. A section of the Wunambal Gaambera people's Uunguu determination includes a small portion of St George Basin, while a small section of the Mayala people's claim (native title not determined at the time of writing of Management Plan) overlies the southwest corner of the marine park (DPaW 2013).

The marine park covers an area of approximately 705,000 ha. It recognises and provides special management arrangements for this area of the Kimberley, which is a principal calving habitat of the humpback whale (Megaptera novaeangliae) population that migrates annually along Western Australia's coast. The marine park also conserves a range of species listed as having special conservation status including marine turtles, snubfin and Indo-Pacific humpback dolphins, dugong, saltwater crododiles, and several species of sawfish. The park also includes a wide range of marine habitats and associated marine life, such as coral reef communities, rocky shoals, and the extensive mangrove forests and marine life of the St George Basin and Prince Regent River (DPaW 2013)

Shark Bay Marine Park

The Shark Bay Marine Park was gazetted on 30 November 1990 as A Class Marine Park Reserve No. 7 and vested in the National Park and Nature Conservation Authority (NPNCA) under the CALM Act. The marine park encompasses an area of 748,725 ha (CALM 1996).

The Bay is located near the northern limit of a transition region between temperate and tropical marine fauna. Of the 323 fish species recorded from Shark Bay, 83% are tropical species with 11% warm temperate and 6% cool temperate species. Similarly, of the 218 species of bivalves recorded in Shark Bay, 75% have a tropical range and 10% a southern Australian range, with 15% being endemic to the west coast (CALM 1996).

Key features of Shark Bay Marine Park include (CALM 1996, DSEWPaC 2013):

- 12 species of seagrass making it one of the most diverse seagrass assemblages in the world;
- Seagrass that covers over 4,000 km^2 of the bay. The 1,030 km^2 Wooramel Seagrass Bank is the largest structure of its type in the world;
- An estimated population of about 11,000 dugongs, one of the largest populations in the world;
- Humpback and southern right whales use the bay as a migratory staging post;

- Bottlenose dolphins occur in the bay, and green turtle and loggerhead turtle nest on the beaches;
- Large numbers of sharks including whaler, tiger shark and hammerhead are present as well as an abundant population of rays, including the manta ray;
- Hamelin Pool in Shark Bay contains the most diverse and abundant examples of stromatolite forms in the world, representative of life-forms which lived some 3,500 million years ago; and
- Shark Bay Marine Park does not cover Bernier and Dorre Islands and only coastal waters inshore of Dirk Hartog Island (east of eastern shoreline).

Shark Bay was included on the World Heritage List in 1991 primarily on the basis of three natural features: vast seagrass beds; dugong population; and stromatolites (microbial colonies that form hard, dome-shaped deposits and are among the oldest forms of life on Earth) (DSEWPaC 2013).

Proposed marine parks

On 22 October 2010, the Western Australian Government announced a commitment to the Kimberley Wilderness Parks initiative under the Kimberley Science and Conservation Strategy. A key component of this initiative was the commitment to establish four marine parks: at North Kimberley, Camden Sound, Roebuck Bay and Eighty Mile Beach. On 28 January 2013 the government announced the intention to create an additional fifth park, the Horizontal Falls Marine Park (DPaW 2013a).

When these new marine parks are gazetted, their management plans (and permitted activities) will also come into effect:

- Horizontal Falls Marine Park;
- North Kimberley Marine Park;
- Dampier Archipelago Marine Park and Regnard Marine Management Area; and
- Roebuck Bay Marine Park

4.3.3 World Heritage Areas

The Ningaloo Coast

The Ningaloo Coast was included on the World Heritage List in 2011 and was inscribed for outstanding natural universal values:

- An example of superlative natural phenomena and areas of exceptional natural beauty and aesthetic importance;
- outstanding examples representing major stages of Earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features; and
- the most important and significant natural habitats for in situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

The Ningaloo Coast WHA includes (DEWHA 2010):

- Ningaloo Commonwealth Marine Reserve (previously named Ningaloo Marine Park – Commonwealth waters);
- Ningaloo Marine Park (Western Australia state waters);
- Muiron Island Marine Management Area (including the Muiron Islands);
- Jurabi Coastal Park;
- Bundegi Coastal Park;

- Cape Range National Park; and
- Learmonth Air Weapons Range.

The Ningaloo Coast World Heritage Area (including the Muiron Islands) is managed under a plan that is consistent with the World Heritage Convention and Australia's World Heritage management principles. World Heritage Management principles are set out in regulations and cover matters relevant to the preparation of management plans, the environmental assessment of actions that may affect the property and community consultation processes.

The Australian World Heritage management principles are outlined under Schedule 5 of the EPBC regulations (2000). The objective is to ensure that any likely impact of an action on the World Heritage values of the property should be considered. Any action should be consistent with the protection, conservation, presentation or transmission to future generations of the World Heritage values of the property.

Shark Bay WHA

Shark Bay was included on the World Heritage List in 1991 and is one of the few properties inscribed for all four outstanding natural universal values:

- An outstanding example representing the major stages in the earth's evolutionary history;
- An outstanding example representing significant ongoing ecological and biological processes;
- An example of superlative natural phenomena; and
- Containing important and significant habitats for in situ conservation of biological diversity.

Since 1997, an agreement established the joint management of the Shark Bay WHA by the Australian Commonwealth government and the Western Australian state government, with the operational responsibility by the Western Australian agencies (DEWHA 2008). This agreement also created a Community Consultative Committee and a Scientific Advisory Committee, both of which provide advice as required. The entire WHA encompasses islands and peninsulas, with an area of approximately 2.2 million hectares (70% of which is marine waters), and includes the following areas (UNESCO 2014):

- Hamelin Pool Marine Nature Reserve;
- Francois Peron National Park;
- Shell Beach Conservation Park;
- Monkey Mia Reserve;
- Monkey Mia Conservation Park;
- Zuytdorp Nature Reserve;
- Bernier, Dorre and Koks Islands Nature Reserves;
- Dirk Hartog Island National Park; and
- Various pastoral leases.

The marine environment of the Shark Bay WHA is protected as a State Marine Reserve.

4.3.4 Ramsar listed wetlands

Eighty-mile Beach Ramsar Wetland

Eighty-mile Beach Ramsar Wetland covers an area of approximately 175,487ha and meets six of the nine Ramsar criteria. It is made up of Eighty-mile Beach and, 40 km to the east, Mandora Salt Marsh. Eighty-mile Beach is a 220 km section of coastline and adjacent intertidal mudflats. Mandora Salt Marsh includes two large seasonal wetlands and a series of small permanent mound springs. A small number of tidal creeks dissect the beach, including Salt Creek which is fed partly from groundwater and has permanent surface water. The beach is used for beach based recreation.

Eighty-mile Beach is characterised by extensive mudflats supporting an abundance of macroinvertebrates which provide food for large numbers of shorebirds. More than 472,000 migratory waders have been counted on the mudflats during the September to November period. The site is considered to be one of the major arrival and departure areas for migratory shorebirds visiting Australia, particularly on southward migration. It is one of the most important sites in the world for the migration of Great Knot. Flatback Turtles regularly nest at scattered locations along Eighty-mile Beach.

Roebuck Bay Ramsar Wetland

Roebuck Bay Ramsar Wetland covers an area of approximately 34,119ha and meets seven of the nine Ramsar criteria. Roebuck Bay has a very large tidal range which exposes around 160km^2 of mudflat, covering most of the Ramsar site. The eastern edge of the site is made up of microscale linear tidal creeks.

The site receives tidal seawater as well as fresh surface and groundwater, and the balance between the two influences the residual groundwater salinity and the distribution of plants and animals. Mangrove swamps line the eastern and southern edges of the site, and extend up into the linear tidal creeks. They are important nursery areas for marine fishes and crustacea, particularly prawns.

Extensive seagrass beds occur in the bay, providing an important feeding ground for dugong and green turtle. Dolphins and nationally threatened turtles also regularly use the site. The intertidal mud and sand flats support a high abundance of bottom dwelling invertebrates, which are a key food source for waterbirds. The site is one of the most important migration stopover areas for shorebirds in Australia and globally. For many shorebirds, Roebuck Bay is the first Australian landfall they reach on the East Asian Australasian Flyway. The total numbers of waders using the site each year is estimated at over 300 000. The northern beaches and Bush Point provide important high tide roost sites.

The site is used for recreational or tourism activities such as fishing, crabbing, sightseeing and bird watching. Broome Bird Observatory, a small reserve at the northern end of the site, engages in shorebird research and public education.

Ashmore Reef National Nature Reserve

In addition to being listed as a National Nature Reserve, Ashmore Reef has been designated a Ramsar Wetland of International Importance due to the importance of the islands in providing a resting place for migratory shorebirds and supporting large breeding colonies of seabirds (Hale and Butcher, 2013). The reserve provides a staging point for many migratory wading birds from October to November and March to April as part of the migration between Australia and the northern hemisphere (Commonwealth of Australia, 2002). Migratory shorebirds use the reserve’s islands and sand cays as feeding and resting areas during their migration.

Ashmore is the largest of the atolls in the Timor Province bioregion. The three islands within the site are also the only vegetated islands in the bioregion. Each of the wetland types present are in near natural condition and the site has the largest seagrass coverage in the bioregion. The reserve supports 64 species of internationally and nationally threatened species. This includes 41 species of hard reef forming coral, eight fish, six reptiles (including endangered and critically endangered sea turtles and seasnakes), five sea cucumbers, two giant clams, one soft coral and the dugong.

Ashmore Reef plays a primary role in the maintenance of biodiversity in reef systems in the region. The Reserve supports 275 species of reef building coral, 13 species of sea cucumbers, and high numbers of mollusc species. There are over 760 fish species, 13 species of sea snake, 99 species of decapod crustacean and 47 species of waterbird listed as migratory under international treaties. It supports breeding of 20 species of waterbirds including the brown booby, lesser frigatebird, crested tern, bridled tern, sooty tern and common noddy. The Ramsar site is also important for feeding for green turtles, hawksbill turtle and loggerhead turtle and critical nesting and inter-nesting habitats for green and hawksbill turtles.

Ashmore Reef regularly supports more than 20,000 waterbirds and has been known to support more than 65,000 waterbirds. The Ramsar site regularly supports more than one per cent of at least six species of waterbird including the sooty tern, bar-tailed godwit, grey-tailed tattler, ruddy turnstone, sanderling and greater sand plover.

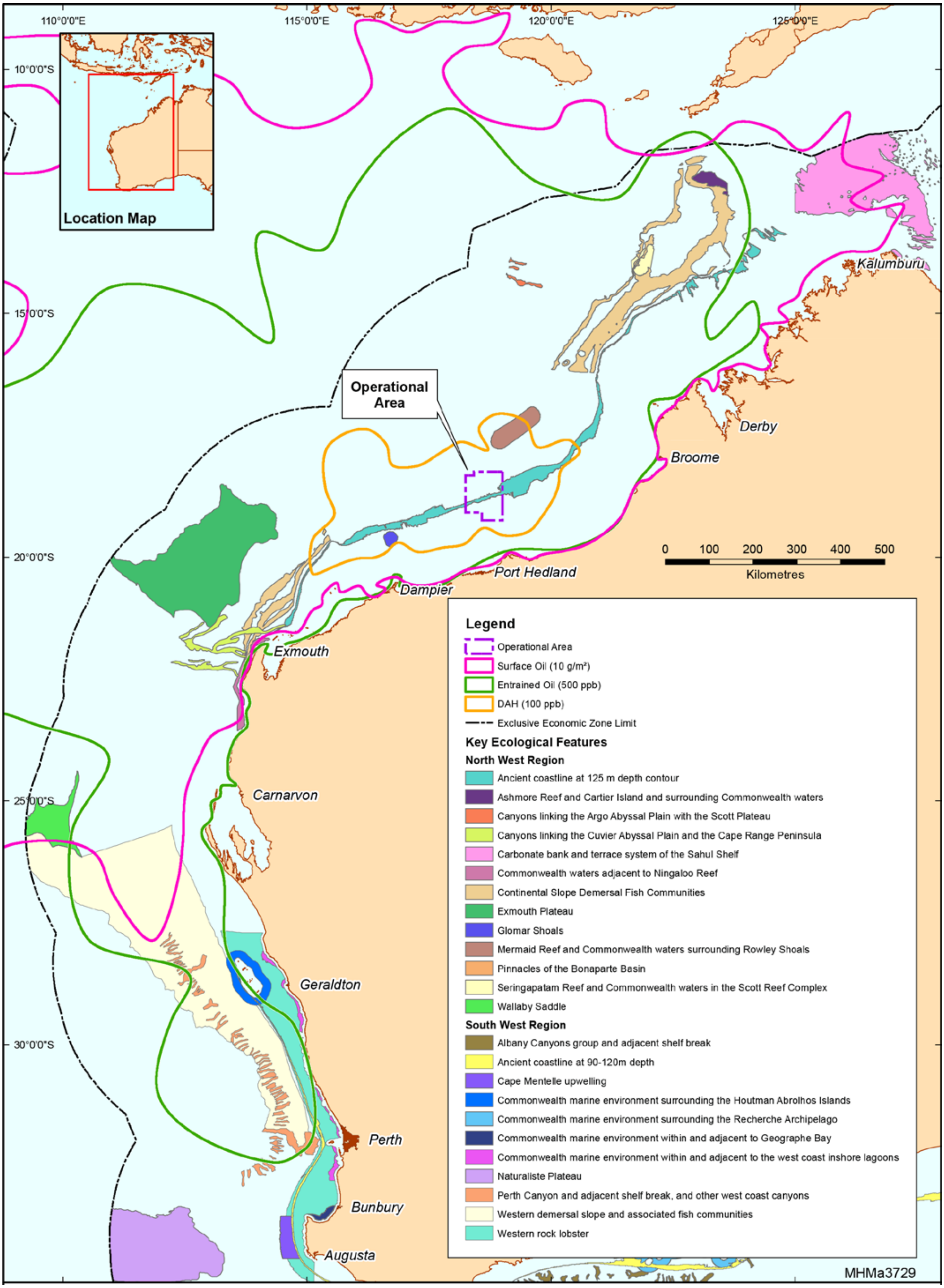

Figure 4-2: Key Ecological Features that occur within the EMBA

4.4 Marine Fauna

Desktop searches of the Operational Area and larger EMBA were undertaken using DoE's Protected Matters Search Tool for the purposes of identifying species listed under the EPBC Act. The search identified 84 Listed Threatened Species (LTS) and 104 Listed Migratory Species (LMS) as having the potential to occur within the EMBA**.**

An assessment of all the marine and coastal species was undertaken to identify if these species have the potential to occur in either the Operational Area or larger EMBA. Those fish, sharks, rays, marine mammals and marine reptiles listed as threatened or vulnerable species that have been identified as likely to be present in the vicinity of the Operational Area are shown in **Figure 4-3**, **Figure 4-4** and **Figure 4-5** . Thirteen BIAs for bird species are also overlapped by the EMBA.

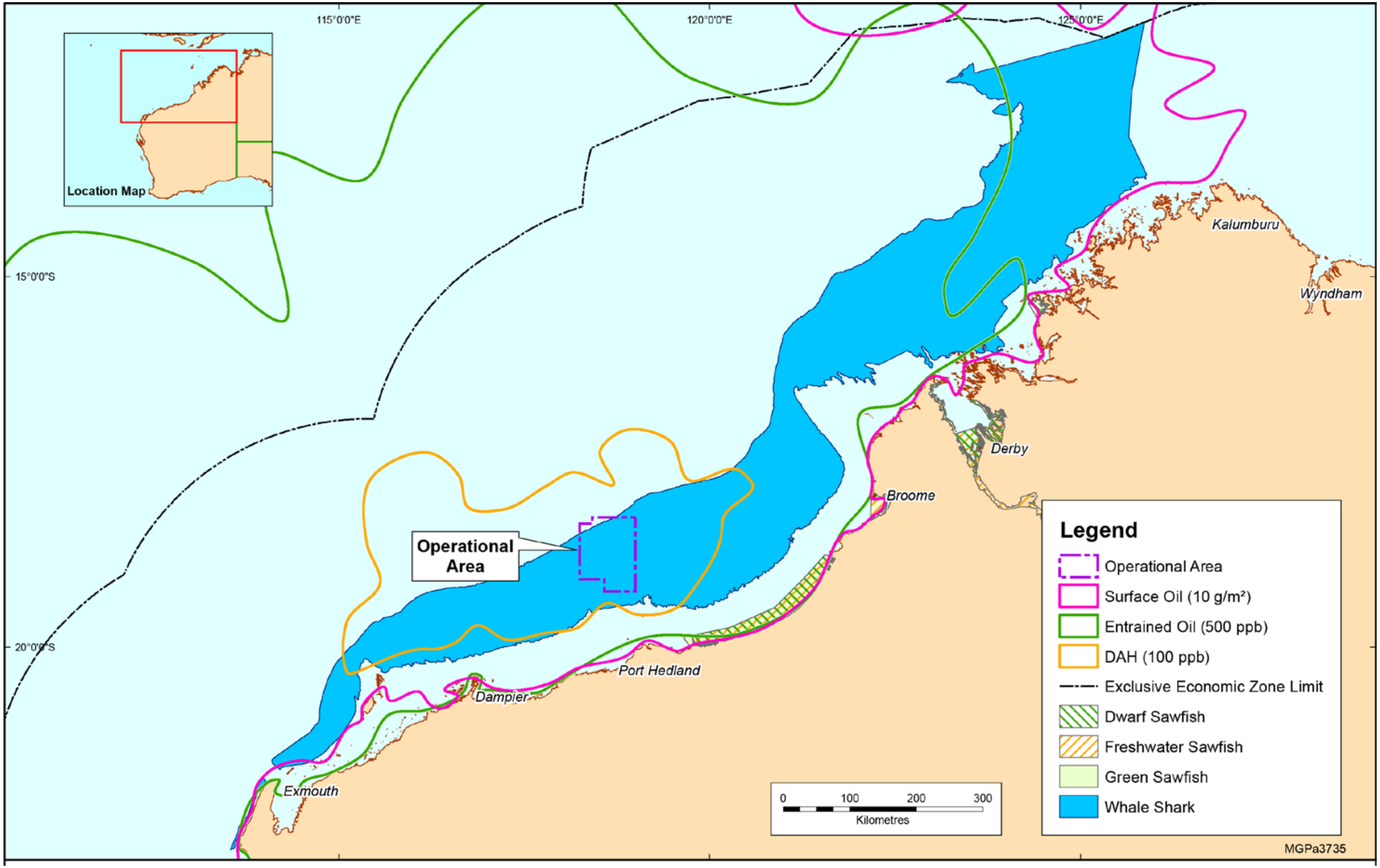

Figure 4-3: Biologically Important Areas for EPBC Protected Fish and Sharks within the vicinity of the Operational Area

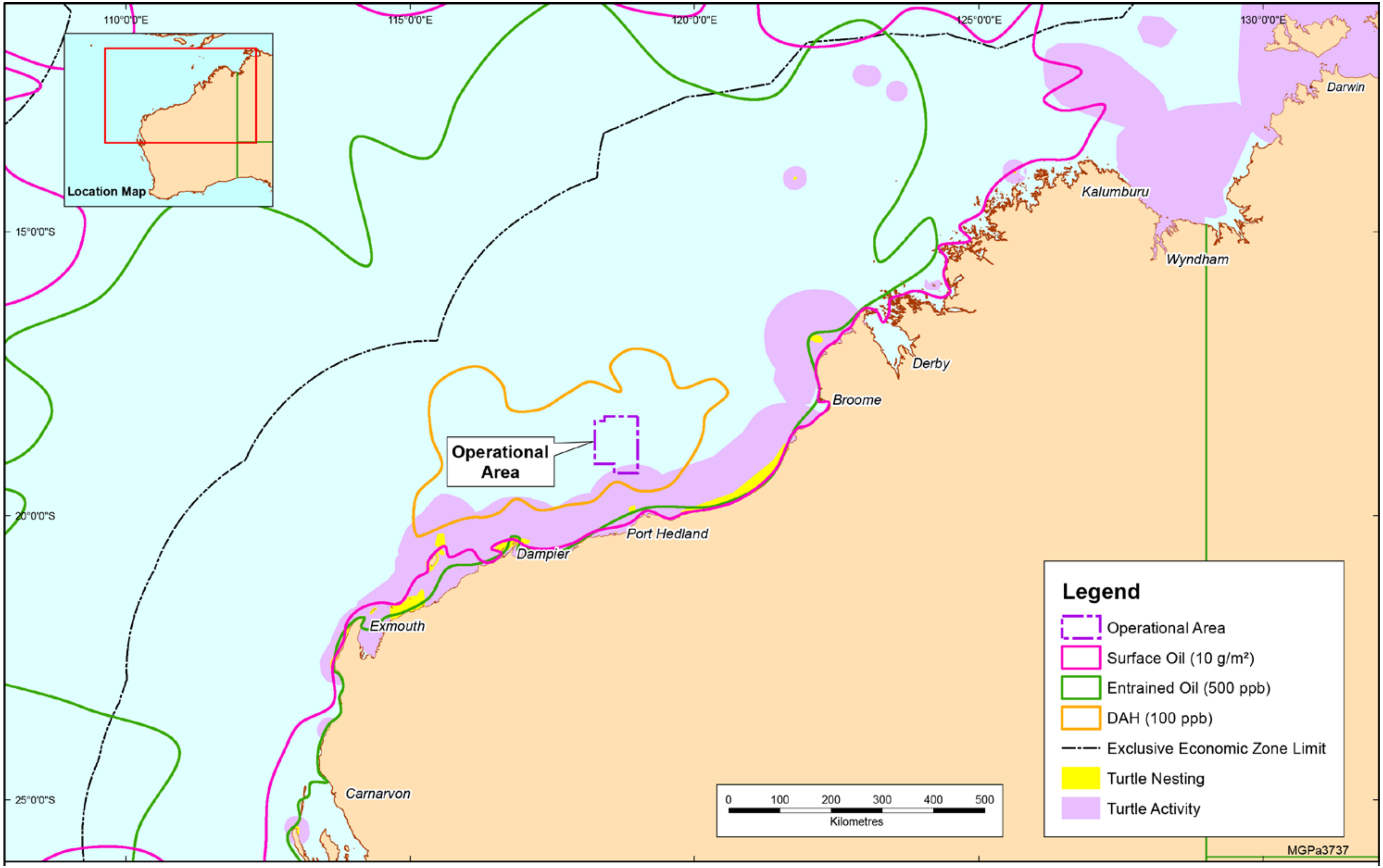

Figure 4-4: Biologically Important Areas for EPBC Protected Turtles within the vicinity of the Operational Area

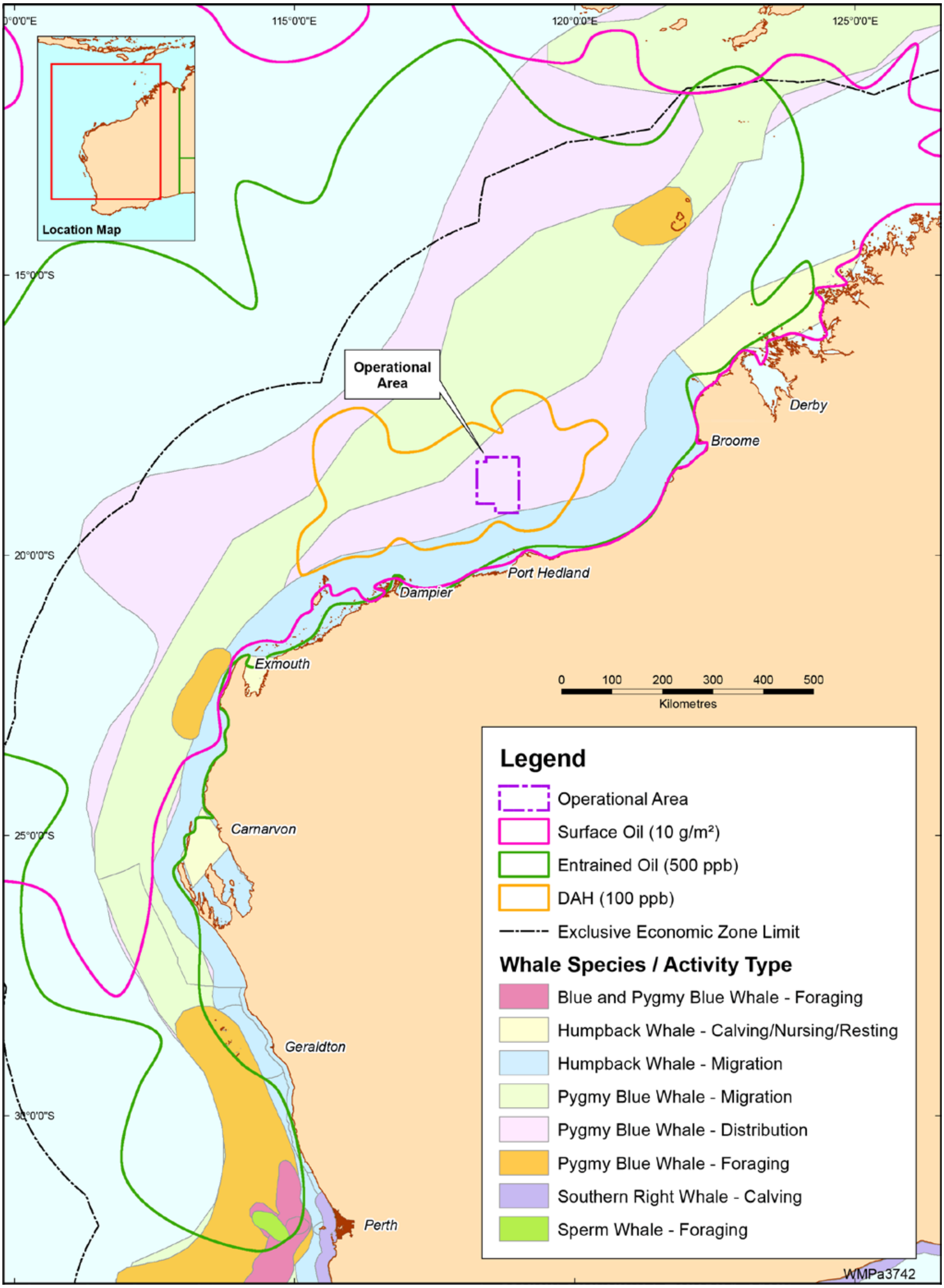

Figure 4-5: Migration pathways, calving and resting areas for EPBC Protected Whales within the vicinity of the Operational Area

4.5 Socio-economic Environment

Commonwealth and State fisheries overlap with the Operational Area and the EMBA. Table 4-4 describes each of these fisheries and indicates what events associated with the Activity may impact on these fisheries. Other socioeconomic considerations such as shipping, recreational fishing, oil and gas industry, tourism and cultural heritage in relation to the Operational Area of the Activity are summarised in Table 4-5.

Table 4-4: State and Commonwealth Fisheries within the EMBA

Value/Sensitivity	Description	Operational Area presence	Present within the EMBA
Commonwealth Managed Fisheries			
North West Slope Trawl	Extends from 114° E to approximately 125° E off the WA coast between the 200 m isobath and the outer limit of the Australian Fishing Zone (AFZ).	Unlikely	✓
Western Tuna and Billfish Fishery	Extends westward from Cape York Peninsula (142°30’ E) off Queensland to 34° S off the WA west coast. It also extends eastward from 34° S off the west coast of WA across the Great Australian Bight to 141° E at the South Australian–Victorian border. No current effort on NW Shelf	✓	
Western Skipjack Tuna Fishery	No current effort on NW Shelf	✓	
Southern Bluefin Tuna	No current effort on NW Shelf	✓	
Western Deepwater Trawl Fishery	A developing fishery. No current effort on NW Shelf	Unlikely	
State Managed Fisheries (Whole of State)			
Marine Aquarium Fish Fishery	All year Effort within the Operational Area is unknown, but is unlikely due to the depth and the dive based method of collection Unlikely to occur	✓	✓
Specimen Shell Managed Fishery	All year Effort within the Operational Area is unknown, but it is unlikely due to the depth and the dive based method of collection Unlikely to occur	✓	N/A
Beche-de-mer Fishery	All year Although permitted to fish within the Operational Area, the fishery is restricted to shallow coastal waters suitable for diving and wading Unlikely to occur	✓	✓
Mackerel Managed Fishery (Area 2 and 3)	Trolling or handline. Near-surface trolling gear from vessels in coastal areas around reefs, shoals and headlands Unlikely to occur	✓	
Octopus	Fishery is in development phase. Effort within the Operational Area is unknown, but is unlikely due to water depth and pot collection method. Largest fishery is located south of the EMBA Unlikely to occur		N/A
West Coast Blue Swimmer Crab (West Coast)	Effort within the Operational Area is unknown, but is unlikely due to the depth and the pot method of collection Unlikely to occur		N/A

Value/Sensitivity	Description	Operational Area presence	Present within the EMBA
State Managed Fisheries (North Coast Bioregion)			
Pilbara Trap (open to traps) and Trawl Managed Fishery	All year - Trap and Line may occur in Operational Area Pilbara Trawl Fishery (Prohibited Fishing Area) may occur in the Operational Area. Pilbara Trawl (Zone 1) has been closed since 1998), Zone 2 overlaps the Operational Area.	✓	✓
Pilbara Line Fishery	Operational Area overlaps fishing area.	✓	
Northern Demersal Scalefish Managed Fishery	Operational Area does not overlap fishing area.		
Pearl Oyster Managed Fishery (Zone 1, Zone 2, Zone 3)	Mostly operate March to June Operational Area does occur within the boundaries of the fishery, as it is restricted to shallow diving depths. Unlikely to occur	✓	✓
Nickol Bay Prawn Managed Fishery	Otter trawl. Operates along the western part of the North-West Shelf in coastal shallow waters up to 200m depth Unlikely to occur	✓	✓
Onslow Prawn Managed Fishery	6 May to 22 October Operational Area does not overlap fishing area		✓
Broome Prawn Managed Fishery	Otter trawl. The BPMF operates in a designated trawl zone off Broome Unlikely to occur		✓
Aquaculture Pearling Sites	All year Unlikely to occur		✓
Kimberley Prawn Managed Fishery (KPMF)	All year. North of the state between Koolan Island and Cape Londonderry		✓
The Kimberley Gillnet and Barramundi Managed Fishery (KGBF)	Nearshore and estuarine zones of the North Coast Bioregion from the WA/NT border (129ºE) to the top end of Eighty Mile Beach, south of Broome (19ºS). Gillnet in inshore waters		✓
Gascoyne Demersal Scalefish Fishery	Mechanised handlines. Unlikely to occur		✓
Exmouth Gulf Prawn Fishery	Low opening otter trawls. Sheltered waters of Exmouth Gulf. Opening and closing dates vary each year. Closures in the early part of the season (April–July) to avoid fishing on small prawns. Unlikely to occur		✓
West Coast Rock Lobster Fishery	Baited traps (pots). Unlikely to occur		✓
Shark Bay Prawn and Scallop Limited Entry Fishery	Low opening otter trawls. The boundaries of the Shark Bay Prawn Managed Fishery and the Shark Bay Scallop managed Fishery are located in and near the waters of Shark Bay		✓
Shark Bay Crab Interim Managed Fishery	Trawl and trap fishery. Waters of Shark Bay north of Cape Inscription, to Bernier and Dorre Islands and Quobba Point. In addition, waters of Shark Bay south of Cape Inscription. No overlap with Operational Area		✓
Abrolhos Islands and Mid West Trawl Managed Fishery (AIMWTMF)	No scallop fishing occurred in this fishery during 2014 because the annual scallop survey showed scallop abundance below the limit reference level to commence fishing. Low opening otter trawl systems. Unlikely to occur		N/A

Value/Sensitivity	Description	Operational Area presence	Present within the EMBA
West Coast Demersal Scalefin Interim Managed Fishery	The commercial fishery is divided into five management areas comprising four inshore areas and one offshore area. The inshore areas do not occur in Operational Area		✓

Table 4-5: Environmental values and sensitivities – Socioeconomic within Operational area and EMBA

Value/ Sensitivity	Description	Operational Area presence	EMBA Presence
Shipping	The Bedout Basin permit area overlaps three designated shipping routes (AMSA 2014) with two north-south oriented lanes servicing Port Hedland and one north-south lane servicing Port Walcott. Commercial shipping moves through the offshore waters en route to or from the marine terminals at Barrow and Varanus Islands. Shipping using NWS waters includes iron ore carriers, oil tankers and other vessels proceeding to or from the ports of Dampier, Port Walcott and Port Hedland; however, these are predominantly heading north from these ports. Large cargo vessels carrying freight bound or departing from Fremantle, transit along the WA coastline heading north and south in deeper waters.		✓
Recreational fishing	Within the North Coast Bioregion, recreational fishing is experiencing significant growth, with a distinct seasonal peak in winter when the local population increases significantly. Increased recreational fishing has also been attributed to those involved in the construction or operation of developments within the region. Consultation has indicated recreational fishing Hot Spots include Eighty Mile Beach, the Montebello Islands, Barrow Island, the Lowendal Islands, the Muiron Islands, Dampier Archipelago, the Broome North Coast and the Ningaloo and Exmouth Coast are of high value to recreational fishers. Charter Boat and tourism operators also frequent those areas not easy accessible by recreational fishers including Mermaid Reef, Imperieuse Reef, Clerke Reef, Camden Sound, the Lacepede Islands and the Kimberley Coast.	-	✓
Oil and gas	The area of the NW Shelf is a major oil and gas hub in Australia, with several companies operating on the Shelf. The Activity occurs in a particularly isolated area of the NW Shelf with respect to the main oil and gas operational and exploratory fields. There are currently no operating fields in the Operational Area. The nearest operating facility is Santos' Modec Venture II FPSO and Woodside's Angel oil field and associated infrastructure, located > 174km and 180km from the Operational Area respectively.	-	✓
Tourism	There are many sources of marine-based tourism within the environment that may be affected. Aquatic recreational activities such as boating, diving and fishing occur near the coast and islands off of the Pilbara and Ningaloo coasts. These activities are concentrated in the vicinity of the population centres such as Broome, Roebuck Bay, Exmouth, Dampier and Onslow. The socio-economic and heritage features in the region are of high value for the tourism industry. The potentially affected area is of high value for eco-tourism based on specific local values (whale sharks, game fish, nearshore reef snorkelling and diving). Social amenities of the area including beachside recreation (camping, non-fishing water activities), "iconic" locations, landscape and scenery is also capitalised on by the tourism industry. In the waters immediately surrounding the Operational Area, tourism activities are limited due to its distance from the mainland and island shorelines.	-	✓
Cultural Heritage	No known sites of Aboriginal Heritage significance occur within the Operational Area.	-	✓

5. STAKEHOLDER CONSULTATION

Quadrant Energy understands retaining a broad licence to operate depends on the development and maintenance of positive and constructive relationships with a comprehensive set of stakeholders in the community, Government, non-government and business sectors.

To allow an informed assessment by stakeholders of the potential impact of Quadrant Energy's activities, Quadrant Energy has established long-term and meaningful dialogue with those stakeholders who have demonstrated an interest in its present and planned future activities in Australia.

For the activities to be undertaken under this EP, a standardised approach is applied to identify key stakeholders for the Activity in question, beginning with a review of the stakeholder database, and of the stakeholders consulted over other recent activities in the area. In particular, the Operational Area for the Activity is used to identify relevant persons on an activity-by-activity basis, and will be used throughout the lifetime of this EP. The key stakeholders identified for the activity are based on the Operational Area and EMBA and are provided in **Table 5-1**.

Table 5-1: Summary of Key Stakeholders Consulted for the Activity

Group	Stakeholder
Marine Conservation	• Department of Fisheries (DoF) • Department of Parks and Wildlife (DPaW)
Shipping safety and security	• Australian Maritime Safety Authority (AMSA) • Department of Defence (DoD) • Department of Transport (DoT)
Adjacent regulator	• Department of Mines and Petroleum (State)
Fishing bodies	• A Raptis and Sons • Austral Fisheries • Australian Fisheries Management Authority (AFMA) • Australian Southern Bluefin Tuna Association (ASBTIA) • Commonwealth Fisheries Association (CFA) • Fat Marine • Marine Tourism WA • MG Kailis • Pearl Producers Association • Quest Maritime Services • Recfishwest • RNR Fisheries • Shark Bay Seafoods • Western Australian Fishing Industry Council (WAFIC) • Western Wild Fisheries • WestMore Seafoods
Karratha/Port Hedland Stakeholder Reference Group	• City of Karratha • Dampier Port Authority • Pilbara Port Authority • Town of Port Hedland
Communications	• Telstra

Quadrant Energy maintains a comprehensive stakeholder database with stakeholders identified through the following mechanisms:

- Regular review of all legislation applicable to petroleum and marine activities;
- Identification of marine user groups and interest groups active in the area (e.g., recreational and commercial fisheries, other oil and gas producers, merchant shipping etc.);
- Active participation in industry bodies (e.g. APPEA and Australian Marine Oil Spill Centre, AMOSC); and

- Records from previous consultation activities in the area.

Details of this EP including project summary, coordinates, location map, water depth, distance to key regional features, exclusion zone details and estimated timing were most recently distributed to stakeholders in a detailed consultation package on April 29, 2016. This consultation package outlined details of proposed activities including drilling, well evaluation, ROV activities and temporary suspension, to ensure stakeholders could adequately assess potential impacts to their activities.

No concerns with the Activity were raised during this consultation period.

Further, Quadrant Energy has three accepted EPs covering activities in permits WA-437-P and WA-435-P and advice from stakeholders received during the consultation processes for these EPs has been incorporated into the preparation of the Bedout Basin EP. Activities covered under this EP will be included in *Quarterly Consultation Updates* until they can be listed as a 'completed activity', with updates scheduled for approximately June, September, December and March annually.

5.1 Addressing consultation feedback

Quadrant Energy's Consultation Coordinator is available before, during and after the Activity to ensure opportunities for stakeholders to provide feedback are available. Consultation material is provided to relevant internal, activity personnel to ensure the Quadrant Energy business has a thorough understanding of how the Activity is being received by relevant persons.

Drilling activities covered by this EP will be consulted via three tiers, the Activity Consultation Package distributed prior to EP acceptance (sent on April 29, 2016), a Notification Package prior to activity commencement when timing and other details are confirmed, and within Quadrant Energy's *Quarterly Consultation Updates* (last issued June 2016, next planned for September 2016).

Stakeholder consultation will be ongoing and Quadrant Energy will work with stakeholders to address any future concerns if they arise throughout the validity (5 years) of this EP. Should any new stakeholders be identified, they will be added to the stakeholder database and included in all future correspondence as required, including specific drilling activity notifications.

5.2 Summary

Quadrant Energy considers that consultation with regulators and key stakeholders for this activity has been adequate; all stakeholders and relevant parties have been actively engaged by Quadrant Energy regarding its activities on the NW Shelf (including this Activity) and also, where applicable the proposed oil spill response strategies for these activities.

No objections to the Activity were raised during this consultation period. Additionally, No comment has been received regarding any activities in permits WA-435-P or WA-437-P in response to a Quarterly Consultation Update.

If stakeholders request additional information or raise concerns on any activity, a dialogue with these stakeholders can continue during or post the preparation of an EP and will be recorded for future reference. Quadrant Energy commits to respond and address any comments to the satisfaction of both parties and keep any consultation on file during and post acceptance of an EP.

Table 5-2: Consultation summary for activity

Stakeholder	Assessment of Consultation Undertaken
Fishing bodies	
A Raptis and Sons	A Raptis and Sons were provided the Bedout Basin Consultation Package on March 12, 2015 and a revised package on April 29, 2016, and receive all Quadrant Energy's Quarterly Consultation Update documents. No comment on the Activity has been received to date, and the stakeholder has previously confirmed that no response means 'no concern' with the Activity. No action arising from this consultation for this EP.
Austral Fisheries	Austral Fisheries were provided the Bedout Basin Consultation Package on March 12, 2015 and a revised package on April 29, 2016, and receive all Quadrant Energy's Quarterly Consultation Update documents. No comment on the Activity has been received to date, and the stakeholder has previously confirmed that no response means 'no concern' with the Activity. No action arising from this consultation for this EP.
Australian Fisheries Management Authority	AFMA were provided the Bedout Basin Consultation Package on March 12, 2015 and a revised package on April 29, 2016, and receive all Quadrant Energy's Quarterly Consultation Update documents. Previous interaction with stakeholder has reassured Quadrant Energy that a response would only be received in the event of concern regarding the Activity. No response regarding the Activity has been received to date.
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	ASBTIA were provided the Bedout Basin Consultation Package on March 12, 2015 and a revised package on April 29, 2016, and receive all Quadrant Energy's Quarterly Consultation Update documents. No response regarding the Activity has been received to date.
Commonwealth Fishing Association	The CFA were provided the Bedout Basin Consultation Package on March 12, 2015 and a revised package on April 29, 2016, and receive all Quadrant Energy's Quarterly Consultation Update documents. No response regarding the Activity has been received to date.
Fat Marine	Fat Marine were provided the Bedout Basin Consultation Package on March 12, 2015 and a revised package on April 29, 2016, and receive all Quadrant Energy's Quarterly Consultation Update documents. No response regarding the Activity has been received to date.
Marine Tourism WA	MTWA were provided the Bedout Basin Consultation Package on March 12, 2015 and a revised package on April 29, 2016, and receive all Quadrant Energy's Quarterly Consultation Update documents. No comment has been received to date relating to this EP; previous interaction with stakeholder has reassured Quadrant Energy that a response would only be received in the event of concern regarding the Activity.
MG Kailis	MG Kailis were provided the Bedout Basin Consultation Package on March 12, 2015 and a revised package on April 29, 2016. A follow up phone call on May 2, 2016 was made, and a voice mail left referring to the email and proposal for drilling in these permits. While no response to this consultation has been received, Quadrant Energy commits to ongoing consultation with MG Kailis Group to minimise any impacts to Pilbara Fish Trawl, as successfully completed with the Roc-1 drilling campaign. Quadrant Energy understands the permits relevant to the Activity are located within the Pilbara Fish Trawl State Fishery and commits to open and transparent consultation with MG Kailis, including the provision of specific timing and rig details prior to commencement of the Activity.
Pearl Producers Association	The PPA were provided the Bedout Basin Consultation Package on March 12, 2015 and a revised package on April 29, 2016, and receive all Quadrant Energy's Quarterly Consultation Update documents.

Stakeholder	Assessment of Consultation Undertaken
	In phone consultation on 2 June 2016, the PPA Chief Executive advised drilling activities and VSP were of little concern to their interests given localised impacts. Quadrant Energy and the PPA agreed to continue with ongoing communications regarding activities around Eighty Mile Beach.
Quest Maritime Services	Quest Maritime Services were provided the Bedout Basin Consultation Package on March 12, 2015 and receive all Quadrant Energy's Quarterly Consultation Update documents. No comment on the Activity has been received to date.
Recfishwest	Recfishwest were provided the Bedout Basin Consultation Package on March 12, 2015 and a revised package on April 29, 2016, and receive all Quadrant Energy's Quarterly Consultation Update documents. No comment on the Activity has been received to date. Given the location of permits WA-437-P and WA-435-P, and historic consultation with Recfishwest on other Quadrant Energy activities, recreational fishing will not be expected to occur at this location. Therefore no comment is expected from Recfishwest regarding this EP.
RNR Fisheries	RNR Fisheries were provided the Bedout Basin Consultation Package on March 12, 2015 and a revised package on April 29, 2016, and receive all Quadrant Energy's Quarterly Consultation Update documents. No comment on the Activity has been received to date.
Western Australian Fishing Industry Council	WAFIC were provided the Bedout Basin Consultation Package on March 12, 2015 and a revised package on April 29, 2016, and receive all Quadrant Energy's Quarterly Consultation Update documents. WAFIC responded to consultation with thanks on May 13, 2016, and gave suggestions on what fisheries to eliminate in future consultation. No concerns raised. Quadrant Energy will note this advice in ongoing consultation for activities covered under this EP.
Western Wild Fisheries	Western Wild Fisheries were provided the Bedout Basin Consultation Package on March 12, 2015 and a revised package on April 29, 2016, and receive all Quadrant Energy's Quarterly Consultation Update documents. No comment on the Activity has been received to date.
WestMore Seafoods & Shark Bay Seafoods	These fishers were provided the Bedout Basin Consultation Package on March 12, 2015 and a revised package on April 29, 2016, and receive all Quadrant Energy's Quarterly Consultation Update documents. Gary Kessell at Westmore Seafoods also represents Shark Bay Seafood, and operates within the Western Deep Water Trawl Fishery, North West Slope Trawl Fishery, Shark Bay Prawn Fishery, Pilbara Fish Trawl, Nickol Bay Prawn Fishery and the Kimberley Prawn Fishery zones. No comment on the Activity has been received to date, and the stakeholder has previously confirmed that no response means 'no concern' with the given activity. No action arising from this consultation for this EP.
Karratha/Dampier Stakeholder Reference Group	
Dampier Port Authority	The DPA were provided the Bedout Basin Consultation Package on March 12, 2015 and a revised package on April 29, 2016, and receive all Quadrant Energy's Quarterly Consultation Update documents. No comment on the Activity has been received to date.
Pilbara Port Authority	The PPA were provided the Bedout Basin Consultation Package on March 12, 2015 and a revised package on April 29, 2016, and receive all Quadrant Energy's Quarterly Consultation Update documents. No comment on the Activity has been received to date.

Stakeholder	Assessment of Consultation Undertaken
City of Karratha	The City of Karratha were provided the Bedout Basin Consultation Package on March 12, 2015 and April 29, 2016, and receive all Quadrant Energy's Quarterly Consultation Update documents. No comment on the Activity has been received to date.
Town of Port Hedland	The ToPH were provided the Bedout Basin Consultation Package on March 12, 2015 and a revised package on April 29, 2016, and receive all Quadrant Energy's Quarterly Consultation Update documents. No comment on the Activity has been received to date.
Marine Conservation	
Department of Fisheries	Information detailing this EP was lodged using DoF's online Environmental Impact Assessment form on April 29, 2016. DoF responded with advice dated May 12, 2016, regarding fishing activities, fish spawning grounds in the area, pollution emergency plan advice and biosecurity. Quadrant Energy has responded to this advice on June 20, 2016, addressing each of the key issues raised including but not limited to fishing activities in the area, pollution emergency plans and biosecurity. DoF reviewed Quadrant's response and responded with thanks on July 6, 2016, providing a link to Status of the Fisheries reports if additional information regarding fish, fishers and fish habitats is required during the development of this EP. Consultation is considered adequate for this activity, DoF receive Quadrant Energy's Quadrant Energy *Quarterly Consultation Updates* and any relevant ongoing consultation. Quadrant previously provided a response to DoF advice around the Bedout Basin EP, via email on October 19, 2015. DoF accepted this advice on October 21, 2015. Quadrant Energy commits to ongoing consultation with DoF to ensure this advice remains valid through the lifecycle of this EP using DoF's online Environmental Impact Assessment form. DoF request information be lodged online three months prior to activity commencement (implementation of control measure in providing information regarding the Activity to DoF by email or through the online Environmental Impact Assessment form 3 months prior to activity commencement). DoF's advice regarding biofouling suggests the following: 1. *DoF request vessels moving into WA waters from overseas or interstate be risk assessed using a biofouling risk assessment tool to prevent offence under Fish Resource Management Act 2004.* Quadrant Energy ensures a biofouling Vessel Risk Assessment (VRASS) has been undertaken on any international or domestic (interstate) vessels/MODU at the point of entry into Western Australian waters. 2. *DoF recommends the active use of a biofouling management plan and record book that meets requirements under Appendix 2 of the current edition of the International Maritime Organisation's Guidelines for the Control and Management of Ships' Biofouling to Minimise the Transfer of Invasive Aquatic Species.* The IMO Guidelines are intended to provide useful recommendations on general measures to minimize the risks associated with biofouling for all types of ships. They recommend that to minimise the transfer of invasive aquatic species, a ship should implement biofouling management practices, including the use of anti-fouling systems and other operational management practices to reduce the development of biofouling. The intent of such practices is to keep the ship's submerged surfaces, and internal seawater cooling systems, as free of

Stakeholder	Assessment of Consultation Undertaken
	biofouling as practical. As discussed in the EP, Quadrant Energy undertakes a VRASS to ensure the vessel has a low risk of introducing IMS prior to allowing the vessel to operate in Western Australian waters for Quadrant Energy and assesses information that would be contained within a biofouling record book. The presence of an anti-fouling system and the management of it (e.g. through a biofouling management plan) falls to the vessel operator, but Quadrant verifies the low risk of IMS introduction through a review of the VRASS (implementation of control measure - An international and domestic (interstate) plying MODU or support vessel has a completed biofouling vessel risk assessment (VRASS) at the point of entry into Western Australia offshore waters) and this approach is consistent with other operators on the NWS. This approach is acceptable by DoF as evidenced through responses to consultation. 3. *DoF also request Quadrant plan to ensure all vessels remain at a low risk after arriving in WA waters, i.e. vessel inspections for vessels staying longer than a few days in Australian waters.* Through the use of the VRASS on all vessels/MODU entering the Operational Area, Quadrant ensures that all vessels have a low risk ranking (implementation of control measure measure - An international and domestic (interstate) plying MODU or support vessel has a completed biofouling vessel risk assessment (VRASS) at the point of entry into Western Australia offshore waters). In conjunction with ballast water management (control measure - MODU and support vessels carrying ballast water and engaged in international voyages shall manage ballast water in accordance with a Ballast Water Management Plan so that marine pest species are not introduced pursuant to the International Convention for the Control and Management of Ships' Ballast Water and Sediment 2004), the risk of introducing IMS remains low when vessels are in the Operational Area. If the vessel is identified as requiring further inspection (e.g. IMS Inspection report requires follow up inspection) it is the vessel operators' responsibility to maintain their vessel in accordance with their biofouling management plan and therefore maintaining the low biofouling risk status. 4. *Any equipment coming from overseas or interstate should be new, or thoroughly cleaned, and inspected for marine pests before use in WA waters.* Any equipment coming from overseas or interstate will be new or thoroughly cleaned, and inspected for marine pests before use in WA waters as per the control measure that any equipment coming from overseas or interstate will be new or thoroughly cleaned, and inspected for marine pests before use in WA waters. 5. *If marine pests or disease are suspected this must be reported to DoF within 24 hours by telephone.* Quadrant Energy will report the presence of marine pests or disease to DoF.
Department of Parks and Wildlife	DPaW were provided the Bedout Basin Consultation Package on March 12, 2015 and a revised package on April 29, 2016, and receive all Quadrant Energy's Quarterly Consultation Update documents. In phone consultation on June 1, 2016, DPaW noted the consultation package had been received and discussed the location of the relevant permits in relation to the Rowley Shoals, Bedout Island and Eighty Mile Beach CMR. No objection was raised. DPaW noted the importance of adhering to Oiled Wildlife Plans.

Stakeholder	Assessment of Consultation Undertaken
Shipping safety and security	
Australian Maritime Safety Authority	AMSA were provided the Bedout Basin Consultation Package on March 12, 2015 and a revised package on April 29, 2016, both outlining the full Operational Area and five year, multi-well nature of the Bedout Basin EP. Advice from AMSA was received on March 19, 2015, noting location of eight proposed wells and again on May 2, 2016, noting the location of the Phoenix South well. AMSA advice includes charts outlining all three shipping fairways passing through permits WA-435-P and WA-437-P which have been evaluated by Quadrant in the development of Quadrant's relevant Safety Case documents. Additional consultation was initiated with AMSA by phone and email from July 28, 2016, to discuss the Operational Area and five year period of validity for the EP. Shipping traffic plots provided on August 3, 2016, indicate cargo and local offshore support vessel traffic may be encountered within the Operational Area, however traffic is mostly confined to three designated shipping fairways. AMSA noted mooring a MODU within a charted shipping fairway would be a concern and AMSA advised Quadrant to reconsider any decision to position infrastructure within a charted shipping fairway. Quadrant responded to this consultation on August 5, 2016. In response Quadrant has committed to avoid mooring a MODU within a charted shipping fairway and the following measures as outlined in the activity Safety Case: • The MODU will be fitted with an AIS transceiver or a radar transponder to aid in its detection at sea. • Support vessels will be equipped with an automatic identification system and radar detection and will be located within 3nM of the MODU at all times. • An errant vessel procedure will be implemented to define the support vessel's response to potential incursions of the 500 m exclusion zone as well as the watch duties required specific to the drilling campaign. • Quadrant commits to providing notifications to AMSA's RCC and the Australian Hydrographic Service prior to any drilling activity under this EP. Where the drilling location is within <5nM of a shipping fairway, an additional control will be added: • Where the well location is <5nm from a shipping fairway, an Aid to Navigation (AtoN) will be installed on the MODU and will be located in a constantly manned area. Quadrant commits to consultation with AMSA'S Joint Rescue Coordination Centre (JRCC) 24-48 hours before a drilling activity commences under this EP and with the Australian Hydrographic Service (AHS) four weeks prior to commencement as requested by AMSA. Previously in consultation (March 19, 2015) AMSA has suggested providing a lessons learnt following activities, in recent consultation AMSA confirmed lessons learnt after every drilling activity is not necessary (August 3, 2016). Quadrant does commit to notifying AMSA of vessel related incidents. Additionally AMSA receive all Quadrant Energy's *Quarterly Consultation Update* documents. AMSA's advice regarding drilling in the permits WA-437-P and WA-435-P showed vessel traffic is mainly confined to three nominated shipping fairways. Following assessment of this Quadrant has committed to not position a MODU within an AMSA nominated shipping fairway
Department of Defence	The Department were provided the Bedout Basin Consultation Package on March 12, 2015 and a revised package on April 29, 2016, and receive all Quadrant Energy's Quarterly Consultation Update documents. No comment on the Activity has been received to date.

Stakeholder	Assessment of Consultation Undertaken
	The AHS branch of the Department receive notifications.
Department of Foreign Affairs and Trade	DFaT were originally consulted regarding the proposed Bedout Basin EP on December 17, 2014. Quadrant presented activity description and modelling by email. DFaT responded to consultation on January 14, 2015, advising in the event of a spill DFaT would be engaged in a whole-of-government response if required. DFaT could be contacted as a courtesy only, and requested DFaT contact details be included in Quadrant's plan. DFaT were updated on the Bedout Basin EP on August 1, 2016, and responded on August 4, 2016, noting DFaTs' response to consultation remains the same however contact details have been updated. Quadrant commits to including DFaT in all pre-start notifications
Department of Transport	DoT were provided the Bedout Basin Consultation Package on March 12, 2015 and April 29, 2016. DoT responded noting consultation had been received on May 24, 2016. Follow up consultation on June 7, 2016, confirmed consultation for this activity has been adequate and DoT does not require additional information for the Bedout Basin EP. DoT receive all Quadrant Energy's Quarterly Consultation Update documents.
Adjacent Regulators	
State Department of Mines and Petroleum (DMP)	DMP were provided the Bedout Basin Consultation Package on March 12, 2015 and receive all Quadrant Energy's Quarterly Consultation Update documents. Additional consultation was provided to DMP on June 21, 2016, as per the DMP Consultation Guidelines. Additional information was provided at DMP's request on June 28, 2016. DMP confirmed this was adequate and no additional information regarding the Bedout Basin would be required via email on June 28, 2016. DMP is a valued stakeholder and Quadrant Energy commits to open on ongoing consultation before, during and after the Activity Including the provision of pre-start and cessation notifications as per DMP's Consultation Guidelines.

6. ENVIRONMENTAL HAZARDS AND CONTROLS

The impact and risk assessment approach is consistent with the requirements of AS/NZS ISO 31000:2009 Risk Management – Principles and guidelines and ISO/IEC 31010 Risk management – Risk management techniques. The approach can be mapped to the requirements of the OPGGS (E) Regulations for an EP, as described by NOPSEMA (N4700-GN1074 Rev 1 2013). The key steps are illustrated in Figure 6-1.

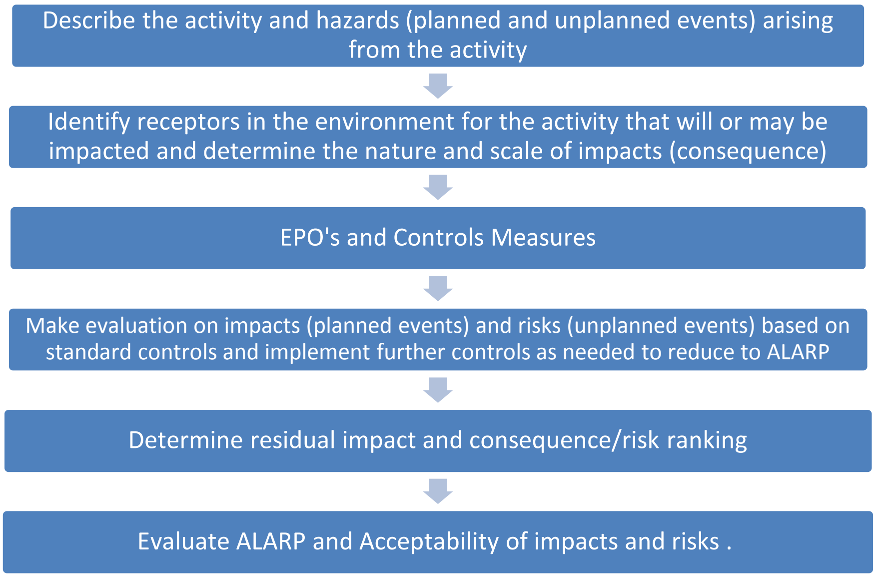

Figure 6-1: Risk and Impact Process

An assessment against the Activity was undertaken and the environmental hazards or aspects were then identified. The risk assessment identified 4 potential unplanned events and 8 planned events. Environmental aspects/hazards identified for the Activity**.**

The extent of actual impacts from planned events or potential impacts from unplanned events is assessed using the description of the Activity and known information on impacts (published industry reports and scientific studies) and in some circumstances predictive information such as modelling (e.g. noise and discharges modelling, oil spill trajectory and fate modelling). Impact mechanisms and thresholds for impact where relevant are determined and described, using scientific literature and modelling where required. The consequence level of the impact is then determined for each planned and unplanned event based on the severity of the impact to relevant receptor.

This process determines a consequence level based on set criteria for each receptor category and takes into consideration the duration and extent of the impact, receptor recovery time and the effect of the impact at a population, ecosystem or industry level. The consequence definitions are outlined in **Table 6-1** below.

Table 6-1: Consequence level description

Consequence Level		**Consequence Level description**
A	Negligible	No impact or negligible impact.
B	Minor	Detectable but insignificant change to local population, industry or ecosystem factors. Localised effect with rapid recovery
C	Moderate	Significant impact to local population, industry or ecosystem factors. Medium term recovery
D	Major	Major long-term effect on local population, industry or ecosystem factors. Slow recovery over decades
E	Critical	Complete loss of local population, industry or ecosystem factors AND/ OR major wide-spread

		regional impacts with slow recovery.

For unplanned events, a risk ranking is also determined using an assessment of the likelihood (likelihood ranking) of the event as well as the consequence level of the potential impact should that event occur. A description of likelihood as per Quadrant Energy's Risk Matrix.

Table 6-2: Likelihood description

No.	Matrix	Description
7	Expected	1. Consequence can reasonably be expected to occur in life of facility or this type of operation/project. 2. Greater than 1 incident per annum.
6	Probable	1. Consequence or event has occurred within the Company. 2. Between 1 and 10 incidents every 10 years (i.e. up to frequency 1/year).
5	Likely	1. Has occurred more than once in the Industry & team have had first-hand experience. 2. Between 1 and 10 incidents every 100 years (i.e. up to frequency 10-1/year).
4	Unlikely	1. Has occasionally occurred within the Industry & team has had first-hand experience. 2. Between 1 and 10 incidents every 1000 years (i.e. up to frequency 10-2/year).
3	Very Unlikely	1. Has occasionally occurred within the Industry & team has not had first-hand experience. 2. Between 1 and 10 incidents every 10,000 years (i.e. up to frequency 10-3/year).
2	Rare	1. Has occurred within industry but team not has not had first-hand experience. 2. Between 1 and 10 incidents every 100,000 years (i.e. up to frequency 10-4/year).
1	Very Rare	1. Unheard of in industry but team agrees that it could happen under exceptional circumstances. 2. Less than 1 incident every 100,000 years (i.e. up to frequency 10-5/year).

For each planned and unplanned event a set of Environmental Performance Outcome(s) (EPO's), Environmental Performance Standards (EPS) and Measurement Criteria (MC) are identified. The definitions of the performance outcomes, standards and measurement criteria are consistent with the OPGGS (E) Regulations. For planned and unplanned events, an ALARP and Acceptability assessment is also undertaken.

6.1 ALARP Evaluation

The ALARP principle is that the residual impacts and risk shall be 'as low as reasonably practicable'. It has particular connotations as a route to reduce risks when considering law, regulation and standards.

For an impact or risk to be ALARP it must be possible to demonstrate that the cost involved in reducing the impact or risk further would be grossly disproportionate to the benefit gained. The ALARP principle arises from the fact that infinite time, effort and money could be spent on the attempt of reducing a risk to zero. It should not be understood as simply a quantitative measure of benefit against detriment. It is more a best common practice of judgement of the balance of impact or risk and societal benefit.

For planned and unplanned events, an ALARP assessment is undertaken to demonstrate that the standard control measures adopted reduce the consequence or risk to ALARP. This process relies on demonstrating that further potential control measures would require a disproportionate level of cost/effort for the consequence or risk. If this cannot be demonstrated then further controls are implemented. The level of detail included within the ALARP assessment is based upon the nature and scale of the potential impact and risks.

6.2 Acceptability Evaluation

Quadrant Energy considers the impacts or risks associated with the Activity to be acceptable if the following criteria are met:

1. A consequence from a planned event is ranked as A or B; or a risk of impact from an unplanned event is ranked low to medium/high;

2. An assessment has been completed to determine if further information/studies are required to support or validate the consequence assessment;
3. Performance standards are consistent with legal and regulatory requirements;
4. Performance standards are consistent with Quadrant Energy Environmental Management Policy;
5. Performance standards are consistent with stakeholder expectations, and
6. Performance standards have been demonstrated to reduce the impact or risk to ALARP.

Table 6-3 and **Table 6-4** summarise the identified hazards and potential impacts associated with the activity. The table also lists the controls to prevent or mitigate impacts such that impacts and risks are reduced to ALARP and are at acceptable levels.

Table 6-3: Environmental Risk Treatment Summary for Planned Events

Event : Light Emissions	
Potential Impacts	*Threatened, migratory, local fauna* Continuous lighting in the same location for an extended period of time may result in alterations to normal marine fauna behaviour. Fish Increased predation associated with light attraction may result from artificial light emissions given that experiments using light traps indicate that some fish and zooplankton species are attracted to light sources (Meekan *et al*., 2001). Lindquist *et al*. (2005) concluded from a study that artificial lighting associated with a MODU resulted in an increased abundance of clupeids (herring and sardines) and engraulids (anchovies); these species are known to be highly photopositive. Shaw *et al*. (2002), in a light trap study, noted that juvenile tuna (Scombridae) and jack (Carangidae), which are highly predatory, may have been preying upon higher than usual concentrations of zooplankton that were attracted to a MODU's light field. Seabirds Studies conducted between 1992 and 2002 in the North Sea confirmed that artificial light was the reason that birds were attracted to and accumulated around illuminated offshore infrastructure (Marquenie *et al*., 2008) and that lighting can attract birds from large catchment areas (Wiese *et al*., 2001). Birds may either be attracted by the light source itself or indirectly as structures in deep water environments tend to attract marine life at all trophic levels, creating food sources and providing artificial shelter for seabirds (Surman, 2002). The light sources associated with the MODU, support vessels and flaring may also provide enhanced capability for seabirds to forage at night. Marine turtles The EPA estimates light may influence marine turtles within a distance of approximately 1.5km (EPA, 2010). Given that the closest beaches to the Operational Area are ~38km away and the closest known significant nesting beach is >100km away, significant impacts are not expected on nesting adults or hatchlings. Given that no light sensitive nesting habitat is present within the area over which light will be visible, the most significant risk posed to marine turtles from artificial lighting (being disorientation of hatchlings following their emergence from nests) is not considered credible. Transient individuals may be exposed to the artificial light from the Activity. Other marine fauna There is no evidence to suggest that artificial light sources adversely affect the migratory, feeding or breeding behaviours of cetaceans. Cetaceans predominantly utilise acoustic senses to monitor their environment rather than visual cues (Simmonds *et al*., 2004), therefore impacts are not considered likely.
Consequence Ranking	Negligible
Management Controls	**Effectiveness of control**
No standard controls are in place other than those required for navigational and safety requirements which are detailed in each Vessel Safety Case.	Vessels and MODU adhere to safety cases
Event : Noise Emissions	

Potential Impacts	Underwater noise generated from anthropogenic sources may impact on marine fauna by: • Causing physical injury to hearing organs; • Causing behavioural changes including displacement from biologically important habitat areas (such as breeding, feeding, calving and nursery sites); and • Masking or interfering with other biologically important sounds such as communication or echolocation systems used by certain cetaceans for location of prey and navigation. The extent of the impacts from underwater noise on marine fauna will depend upon the Activity and associated frequency range and intensity of the noise produced and sensitivity of the species affected. *Threatened, migratory, local fauna* Marine species that use sound for navigation and communication, like cetaceans, are particularly susceptible to noise impacts. Marine reptiles (turtles) and fish can also be vulnerable to noise impacts. A number of shark species may also occur in the region, including the EPBC Act listed whale shark. Elasmobranchs (rays, skates, sharks) rely on low frequency sound to locate prey (Myrberg, 1978). Elasmobranchs do not have swim bladders and are not typical hearing specialists (Baldridge, 1970). <u>Causing physical injury to hearing organs</u> Physiological damage to cetaceans from noise, such as hearing loss, is only likely to result from close proximity to intense sounds from high energy sources. This threshold is generally considered to be >200dB re 1 µPa (McCauley, 1994; Richardson *et al*., 1995) with physical injury leading to death only possible when peak pressure levels exceed 240dB re 1 µPa (Parvin *et al*., 2007). Fish sensitivity and resilience to underwater noise varies greatly depending on the species, hearing capability, habits, proximity to the noise source, and the timing of the noise (i.e. the noise may occur during a critical part of the fish's lifecycle) (McCauley and Salgado-Kent, 2008). Most marine fish are hearing generalists (Amoser and Ladich, 2005) with relatively poor hearing. Hearing generalists are not as sensitive to noise and vibration as hearing specialists, which have developed hearing specialisations and can be particularly vulnerable to intense sound vibrations because many possess an air-filled swim bladder (Gordon *et al*., 2004). No absolute thresholds are known for the sensitivity of turtles to underwater noise, or the levels required causing pathological damage. <u>Causing behavioural changes</u> Behavioural avoidance of baleen whales may onset from 140 to 160dB re 1 µPa (Richardson *et al*., 1995; Southall *et al*., 2007). Baleen whales display a gradation of behavioural responses to seismic activities, suggesting that seismic acoustic discharges are audible to whales at considerable distances from the source, but indicate that whales are not disrupted from normal activities even during migration (McCauley, 1994). Reactions of whales to circling aircraft (fixed wing or helicopter) are sometimes conspicuous if the aircraft is below an altitude of approximately 300m, uncommon at 460m and generally undetectable at 600m plus (NMFS, 2001). Baleen whales sometimes dive or turn away during overflights, but sensitivity seems to vary depending on the Activity of the fauna. The effects on whales seem transient, and occasional overflights are unlikely to have long-term consequences to cetaceans (NMFS, 2001). Observations by Richardson and Malme (1993) indicate that, for bowhead whales, most individuals are unlikely to react significantly to occasional low-flying single helicopter passes ferrying personnel and equipment to offshore operations at altitudes above 150m. Leatherwood *et al.,* (1982) observed that minke whales responded to helicopters at an altitude of 230m by changing course or slowly diving. Turtles have been shown to respond to low frequency sound, with indications that they have the highest hearing sensitivity in the frequency range between 100 – 700Hz (Bartol and Musick, 2003) which is within the range of noise generated by vessels. Reported responses of turtles to high levels of anthropogenic noise include increased swimming activity and erratic swimming patterns (McCauley *et al.,* 2002). Elasmobranchs (rays, skates, sharks) rely variably on low frequency sound to locate prey (Myrberg, 1978). Elasmobranchs do not have swim bladders and are not typical hearing specialists (Baldridge, 1970). Additional evidence from study observations in the NW Shelf suggests that in response to drill noise, behavioural changes for some fish species are temporary and short-ranged (i.e. nuisance factor) (McCauley, 1998). Under still conditions, drilling noise was detectable in this study up to 20km away, though at levels below the expected hearing range of the fish studied.

	<u>Masking or interfering with other biologically important sounds</u> Underwater noise produced by drilling and associated vessel operations may interfere with the ability of marine fauna to detect naturally produced sounds including communication signals. This effect is termed 'auditory masking' and has the potential to impact on marine fauna through inhibiting their ability to detect predators and prey, altering their navigational ability and ability to communicate. Cetaceans are the only species likely to be susceptible to this. Baleen whales produce a complex range of underwater sounds ranging in frequency from approximately 12 hertz (Hz) to 8kHz, with the most commonly produced frequencies below 1kHz (McCauley, 1994); studies of baleen whale hearing apparatus also suggest that their hearing is best adapted for low frequency sounds (McCauley, 1994; Richardson *et al*., 1995). Hearing ranges in toothed whales (e.g. sperm whales, orcas) has been estimated at between 150Hz and 160kHz (Southall *et al*., 2007), these are considered mid-frequency cetaceans in Southall *et al*. (2007). Research has indicated that toothed whales are most sensitive to sounds above approximately 10kHz (NRC, 2003). Below about 10kHz sensitivity deteriorates with decreasing frequency and below 1 kHz sensitivity appears to be poor. There is a paucity of information available regarding call masking in whales (Richardson *et al.,* 1995), although it has been suggested that an observed lengthening of calls in response to low-frequency noise in humpback whales and orcas may be a response to auditory masking (Fristrup *et al.,* 2003; Foote *et al.,* 2004). Toothed whales hear at frequencies predominantly above those of the noise sources that result from typical drilling programs and are therefore unlikely to be susceptible to auditory masking. *Socio-Economic Receptors* There are a number of commercially important fish species in the region with unknown noise sensitivities.
Consequence Ranking	Negligible

Management Controls	**Effectiveness of control**
Procedures for interacting with cetaceans	Support vessel complies with Part 8 of EPBC Regulations for interacting with cetaceans to avoid collision with cetaceans. Helicopter complies with Part 8 of EPBC Regulations for interacting with cetaceans to reduce noise impacts.
MODU seismic survey procedures	Vertical seismic profile (VSP) or check-shot survey implemented in accordance with Quadrant's Environmental Checklist for MODU Seismic Operations which includes controls that reduce the risk of harm to cetaceans and whale sharks.

Event : Atmospheric Emissions	
Potential Impacts	Air emissions through the release of ODS and use of fuel (specifically marine-grade diesel) to power MODU, vessel, and helicopter engines, generators and mobile and fixed plant and equipment may result in a temporary, localised reduction of air quality in the environment immediately surrounding the discharge point. Similarly, flaring will reduce the air quality immediately surrounding the discharge point. The emissions may contain greenhouse gases (GHG) such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), along with non-GHG such as sulphur oxides (SO_x) and nitrous oxides (NO_x). Emissions of dry bulk products could include cement, barite and bentonite. Anecdotal observations on drilling rigs during transfers indicate small releases due to the closed system used. A temporary reduction in local air quality may occur due to the presence of bulk product particles.
Consequence Ranking	Negligible

Management Controls	**Effectiveness of control**
Bulk solid transfer procedure	Includes control measures to minimise release to atmosphere.
Waste incineration (No incineration within 500m exclusion zone)	Waste incineration managed in accordance with MARPOL Annex VI, except no incineration within 500m exclusion zone.
Fuel oil quality (MODU and support vessels)	Reduced sulphur emissions during the activity.
Air pollution prevention certification	MODU and support vessels will maintain a current International Air Pollution Prevention (IAPP) Certificate which certifies that measures to prevent ozone-depleting substance (ODS) emissions, and reduce NOx, SOx emissions during the activity are in place.

<table>
<tr><td colspan="2">Well test procedures</td><td>Includes control measures that reduce the risk of poor quality incineration of hydrocarbons entering the atmosphere and reduces flare dropout. Oil-in-water filtration equipment</td></tr>
<tr><td colspan="3">Event : Planned Operational Discharges – Surface and subsea</td></tr>
<tr><td>Potential Impacts</td><td colspan="2">Operational discharges will be small, continuous and dependent on rainfall, the number of persons onboard, and the machinery used in the Activity. The operational discharges will result in a reduction in water quality of the receiving marine waters. This will be temporary (hours), localised and limited to the surface waters (<5m). The discharges will be dispersed and diluted rapidly with increasing distance from the MODU and vessels, so that temporary changes to ambient conditions are unlikely outside the 500m exclusion zone around the MODU.
Operational discharges have the potential to impact on environmental receptors through:
Nutrient enrichment
Discharge of food waste and sewage can cause eutrophication in the surrounding waters resulting in changes to plankton in the immediate area which could subsequently impact on fish and planktonic feeders. In a study of sewage discharge in deep ocean waters, Friligos (1985) reported no appreciable differences in the inorganic nutrient levels between the outfall area and background concentrations suggesting rapid uptake of nutrients and/or rapid dispersion in the surrounding waters. Similar studies (Parnell, 2003) concluded similar results with rapid dispersion and dilution within hours of discharge.
Subsequently nutrient enrichment is not expected to affect identified receptors.
Toxicity
In general, dilution after dumping at sea is rapid with results showing 1 in 1,000 dilution within 30 minutes (Costello and Read, 1994). Subsequently acute toxicity to marine fauna is not expected to affect identified receptors at ecologically significant or detectable levels at the discharge site.
Discharge of anti-scalant dosed into the potable water system will be periodic, when maintenance is required. The chemical used for this process is diluted prior to discharge within the potable water system and as only small volumes are released at the sea surface and it is mixed with the water in the system. Acute toxicity is therefore unlikely to occur at ecologically significant or detectable levels.
Oily water discharged from support vessels and deck runoff from the MODU could result in turbidity and toxic effects on marine organisms from hydrocarbons and other contaminants.
Water column turbidity
Deposition of food waste, sewage, oily water and ballast water may contribute to turbidity in the water column. Since the largest potential source of turbidity is discharged drilling fluids and cuttings, this is discussed in Section 6.6. Given that ballast water will be seawater or freshwater, no impacts to seawater quality due to the Activity are expected.
Temperature effects
Marine fauna with the inability to regulate body temperatures are the most susceptible to changes in sea water temperature. Cooling water will be discharged at elevated temperature to the sea where it will initially be subjected to turbulent mixing and some transfer of heat to the surrounding waters. The plume will disperse and rise to the sea surface where further dilution and loss of heat will occur as it mixes and aligns with the local currents.
Temperature dispersion modelling shows that water temperature of discharged water will decrease rapidly as it mixes with the receiving waters, with discharge waters being less than 1°C above background levels within less than 100m (horizontally) of the discharge point. Vertically, the discharge will be within background levels within 10m (Woodside, 2008).
Given the relatively low volume of cooling water, temperature differential, the deep, open-sea surrounding the Operational Area, impact on water quality is expected to be negligible.
Salinity effects
Discharges of desalination plant effluents will result in a slightly elevated salinity (around 10% higher than seawater). Most marine species are able to tolerate short-term fluctuations in salinity in the order of 20–30% (Walker and McComb, 1990). As such it is expected that most pelagic species would be able to tolerate short-term exposure to the slight increase in salinity and lethal effects are not expected.</td></tr>
<tr><td>Consequence Ranking</td><td colspan="2">Negligible</td></tr>
<tr><td colspan="2">Management Controls</td><td>Effectiveness of control</td></tr>
<tr><td colspan="2">Sewage treatment system</td><td>Stipulates sewage disposal conditions and limitations</td></tr>
</table>

Deck cleaning product selection procedure	Improve water quality discharge (reduce toxicity) to the marine environment
Oily water treatment system	Oily mixtures discharged to sea in accordance with MARPOL Annex I. to reduce impacts of planned oil discharges
Ballast water management plan	The plan addresses requirements for compliance with the *International Convention for the Control and Management of Ships' Ballast Water and Sediment* 2004 so that marine pest species are not introduced.
Waste (garbage) management procedure	Includes controls for putrescible waste disposal to limit environmental impact and to reduce the risk of unplanned release of waste to sea
Event : Physical Presence/seabed disturbance	
Potential Impacts	<u>Threatened/Migratory fauna: (Sharks, Turtles, Marine Mammals and Seabirds)</u> For migratory/threatened fauna (sharks, turtles, marine mammals and seabirds) there is expected to be a temporary behavioural alteration to a very small proportion of the population (solitary individuals or small groups). The presence of the MODU and support vessels is unlikely to disrupt important life-cycle events as no aggregation or calving grounds are located in the vicinity. Whale sharks aggregate well inshore of the Operational Area and any attraction to whale sharks is expected to be temporary and to solitary migrating individuals to/from these aggregations. Likewise, while cetaceans (including humpback whales) may pass within close proximity to the MODU and support vessels during migration, the presence of MODU and vessels is not expected to disrupt this lifecycle event. The MODU may provide resting and feeding advantages to seabirds. Solitary individuals or small groups only are expected to be attracted. <u>Physical Environment</u> For the majority of the Operational Area, the main benthic habitat type expected is sand and subtidal soft bottom communities. Disturbance of this benthos may result in the mortality of flora, sessile fauna and associated benthic infauna within the MODU anchoring footprint (approximately 1560m^2 based on 130m^2 per anchor, 12 anchors used for a semi-submersible, or 780m^2 for a jack-up assuming 3 spud cans at 260m^2 each) with additional linear disturbance from anchor line depressions likely 100-1000 m in length. Disturbance from installation of the stand-by mooring footprint and area of seabed contacted by towing line or excess chain is also expected. This impact would be within a 1.5km to 5km radius of the well if required. Impacts will be short term as new sediment settles over disturbed areas post activity. Benthic flora and fauna are expected to rapidly recolonize the site. Benthic epifauna and infauna may be damaged or smothered by placement of subsea infrastructure (jack-up legs, anchors, wellhead, BOP etc.) on the seabed. Observations of anchor scars in soft sediment environments at previous Quadrant Energy (formerly Apache) drilling locations show a depression of approximately 0.4 m in depth below the surrounding seabed (Neptune Geomatics, 2012). Anchor scars in the Van Gogh and Coniston-Novara areas have been identified from previous surveys and varied in the length from 100 to 1000m (Tri-Surv 2007, Neptune Geomatics 2011). Once temporary equipment is removed the depression will begin to fill from movement and settlement of sediments and the infauna and epifauna community is expected to re-colonise quickly. The Operational Area overlaps the Ancient Coastline (KEF) along the 125m contour. Where the ancient submerged coastline provides areas of hard substrate higher biological diversity habitat may be present. Little detailed knowledge is available for this area but the hard substrate of the escarpment is known to support sponges, corals, crinoids, molluscs, echinoderms. Given the features of the ancient coastline and recent seismic surveys in the area that also indicate areas of sloping topography which align with the ancient coastline perimeter, it is unlikely that MODU legs or anchors could be placed on the KEF and provide stability. However, the possibility cannot be excluded given the feature runs through the Operational Area, and it remains feasible that wells could be drilled on the KEF given its overlap with the reservoirs. The North-west bioregional plan (DSEWPaC, 2012) outlines key concerns for the KEF and it is noted that 'physical habitat modification' is listed as 'not of concern' for this KEF. The plan also states that generally most actions occurring along the ancient coastline are unlikely to impact adversely on the ecosystem functioning and integrity of this feature, with only ocean acidification of potential concern. Due to the proximity of the reservoirs of interest to the KEF, it is possible that wells proposed to be drilled by Quadrant under this EP may require anchoring/ drilling/ jack-up legs to be on the KEF. Given the uncertainty around the potential value associated with the KEF, Quadrant will review available information, inclusive of the DoE information, and available bathymetry data for proposed well locations and MODU anchor positions or jack-up leg positions. Should there be potential for

	contact to the KEF, then Quadrant will undertake a seabed survey to obtain visual confirmation of the nature of the habitat at the proposed well location in order to evaluate the value of the ancient coastline and whether there are areas of high biological diversity to be avoided. If high biological diversity value is identified and the potential impacts are not considered acceptable using Quadrant's consequence assessment matrix, the well/MODU location will be re-evaluated. <u>Socio-economic Receptors</u> The physical presence of the MODU, support vessels, and the existence of a controlled safety zone around the MODU may be an obstacle for shipping traffic in the region and may disrupt commercial fishing operations through a temporary loss of fishing area and potential inconvenience to fishing practices. This EP proposes a well in water deeper than 70m, given the pearling industry's activities are likely to only occur in water up to 40m deep pearling activities will not be impacted. No objection has been raised for the Activity by commercial fisheries in consultation. A review of shipping data indicates that the Activity may be in close proximity to recognised commercial shipping routes and charted shipping fairways. In consultation on August 3, 2016, AMSA provided an assessment of vessel traffic within the Operational Area. Shipping traffic plots provided by AMSA indicate cargo and local offshore support vessel traffic may be encountered, however traffic within the Operational Area is mostly confined to three designated shipping fairways. In response Quadrant has committed to not positioning a MODU within a charted shipping fairway. AMSA requested the following management controls: 1. Updates of movements to the AMSA RCC; and 2. Notifying the Australian Hydrographic Service.
Consequence Ranking	Minor

Management Controls	**Effectiveness of control**
Maritime notices Regulatory notifications	Information provided on MODU arrival and departure so that the maritime industry is aware of petroleum activities (including how the site is left). Regulatory notifications also issued in accordance with relevant regulations to NOPSEMA and DMP.
Stakeholder Engagement	Stakeholders are aware in advance of proposed activities to reduce the impact to them. Ongoing consultation occurs as activity details are confirmed and all correspondence logged in stakeholder consultation database. Quadrant Energy's consultation coordinator available before, during and after the Activity to ensure stakeholder feedback is evaluated and considered during the operational activity phases
MODU identification system	MODU has a RACON (radar transponder) or Automatic Identification System (AIS) to aid in its detection at sea. Where the well location is <5nm from a shipping fairway, an Aid to Navigation (AtoN) will be installed on the MODU and will be located in a constantly manned area. This will minimise impacts from physical presence.
MODU move procedure	No accidental contact with the seabed and subsea infrastructure during the MODU move limiting seabed disturbance.
MODU station keeping system	MODU anchors positioned and maintained at locations defined in the rig mooring analysis to reduce risks to seabed habitat and petroleum infrastructure, and are recovered within 3 months of MODU departure.
Standby vessel mooring procedure	Minimises seabed disturbance to planned locations away from sensitive features and petroleum infrastructure
Standby Vessel	Minimises potential interactions with other marine users by maintaining constant watch of the 500m exclusion zone around the MODU.
Site Assessment Process	Review existing seabed and bathymetry survey data in relation to proposed well/MODU location. If preliminary well planning indicates that well location, MODU positioning or drilling discharges footprint is on or will impact the ancient coastline KEF, then a visual seabed survey is carried out to determine the nature and biodiversity value of the potentially impacted KEF
Conduct site survey if proposed well	If planned impacts to the KEF are risk assessed and considered not

location and/or anchors and/or jack-up legs will be located on the KEF	environmentally acceptable, then the location of the MODU/well will be reassessed to prevent impacts to the high biodiversity habitat
Errant vessel procedure	Ensures MODU and support preparedness and response arrangements are in place for an errant vessel
Pre-lay anchoring procedure	Ensures mariners are aware of pre-laid anchors through notifications and surface marker buoys
Event : Drilling discharges	

Potential Impacts	Environmental receptors have the potential to be impacted through smothering (sediment deposition and toxicological effects) and through reduction to water quality (turbidity and toxicological effects). Bulk discharges released during transfers (through venting) can result in particles released into the surrounding air and are included in Atmospheric Emissions. ***Seabed discharges*** *Smothering* The discharge of borehole materials during riserless drilling will occur at the well opening on the seafloor until a riser is installed. These discharges will be seawater with viscous sweeps only as they occur prior to riser installation. Direct contact with these discharges is expected to smother any habitats which may include soft sediment benthic invertebrates. Re-colonisation by benthic invertebrates of the mud coated cuttings will occur through time. Due to the low toxicity of these discharges, effects are similar to those expected from WBM cuttings discharges which result in burial and low sediment oxygen concentrations caused by organic enrichment (Neff 2005). Recovery of benthic communities from burial and organic enrichment occurs by recruitment of new colonists from planktonic larvae and immigration from adjacent undisturbed sediments. Ecological recovery usually begins shortly after the end of drilling and often is well advanced within a year. Full recovery may be delayed until concentrations of biodegradable organic matter decrease through microbial biodegradation to the point where surface layers of sediment are oxygenated. Case studies on impacts of WBM and SBM on soft sediment and benthic fauna are outlined below: • For Quadrant Energy's East Spar development, the area of impact from WBM discharges was not more than 100m from the drill site and short lived (recovery in less than 18 months) (Sinclair Knight Merz 1996, 1997; Kinhill 1997); • Benthic monitoring at Quadrant Energy's Stag production platform indicated that drilling-induced impacts had less of an influence on infaunal assemblages through time than small spatial scale natural variability (Kinhill 1998; CSIRO 2001; IRCE 2001). Two years after the initial production well drilling, the distribution of drill cuttings was mostly restricted to within 50m of the platform, with minor traces out to 1,000m; • Benthic monitoring at the Van Gogh 3 well location months after the well had been drilled revealed than burrow forming worms and crabs still persisted within the area of sediment deposition (Sea Serpent, 2008). It was considered likely that the bioturbation from these invertebrates was contributing to re-oxygenation of the sediments; • Diver observations at SBM sites indicated that coral bommies and assemblages on the limestone pavement habitat within tens to hundreds of metres of the drill sites remain healthy and similar to reference areas; and • An annual marine monitoring program indicated that macroalgal communities located 500 m north of an SBM site had not been impacted. These studies indicate that impacts could be expected on the KEF within the Operational Area, if the cuttings settled on the KEF within tens to hundreds of metres of the drill site. If the KEF, which is likely to be represented by hard substrate, does support a different biological community such as filter feeding organisms (e.g. sponges) there is the potential for smothering of these during the discharge of drill cuttings (including bulk discharges). The increase in turbidity in the water column could also adversely affect these communities temporarily during the discharge of drill cuttings at the seabed (i.e. riserless drilling). Species such as molluscs, crustaceans and fish potentially associated with the KEF could experience temporary impacts within the radius of the wellhead (likely within 1 km), but would recover rapidly as the turbidity would be temporary. Sedimentation changes are likely to be similar to those experienced naturally by the species in the area given the soft sediments known to occur in the Operational Area and as a thin layer on hard substrates. Invertebrates associated with the KEF/hard substrate features are likely to recover rapidly from sedimentation,

although toxicological impacts could be expected (see below). It is unlikely that discharges at the sea surface (i.e. following the installation of the riser/bulk discharges at end of well) would significantly impact on the KEF given the water depths in the Operational Area, the highest potential for impact is considered to be from riserless drilling.

Due to the proximity of the reservoirs of interest to the KEF, it is possible that wells proposed to be drilled by Quadrant under this EP may lead to impacts from drilling discharges on the KEF. Given the uncertainty around the potential value associated with the KEF, Quadrant will review available information, inclusive of the DoE information, and available bathymetry data for proposed well locations. Should there be potential for impact on the KEF, then Quadrant will undertake a seabed survey to obtain visual confirmation of the nature of the habitat, in order to evaluate the value of the ancient coastline and whether there are areas of high biological diversity to be avoided. If high biological diversity value is identified and the potential impacts are not considered acceptable using Quadrant's consequence assessment matrix, the well/MODU location will be re-evaluated.

Toxicological effects

Cementing has the potential to result in toxicity effects, however given that cement is inert once set (CIN, 2005), chronic toxicity from exposure to set cement will not occur. The riserless sections of the well are drilled with seawater, bentonite and viscosified brine (e.g. xanthan gum) and viscosified brine which are low toxicity chemicals and therefore toxicological effects are not expected.

Discharges at the sea surface will result in WBM and NAF (contingency only) cuttings settling on the seabed in the vicinity of the wells, and could impact on the KEF, potential impacts associated with smothering is discussed above.

Many studies by Quadrant Energy and other operators have examined the persistence of hydrocarbons from drilling muds in marine sediments. Apache commissioned studies (IRCE, 2001, 2003,2004; IRC, 2007; RPS Bowman Bishaw Gorham, 2003, 2004, 2005; URS 2008, Cardno 2011) indicated that:

- Samples taken from WBM sites between one and five months after drilling indicated that no hydrocarbons were present (total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAH)) and that infauna composition resembled that from control location;
- Changes to the diversity of infauna at NAF sites was associated with sediment concentrations of TPH above 1,000 mg/kg, with organic enrichment indicated as the cause of the change in infauna community composition;
- Reductions in sediment TPH levels of an order of magnitude were observed over eight to 13 months in one study;
- Recovery of sediment TPH levels to baseline concentrations was seen in a 5 year time period for one study; and
- The footprint of increased concentrations of hydrocarbons and decreased infauna diversity was ellipsoid in shape such that, changes occurred up to 200 m along the dominant current direction from the drill site and up to 50m across the current.

Other case studies from drilling activities on the NW Shelf regarding impacts of NAF cuttings discharge on the marine environment (APPEA, 1998) have shown:

- Wannea-3/6 – drilled by Woodside in 1994 and found that 11 months after the cessation of drilling, low residual concentrations of hydrocarbons were detected (<200 ppm), reducing to less than 1 ppm within 200m of the cuttings discharge point;
- North Rankin-A platform – drilled by Woodside in 1983 and completed in 1991 in water depths of 125m, with 11 of the 23 wells drilled using low-toxicity oil-based mud. Concentrations of hydrocarbons rapidly decreased from 75,000ppm beside the platform to 40ppm at 800m and 2ppm at 2km from the platform in the direction of the prevailing current. Further monitoring conducted in the following years indicated that away from the cuttings pile, the degradation of residual hydrocarbons was occurring successfully with an annual half- life of one year;
- Mydas-1 and Hawksbill-1 – drilled in 1993 and 1994. Results from studies conducted indicated that impacts to seabed fauna were limited in extent and duration, the extent of contamination was approximately 100m from the well head in the direction of the prevailing currents, the biomass and densities of some of the common and numerous taxa had decreased by one to two months after drilling, with effects limited to 100m from the well; in most cases, biomasses and densities of these taxa had recovered 6–8 months after drilling;
- In Bass Strait, studies conducted by Esso Australia Pty Ltd at the Fortescue platform, in a water depth of 70m, found that sediment concentrations of synthetic or oil based fluids were highest (average of 9,600ppm) at the site closest to the platform, but not detectable (<0.2ppm) at any

site beyond 100m from the platform. Four months after the end of drilling, concentrations had decreased to an average of 230ppm at the sites closest to the platform, and were not detected at any monitoring station 11 months after drilling. It was concluded that the risks for long-term alteration of benthic infauna from the use of synthetic based fluids were low; and

- In some cases, increased concentrations of NAF-coated cuttings on the seabed have resulted in a decrease in species diversity driven by organic enrichment rather than toxicity, with opportunistic species out-competing other more temperamental species. Microbial degradation of the base fluid in sediments results in oxygen depletion in sediments (Neff *et al*., 2000), leading to impacts on infaunal communities.

Sea surface discharges

Turbidity

Drill cuttings, fluids, formation water and cement (additives and cured) discharged at sea surface during the Activity will disperse through the water column. This is expected to result in a localised increase in turbidity and could impact on organisms present in the water column. It is not expected that impacts to pearl oyster brood stock would occur due to the presence of drilling discharges in the water column due to the rapid dispersion of the discharges and the expected low toxicity of the discharge.

Pelagic fish species may be impacted by increased suspended solids in the water column. The increased particle load in the water column could adversely affect respiratory efficiency of fish. Most visual orientated fish species would likely relocate to an unaffected area or simply pass unaffected through turbid waters.

Toxicological effects

Components of WBM and NAF with potential toxicity to marine flora and fauna include metals associated with inorganic salt components, organic polymers and additional organic additives as well as barite/bentonite weighting agents. Metals present in base muds generally resemble that of marine sediments, albeit with concentrations of some metals higher than clean marine sediments (*Neff*, 2005) and presence of hydrocarbons. Metals associated with WBM have been shown to have a low bioavailability as they tend to remain in a non-ionic form, remaining bound to other compounds, presenting a low toxicity risk to marine fauna (Neff, 2005).

Cuttings generated using NAFs do not disperse as effectively as those generated with WBMs (Neff, 2005) and therefore the extent of impact will be reduced.

The base oil of the NAF used for the Activities will most likely be Saraline 185V, which has been risk assessed using Quadrant Energy's Drilling Fluids and Chemical Risk Assessment Procedure (EA-91-II-008) and is considered to be readily biodegradable, non-toxic in the water column and of low sediment toxicity.

Toxicity test results from NAFs in one study showed that the olefin and paraffin oil components that made up the synthetic component in the NAF was non-toxic to the water-dwelling organisms studied (Neff et al., 2000a). However, sediment toxicity results vary depending on the type of olefin or paraffin. As olefins are sourced in Europe and America and paraffins are sourced in Malaysia, the preferred product in terms of both the supply and transportation footprint is the paraffin. The paraffin Saraline 185V has been identified as a GTL paraffin that has a similar toxicity to linear alpha olefins (LAOs) (Gagnon, 2006) and is the oil of choice for the majority of Quadrant Energy operations; this oil is used globally and its impacts on the marine environment are well studied and understood.

Bioaccumulation is the uptake and retention of xenobiotics (substances that are not natural components of the environment) by organisms from their environment. This process can have significant ecological consequences as pollutants move up the food chain to higher order species.

Numerous studies have been carried out in the Gulf of Mexico to test and evaluate a range of biological, biochemical and chemical methodologies to detect and assess chronic sub-lethal biological impacts in the vicinity of long duration activities associated with oil and gas exploration and production. Contaminant concentrations at most locations studied were below levels thought to induce biological responses (Kennicutt *et al*., 1996).

Discharge of cement at the sea surface has not demonstrated significant harm to water column flora and fauna (Neff, 2005).

Toxic impacts from the oil content in formation water is expected to be very localised following treatment by filtration to less than 30 ppm. Any toxic effects that might potentially would likely be restricted to small organisms such as plankton, larvae and potentially small fish that become entrained in discharged water resulting in relatively high exposure periods. The period of which formation water may be discharged is short, i.e. nominally 5 days per well test target. Given the very

<table>
<tr><td></td><td>short duration of each well test discharge, the depth of waters and the high degree of dispersal and dilution at the seabed at this depth, seabed loadings of contaminants are not predicted to reach levels of concern.</td></tr>
<tr><td>Consequence Ranking</td><td>Minor</td></tr>
<tr><td>Management Controls</td><td>Effectiveness of control</td></tr>
<tr><td>Chemical selection procedure</td><td>Aids in the process of chemical management that reduces the impact of drilling discharges to sea. Only environmentally acceptable chemicals are used.</td></tr>
<tr><td>Cuttings management system</td><td>Reduces the concentration of drilling mud on cuttings prior to discharge. If drilling with non-aqueous fluid (NAF), the average oil-on-cuttings discharged to sea shall not exceed 10% for any well section</td></tr>
<tr><td>Site Assessment Process</td><td>Review existing seabed and bathymetry survey data in relation to proposed well/MODU location. If preliminary well planning indicates that well location, MODU positioning or drilling discharges footprint is on or will impact the ancient coastline KEF, then a visual seabed survey is carried out to determine the nature and biodiversity value of the potentially impacted KEF</td></tr>
<tr><td>Conduct site survey if proposed well location and/or anchors and/or jack-up legs will be located on the KEF</td><td>If planned impacts to the KEF are risk assessed and considered not environmentally acceptable, then the location of the MODU/well will be reassessed to prevent impacts to the high biodiversity habitat</td></tr>
<tr><td>Oil content measurement procedure</td><td>All drilling-related oil content measurements and calculations will be made in accordance with Quadrant operational guidelines.</td></tr>
<tr><td>Oily water treatment system during well test</td><td>OIW (oil in water) content discharged during well testing is below 30ppm</td></tr>
<tr><td>Well test procedures</td><td>Ensures well testing fluids are appropriately managed and OIW (oil in water) content is below 30ppm</td></tr>
<tr><td>Inventory control procedures</td><td>Only residual fluids are discharged overboard</td></tr>
<tr><td>Bulks mixed with water prior to discharge</td><td>If other options for disposal have been exhausted, bulks mixed with water to aid in dispersion in the surrounding environment.</td></tr>
<tr><td>Bulk solid transfer procedure</td><td>Minimises solids released during bulk transfers</td></tr>
<tr><td colspan="2">Event : Contingency hydrocarbon spill response, including the following strategies:
• Source control;
• Operational monitoring;
• Surface and subsea dispersant application;
• Containment and recovery;
• Protection and deflection;
• Shoreline cleanup;
• Oiled wildlife response; and
• Scientific monitoring.</td></tr>
<tr><td colspan="2">Potential Impacts
Key environmental hazards associated with the potential spill response strategies are provided together with a description of associated impacts to sensitive receptors. Some of these hazards are unique to spill response (e.g. application of chemical dispersants), however some hazards shared with the Activity have been detailed and re-evaluated on the basis that the environment within which spill response activities take place may be of higher sensitivity than the offshore environment within which the Activity occurs. Following this principal, hazards associated with the contingency drilling of a relief well by an additional MODU, as part of the source control strategy, have not been re-assessed since they are considered sufficiently evaluated elsewhere in the EP.</td></tr>
<tr><td>Light emissions</td><td>Lighting may cause behavioural changes to fish, birds and marine turtles which can have a heightened consequence during key life-cycle activities, for example turtle nesting and hatching. Turtles and birds, which includes threatened and migratory fauna, have been identified as key fauna susceptible to lighting impacts during spill response.
Spill response activities may occur on shorelines used by nesting turtles, including flatback, hawksbill, green and loggerhead turtles. During nesting and hatching season (primarily over summer months) lighting may cause behavioural impacts to turtles including aborted nesting attempts and mis-orientation of newly hatched turtles which may increase mortality rates. Spill response Protection Priority areas particularly important for seasonal turtle nesting include Montebello Islands, Dampier Archipelago, Eighty Mile Beach and Lacepede Islands an there is therefore an increased risk of</td></tr>
</table>

	negatively affecting turtles during shoreline operations in these areas. Spill response activities may also occur on shorelines used by nesting and feeding birds including seabirds and shorebirds. Lighting can cause disorientation in flying birds, disrupting nesting and breeding behaviours and impact on the ability of birds to forage. Disturbance to feeding migratory shorebirds may reduce their ability to replenish energy reserves and alter the timing and success of migratory flights. Spill response Protection Priority areas particularly important for seabirds and shorebirds include Montebello Islands, Dampier Archipelago, Eighty Mile Beach, Roebuck Bay, Lacepede Islands and Clerke Reef (Rowley Shoals) an there is therefore a heightened risk of negatively affecting birds during shoreline operations in these areas. Eighty Mile Beach and Roebuck Bay are particularly important areas for seasonal aggregations of migratory shorebirds and are listed Ramsar sites. As a consequence of impacts to fauna, lighting has the potential to impact supported industries such as tourism.
Noise emissions	Underwater noise from the use of vessels may impact marine fauna, such as fish, marine reptiles and marine mammals in the worst instance causing physical injury to hearing organs, but more likely causing behavioural changes which may impact key life-cycle process (e.g. spawning, breeding, calving). Underwater noise can also mask communication or echolocation used by cetaceans. Cetaceans have been identified as the key concern for vessel noise within the EMBA. Spill response activities using vessels have the potential to impact fauna in Protected Areas, this includes the whale conservation zone within the Camden Sound Marine Park. Noise and vibration from terrestrial activities on shorelines has the potential to cause behavioural disturbance to coastal fauna including protected and migratory species of shorebirds and seabirds. Noise and vibration may affect bird breeding and nesting behaviours and disrupt feeding activity. This could potentially impact reproductive success and for migratory shorebirds may negatively impact the ability to replenish energy reserves for migratory flights. Spill response Protection Priority areas particularly important for seabirds and shorebirds include Montebello Islands, Dampier Archipelago, Eighty Mile Beach, Roebuck Bay, Lacepede Islands and Clerke Reef (Rowley Shoals) an there is therefore a heightened risk of negatively affecting birds during shoreline operations in these areas. Eighty Mile Beach and Roebuck Bay are particularly important areas for seasonal aggregations of migratory shorebirds and are listed Ramsar sites. As a consequence of impacts to fauna (including shorebirds, marine mammals and fish), noise has the potential to impact supported industries such as tourism and commercial fishing.
Atmospheric emissions	Atmospheric emissions from spill response equipment will be localised and while there is potential for fauna and flora impacts, the use of mobile equipment, vessels and vehicles is not considered to create emissions on a scale where noticeable impacts would be predicted. Emissions may occur in Protected Areas and/or areas where tourism is important however the scale of the impact relative to potential oil spill impacts is not considered great.
Operational discharges and waste	Operational discharges from vessels may create a localised and temporary reduction in marine water quality. Effects include nutrient enrichment, toxicity, turbidity, temperature and salinity increases. These may impact a different set of receptors than previously described in that section given vessel use may occur in shallower coastal waters during spill response activities. Discharge could potentially occur adjacent to marine habitats such as corals, seagrass, macroalgae, and in Protected Areas, which support a more diverse faunal community, however discharges will be very localised and temporary. The decanting of oily water back into the marine environment during containment and recovery activities has the potential to impact marine organisms from the toxic effects from hydrocarbons, however, given the marine environment is already contaminated with hydrocarbons there is limited potential for an increase in impact, unless the discharge spreads the contamination to a previously uncontaminated area. Cleaning of oil contaminated equipment, vehicles and vessels, has the potential to spread oil from contaminated areas to those area not impacted by a spill, potentially spreading the impact area and moving oil into a more sensitive environment. Flushing of oil from shoreline habitats is a clean-up technique designed to remove oil from the receptor that has been oiled and remobilise back into the marine environment and result in further dispersion of the oil. The process of flushing has the potential to physically damage shoreline receptors such as mangroves and rocky shoreline communities, increase levels of erosion, and create an additional, and potentially higher, level of impact than if the habitat was left to bio-remediate. Sewage, putrescible and municipal waste will be generated from onshore activities at temporary camps which may include toilet and washing facilities. These wastes have the potential to attract

	fauna, impact habitats, flora and fauna and reduce the aesthetic value the environment areas, which may be within Protected Areas. The creation, storage and transport of oily waste and contaminated organics has the potential to spread impacts of oil to areas, habitats and fauna not previously contaminated. The risk of sewage, putrescible and municipal waste is heighted in areas supporting shorebird population where shoreline staging areas may be deployed. Eighty Mile Beach and Roebuck Bay are areas where large-scale shoreline response and development of staging areas could occur as well as being important Ramsar listed sites for migratory shorebirds.
Physical presence and disturbance	<u>Benthic habitat and marine fauna disturbance</u> The use of vessels may disturb benthic habitats in coastal waters including corals, seagrass and macroalgae. Impacts to habitats from shoreline/nearshore activities includes the deployment and dragging of anchor/chain and the grounding of vessels in shallow waters. Booms create a physical barrier inn surface waters which can injure or entangle passing marine fauna using surface waters. Vessel use in shallow coastal waters also increases the chance of contact or behavioural disturbance of marine megafauna such as turtles, dolphins, dugongs and seabirds, while increased vessel activity further offshore has the potential to disturb migrating/calving humpback whales in season. Priority Protection areas at a heightened risk are Roebuck Bay, Dampier Archipelago, King Sound, Camden Sound and Rowley Shoals due to high density/diversity of benthic habitats (e.g. corals, seagrass and/or macroalgae) and high abundance of marine megafuna using these habitats (e.g. feeding turtles, dugongs and dolphins). These areas also have extreme tidal ranges, increasing the risk of vessel grounding and increasing the risk of deployment booms dragging in strong tidal currents. Further offshore, waters along the Dampier Peninsula, King Sound (Buccaneer Archipelago) and Camden Sound are particularly important for seasonal Humpack whale calving. <u>Coastal habitat and shoreline fauna disturbance</u> Vehicles, equipment and personnel used during shoreline response activities have the potential to damage coastal habitats such as dune vegetation, samphire and mangroves and habitats important to threatened and migratory fauna including nests of turtles and birds and bird roosting/feeding areas. Shoreline clean-up may involve the physical removal of substrates that could cause impact to habitats and coastal hydrodynamics and alter erosion/accretion rates. Aside from physical damage to important coastal habitat (e.g. mangroves) and turtle/bird nesting areas, the operation of vehicles, equipment and personnel also can create behavioural disturbance to coastal fauna, particularly birds, which may be present and abundant during daytime operations. As discussed with lighting and noise impacts, disturbance form shoreline operations may affect nesting and feeding behaviours, negatively influencing breeding participation and success or altering migratory behaviours. The disturbance to shorebird feeding may have implications on the replenishment of energy reserves and the timing and success of migratory flights. Sensitive mangroves areas are a key feature of many Protection Priority areas for spill response including Montebello Islands, Dampier Archipelago, Eighty Mile Beach, Roebuck Bay, Dampier Coast North, King Sound and Camden Sound, while Protection Priority areas particularly important for seabirds or shorebirds include Montebello Islands, Dampier Archipelago, Eighty Mile Beach, Roebuck Bay, Lacepede Islands and Clerke Reef (Rowley Shoals). <u>Cultural disturbance</u> Aside from disturbance to habitats and marine/coastal fauna, spill response activities may create disturbance to cultural values additional to the spill itself. Shorelines of Dampier Archipelago (Burrup Peninsula) and Kimberley shorelines (including coastal areas of Dampier Peninsula, King Sound and Camden Sound) have indigenous significance in terms of traditional use for food resources as well as containing symbolic sites and landscapes. Spill response could occur within areas of the Lalang-garram (Camden Sound) Marine Park, which is jointly managed between traditional owners and DPaW, and has special significance for traditional owners. Some shorelines of the Dampier Peninsula, King Sound/Buccaneer Archipelago, Doubtful Bay, Collier Bay and Camden Sound are subject to Native Title. <u>Oiled Wildlife Response</u> Oiled wildlife response may include the hazing, capture, handling, transportation, cleaning and release of wildlife susceptible to oiling such as birds and marine turtles. While oiled wildlife response is aimed at having a net benefit, poor response can potentially create additional stress and exacerbate impacts from oiling, interfering with key life-cycle processes, hampering recovery and in the worst instance increasing levels of mortality. <u>Invasive Marine Species</u> Impacts from invasive marine species released from vessel biofouling include out-competition,

	predation and interference with other ecosystem processes. The ability for a non-native species to establish is generally mitigated in deeper offshore waters where the depth, temperature, light availability and habitat diversity is not generally conducive to supporting reproduction and persistence of the invasive species. However, in shallow coastal areas, such as areas where vessel based spill response activities may take place, conditions are likely to be more favourable. Impacts from invasive terrestrial species are similar in that the invasive species can out-compete local species (e.g. weeds) and interfere with ecosystem processes. Non-native species may be transported attached to equipment, vehicles and clothing. Such an introduction would be especially detrimental to wilderness areas or protected terrestrial reserves which have a relatively undisturbed flora and fauna community.	
Disruption to other users of marine and coastal areas and townships	Shoreline response activities will restrict access and activities along affected shorelines which may include areas popular for tourism. Fisheries and aquaculture activities (e.g. pearl farming) may also be suspended in areas potentially affected by oil without necessarily being contacted by oil. Tourism and fisheries may be important economic drivers for the economies of local townships. Townships may also be impacted through the influx of spill responders using facilities for accommodation and forward operations areas which may negatively impact local businesses.	
Chemical dispersant application	While the aim of chemical dispersants is to provide a net benefit to the environment, the use of dispersants has the potential to increase impact to habitats under the sea surface, including coral, seagrass and macroalgae, and to marine fauna (particularly fish and invertebrates) by increasing entrained oil and dissolved aromatic hydrocarbon concentration and exposure. These sensitive receptors are generally located in shallow coastal areas of the mainland and offshore islands. Increased entrained and aromatic hydrocarbon concentration may also impact on marine fauna either directly or through impacts to subsea habitats. Direct impacts are most likely to be encountered by plankton, benthic filter feeding invertebrates, fish and sharks. Fish and sharks include threatened/migratory species, which may ingest oil or uptake toxic compounds across gill structures. As a result of increased impact to marine fauna and subtidal habitats, including those that represent values of Protected Areas, socio-economic impacts may be felt through industries such as tourism and commercial fishing. A description of the impacts from entrained oil and aromatic hydrocarbons from a worst case loss of well control, without a specific consideration of dispersant addition, is provided in **Table 6-4.** A detailed investigation on the potential effects of adding chemical dispersants to a worst case surface or subsea blowout scenario has been conducted using modelling results and a large-scale application of chemical dispersants as informed by the Chemical Dispersion Plan within the OPEP.	
Consequence Ranking	**Minor/ Tolerable**	

Management Controls	**Tolerable (risk ranking)**
The overarching control to ensure the selection of spill response activities is having an overall net benefit to the environment is the application of a Net Environmental Benefit Analysis (NEBA).	
Light emissions	
No night time nearshore booming and skimming operations (vessels stand-off at night with navigation lighting only)	Reduces potential for behavioural disturbance
Review shoreline lighting to a type (colour) that will reduce impacts to fauna	Reduces potential for behavioural disturbance
Use of directional lighting for shoreline operations	Reduces potential for behavioural disturbance
Selection of temporary camp sites in consultation with DoT and DPaW	Prevents light spill to sensitive fauna areas
Noise emissions	
Support vessel and aircraft compliance with EPBC Act Regulation 8 (cetacean interactions)	Reduces potential for behavioural disturbance to cetaceans
Increased vessel and aircraft minimum approach distances to whales within Camden Sound Marine Park whale conservation zone as per Camden Sound Marine Park Management Plan	Reduces potential for behavioural disturbance to humpback whales during calving
Reduce vessel activity in Camden Sound	Reduces potential for behavioural disturbance to humpback whales

Marine Park – whale conservation zone during whale calving season (July -October)	during calving
Selection of temporary camp sites in consultation with DoT and DPaW	Reduce noise disturbance to sensitive fauna areas
Atmospheric emissions	
If required under MARPOL, Vessels will maintain a current International Air Pollution Prevention (IAPP) Certificate	Reduces level of air quality impacts
Operational discharges and waste	
Selection of non-harmful deck wash chemicals	Reduces potential toxicity impacts to marine organisms
Vessels meet applicable MARPOL and Marine Park sewage disposal requirements	Reduces water quality impacts in nearshore environment
Vessel meet applicable MARPOL requirements for oily water (bilge) discharges	Reduces water quality impacts in nearshore environment
Decant oily water from offshore containment and recovery behind boom	Prevents spreading of oily water
Consultation with DoT/AMSA prior to decanting oily water	Prevents spreading of oily water
Offshore Equipment washdown confined to hot zone	Prevents spreading of oily water
Use of environmentally friendly degreaser for offshore washdown	Reduces toxic impacts within water column
Onshore equipment washdown in decontamination unit	Prevents spreading of oily water
Competent personnel	Prevents spreading of oily water Reduces habitat damage, penetration of oil into sediments and erosion
Low pressure flushing of shoreline habitats	Reduces habitat damage, penetration of oil into sediments and erosion
Selection of appropriate water (salinity/temperature) for flushing	Reduces habitat damage
Use of booms to contain shoreline flushing liquids	Reduces spread of oily water
Compliance with controlled waste and landfill regulations	Prevents secondary contamination from oil waste
Use of no-leachate containers	Prevents secondary contamination
Competent personnel	Prevents secondary contamination
Waste management plan	Prevents secondary contamination and litter
Municipal waste containers present onsite	Prevents litter
Compliance with local government municipal waste requirements	Prevents incorrect disposal
Physical presence and disturbance	
Use of shallow draft vessels for shoreline and nearshore operations	Reduce seabed and shoreline habitat disturbance
Use of competent vessel crew/personnel	Reduce seabed and shoreline habitat disturbance and coastal habitat fauna disturbance onshore
Conduct shoreline/ nearshore habitat/ bathymetry assessment	Reduce seabed and shoreline habitat disturbance
Establish demarcation zones for vessel, boom and skimmer usage	Reduce seabed and shoreline habitat disturbance
Maintenance and inspection personnel assigned to boom sets	Reduce seabed and shoreline habitat disturbance
OSRT Team Leader assessment/selection of vehicles appropriate to shoreline conditions	Reduce coastal habitat and fauna disturbance
Establish demarcation zones for vehicle and personnel movement considering sensitive vegetation, bird nesting/roosting areas and	Reduce coastal habitat and fauna disturbance

turtle nesting habitat	
Operational restriction of vehicle and personnel movement to limit erosion, compaction and disturbance to birdlife	Reduce coastal habitat erosion and compaction and disturbance to birdlife
Prioritise use of existing roads and tracks	Reduce coastal habitat and fauna disturbance
Use of competent personnel	Reduce coastal habitat and fauna disturbance
Use of landing barges	Reduce coastal habitat and fauna disturbance
Use of Heritage Advisor if Operational Area overlapped with potential areas of cultural significance	Reduce disturbance to culturally significant sites
Selection of temporary camp sites and shoreline clean-up areas in consultation with DoT and DPaW	Reduce coastal habitat and fauna disturbance
Pre-cleaning and inspection of equipment (quarantine)	Prevent introduction of invasive species
Soil profile assessment prior to earthworks	Reduce habitat disruption and erosion
Vessel Risk Assessment Scoresheet (VRASS) completed for interstate and international vessels (only)	Reduce risk for introduction of invasive marine species as part of vessel biofouling
Ballast water management plan	Improve water quality discharge to marine environment to ALARP Reduce risk of introduced marine species
Disruption to users of marine and coastal areas and townships	
Stakeholder consultation	Early awareness of spill response activities which reduces potential disruption
Utility resource assessment and support to be conducted if the Activity is of significant size in comparison to the size of the coastal community	Reduces potential impact due to higher utility demands causing disruptions to local community
Accommodation assessment	Reduces strain on accommodation
Security Management Plan (large-scale deployments only)	Reduces potential for security threat causing disruptions in the response activities
Transport Management Plan (large-scale deployments only)	Reduces potential for traffic disruptions
Additional impacts to coastal habitats, fauna and socio-economic activities from addition of chemical dispersants	
Chemical dispersant selected from AMSA approved list or risk assessed through Quadrant Energy Chemical Selection, Evaluation and Approval Procedure	Impacts on fauna / flora from toxicity of the dispersant
Field and laboratory testing of dispersant efficacy	Ensures dispersants are not added for no potential benefit
Dispersant application location and volume assessment undertaken	Reduces impacts from dispersant and oil (entrained and dissolved) to sensitive shallow water habitats
Selection of correct equipment for application	Ensures correct dosage
Use of competent personnel	Ensures correct application
Operational monitoring of oil and oil in water during dispersant application	Provides information to inform NEBA analysis

Table 6-4: Environmental Impact Treatment Summary for Unplanned Events

<table>
<tr><th colspan="3">Event : Marine Operations (Interaction with marine fauna)</th></tr>
<tr><td>Potential Impacts</td><td colspan="2">Cetaceans are naturally inquisitive marine mammals that are often attracted to vessels underway; for example, dolphins commonly ‘bow ride’ with vessels. There have been recorded instances of cetacean deaths as a result of vessel collisions in Australian waters (e.g. a bryde’s whale in Bass Strait in 1992) (WDCS, 2006), though the data indicates this is likely to be associated with container ships and fast ferries. Collisions between vessels and cetaceans are most frequent on continental shelf areas where high vessel traffic and cetacean habitat occur simultaneously (WDCS, 2006).
Potential impacts comprise behavioural disturbance, injury or death. The presence of vessels may create behavioural disturbance such as localised displacement through avoidance behaviour or interruption of normal behaviour. The reaction of whales to the approach of a ship is quite variable. Some species remain motionless when in the vicinity of a ship while others are known to be 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). In avoiding vessels, cetaceans may have longer dives times. All marine fauna species are likely to return to normal behaviour patterns when the interruption has passed (i.e. vessel has moved on). Cetaceans and whale sharks are regularly sighted near Quadrant Energy platforms and activities in the region.
Other marine fauna like turtles and whale sharks that are present in shallow waters or surface waters are also susceptible to vessel strike due to their proximity to the vessel (hull, propeller or equipment) and their limited ability to avoid vessels.
Whale sharks may be behaviourally vulnerable to boat strike. They spend a significant amount of time feeding in surface waters (DEH, 2005; Norman, 1999) and scars have been observed on whale sharks that have likely been caused by boat collision (DEH, 2005). There have also been several reports of whale sharks being struck by bows of larger ships in other regions where whale sharks occur (Norman, 1999).</td></tr>
<tr><td>Consequence Ranking</td><td colspan="2">Tolerable</td></tr>
<tr><td colspan="2">Management Controls</td><td>Effectiveness of control</td></tr>
<tr><td colspan="2">Procedures for interacting with cetaceans</td><td>Vessels maintain distance from cetaceans to reduce noise impacts from propellers.
Helicopter complies with Part 8 of EPBC Regulations for interacting with cetaceans to reduce noise impacts.</td></tr>
<tr><td colspan="2">Standby vessel (bridge watch)</td><td>Monitors surrounding environment to identify and prevent collision risks.</td></tr>
<tr><th colspan="3">Event : Non-hydrocarbon release (surface) – solid</th></tr>
<tr><td>Potential Impacts</td><td colspan="2"><u>Threatened/migratory marine fauna</u>
Non-hazardous solid wastes such as plastics have the potential to smother benthic environments and harm marine fauna through entanglement or ingestion. Marine turtles and seabirds are particularly at risk from entanglement. Marine turtles may mistake plastics for food; once ingested, plastics can damage internal tissues and inhibit physiological processes, which can both result in fatality. Generally, no toxic effects are expected from non-hazardous solids.
Release of hazardous solid wastes may result in the pollution of the immediate receiving environment, leading to detrimental health impacts to marine flora and fauna. Physiological damage can result through ingestion or absorption and may occur to individual fish, cetaceans, marine reptiles or seabirds. Marine fauna (including seabirds) encountered within the Operational Area are expected to be limited to small numbers of transient individuals
<u>Physical environment</u>
Benthic habitats have the potential to be impacted with heavy loads resulting in potential loss of soft sediment communities within the impact zone.
The potential impact may be short term to long term depending on the waste type and its degradation rate.
<u>Socio-Economic Receptors</u>
In the event of buoyant solid waste, it may create a navigational hazard.</td></tr>
<tr><td>Consequence Ranking</td><td colspan="2">Tolerable</td></tr>
<tr><td colspan="2">Management Controls</td><td>Effectiveness of control</td></tr>
</table>

Dropped object prevention procedures	Minimises drop risk during MODU lifting operations that may cause seabed disturbance. MODU objects dropped overboard are recovered to mitigate the environmental consequences from objects remaining in the marine environment, unless the environmental consequences are negligible or safety risks are disproportionate to the environmental consequences.
• Waste (garbage) management procedures • Hazardous chemical management procedures • General chemical management procedures • Maritime Dangerous Goods Code • Ozone-depleting substance handling procedures	Aids in the process of chemical management that reduces the impact of discharges to sea and reduces the risk of unplanned releases to sea. This includes safe handling and storage, spill-response and emergency procedures, and disposal considerations.
Bulk solid transfer procedure	Bulk solids transferred in accordance with bulk transfer procedures to reduce the risk of an unintentional release to sea.
Chemical selection procedures	Only environmentally acceptable chemicals would be released in the event of an accidental discharge to sea. Reduced toxicity to marine environment.
Inventory control procedures	Only residual water-based drilling fluids within the MODU surface mud storage tanks or pits could be discharged overboard in the event of an accidental pit discharge.
Event : Non-hydrocarbon release (surface) – liquid	
Potential Impacts	Hazardous liquids have the potential to impact on local water quality, which in turn may impact on the health and reproductive development of marine fauna (e.g. pelagic fish, cetaceans, marine reptiles and seabirds) and have a flow-on effect through the whole ecosystem including socio-economic receptors. Contaminated fish stocks and filter feeders such as oysters and mussels can also pass on harmful chemicals to humans, if consumed. Potential impacts are varied and will be related to the characteristics and volume of the spilt chemical and the sea state of the receiving environment. Physical environment and habitats can be impacted as a result of smothering (from an accidental spill of mud pits). However, as a result of currents, dilution is expected. Ballast water is responsible for 20–30% of all marine pest incursions into Australian waters. IMS are marine plants, fauna and algae that have been introduced into a region that is beyond their natural range and have the ability to survive, and possibly thrive posing a significant risk to environmental values, biodiversity, ecosystem health, human health, fisheries, aquaculture, shipping, ports and tourism (DAFF, 2011; Wells *et al*., 2009). IMS, if they successfully establish, can out compete native species for food or space, preying on native species or changing the nature of the environment. IMS can cause a variety of adverse effects in a receiving environment, including: • Over-predation of native flora and fauna; • Out-competing of native flora and fauna for food; • Human illness through released toxins; • Depletion of viable fishing areas and aquaculture stock; • Reduction of coastal aesthetics; and • Damage to marine and industrial equipment and infrastructure. The ability for invasive marine species to colonise a habitat is dependent on a number of environmental conditions. 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).
Consequence Ranking	Tolerable
Management Controls	**Effectiveness of control**
Dropped object prevention procedures	Minimises drop object risk during MODU lifting operations that may cause secondary spill (discharges) resulting in reduction in water quality.
Bulk liquid transfer procedures	Reduces risk of accidental discharge to sea.

Hazardous chemical management procedures	Reduces the risk of spills and leaks (discharges) to the sea by controlling the storage, handling and clean up.
General chemical management procedures	Aids in the process of chemical management that reduces the risk of accidental discharge to sea.
MODU and support vessel spill response plans	Effective management of an accidental spill (discharge to sea) to reduce impact to the environment.
Chemical selection procedure	Reduced toxicity to marine environment. Only environmentally acceptable chemicals would be released in the event of an accidental discharge to sea.
Maritime Dangerous Goods Code	Dangerous goods managed in accordance with International Maritime Dangerous Goods Code (IMDG Code) to reduce the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction. Aids in the process of chemical management that reduces the risk of accidental discharge to sea.
Deck cleaning product selection procedure	Improve water quality discharge (reduce toxicity) to the marine environment.
• Biofouling vessel risk assessment • Ballast water management plan • Equipment from outside WA is new or thoroughly cleaned and inspected	Any international and domestic (interstate) MODU or support vessel has a completed biofouling vessel risk assessment (VRASS) to reduce the risk of introduced marine species. Reduce risk of introduced marine species from vessels and equipment used in water.
Event : Hydrocarbon spill - minor	
Potential Impacts	Hydraulic oils behave similarly to marine diesel when released to the marine environment. Hydraulic oils are medium oils of light to moderate viscosity and have a relatively rapid spreading rate and will dissipate quickly, particularly when high sea states afford rapid mixing. Based on material safety data sheets, typically, hydraulic fluids are not expected to be toxic as the mineral oil is not expected to cause any chronic effects to aquatic organisms at concentrations less than 1mg/L. However, it may cause physical fouling of aquatic organisms. NAF's may be synthetic oil based and result in a decrease in water quality in the immediate vicinity of the release. Refer to Hydrocarbon spill – diesel (below) for potential impact description to marine fauna in vicinity which could include marine mammals, marine reptiles, fish and seabirds.
Consequence Ranking	Tolerable
Management Controls	**Effectiveness of control**
• Dropped object prevention procedures • Hazardous and general chemical management procedures	Minimises drop risk during MODU lifting operations that may cause secondary spill (discharges) resulting in reduction in water quality. Reduces the risk of spills and leaks (discharges) to the sea by controlling the storage, handling and clean up.
• Maritime Dangerous Goods Code • Bulk liquid transfer procedures • Standby vessel	Reduces risk of accidental discharge to sea.
Inventory control procedure	Includes controls for them management of WBM and NAF drilling fluids to ensure discharges to sea are risk assessed.
Remotely operated vehicle (ROV) inspection and maintenance procedures	Maintenance on ROV completed as scheduled to reduce the risk of hydraulic fluid releases to sea.
• MODU and support vessel spill response plans • Oil pollution emergency plan (OPEP)	Effective management of an accidental hydrocarbon spill (discharge to sea) to reduce impact to the environment SOPEP or SMPEP spill response exercises conducted.
Well operations management system	Well integrity control measures reduce the risk of unplanned hydrocarbons released to the marine environment.
Well test procedures	Includes control measures that reduce the risk of hydrocarbons from entering the marine environment.
Event : Hydrocarbon spill - diesel	

Potential Impacts	Marine diesel oil is a highly volatile hydrocarbon with a high proportion of toxic monocyclic aromatic hydrocarbons (MAHs) that are harmful in varying degrees to marine fauna. Diesel contains some heavy components (or low volatility components) that have a strong tendency to physically entrain into the upper water column in the presence of moderate winds (i.e. >12knots) and breaking waves, and can re-float to the surface if these energies abate. In the event of a substantial diesel spill, the heavier components of diesel can remain entrained or on the sea surface for an extended period. Given the properties of diesel, it is expected that marine fauna, marine habitats, protected and significant areas and socio-economic receptors have the potential to be impacted by surface and entrained thresholds. *Surface exposures* Estimates for the minimum oil thickness that will harm seabirds (through ingestion from preening of contaminated feathers or loss of thermal protection of their feathers) range from 10g/m^2 (O'Hara and Morandin, 2010) to 25g/m^2 (Koops et al., 2004). These hydrocarbon thresholds are also considered appropriate for consequence assessment of turtles, sea snakes and marine mammals (NRDAMCME, 1997) as the impacts are similar i.e. ingestion and skin irritation. Habitats that may be contacted by floating oil (diesel) include inter-tidal coral reefs and sandy shores within the protected area of the Rowley Shoals. Impacts from physical contact may include toxic response, such as mortality, reduced growth or reproductive success. The impact is likely to be short-term from highly weathered diesel that is still evaporating and mobilising from the tidal action. Impacts to these receptors may have an indirect effect on socio-economic receptors e.g. fishing and nature-based tourism. *Entrained exposure* A review of the concentrations of entrained hydrocarbons at which toxic effects have been demonstrated in laboratory studies show wide variation depending on the test organism, duration of exposure, oil type and the initial oil mixture (i.e. nominal loading rates of hydrocarbon versus measured concentrations) (Clark et al., 2001; NOAA, 2001; Gulec and Holdway, 2000; Gulec et al., 1997; Barron et al., 2004). According to a review by IRC (2011) of Group II (MGO) hydrocarbons toxicity to the marine environment, a contact threshold of 500ppb was found to be highly conservative for a range of species including crustaceans, molluscs, echinoderms and fish. *Type of impact* Potential impacts to marine fauna include: • Harm to internal anatomy if ingested; • Irritation or damage to sensitive external features such as eyes and skin; • Damage to feathers of marine birds; • Damage to respiratory processes of air breathing marine fauna if significant inhalation of volatile fumes occurs at the surface; and • Toxicological effects to invertebrates, including corals, sponges and ascidians. Owing to the low viscosity of the hydrocarbons in question, significant oiling of most hairless/featherless fauna is unlikely to occur. Diesel that reaches shorelines will percolate through sandy beach and cobble profiles, and subsequently biodegrade or continue to evaporate over a short time frame with minute volumes of persistent components taking longer to degrade. Sensitive shoreline habitats such as mangroves and intertidal reef and seagrass areas may be impacted through exposure to the toxic components of the diesel, although exposure times will unlikely be significant given the weathering properties of marine diesel. Impacts to these receptors may have an indirect effect on socio-economic receptors e.g. fishing and nature-based tourism.
Consequence Ranking	ALARP

Management Controls	**Effectiveness of control**
MODU move procedure	MODU move procedure contains a passage plan to reduce risk of collision.
MODU location (shipping fairway)	The MODU will not be positioned within AMSA defined shipping fairways
Bulk liquid transfer procedures	Reduces risk of release accidental discharge to sea.
Maritime notifications	Information provided on MODU arrival and departure so that the maritime industry is aware of petroleum activities to reduce risk of vessel collision.

Standby Vessel	Monitor the 500m exclusion zone and is located within 3nm of the MODU at all times and be equipped with an AIS to reduce risk of vessel collision and subsequent unplanned release of hydrocarbons (diesel) causing potential harm to the marine environment.
MODU identification system	MODU has a RACON (radar transponder) or Automatic Identification System (AIS) to aid in its detection at sea. If MODU located <5nM from shipping fairway AtoN will be installed on the MODU
MODU station keeping system	Maintains the MODU at the desired location reduce risks to petroleum infrastructure in situ whilst drilling and subsequent unplanned release of hydrocarbons causing potential harm to the marine environment
Standby vessel mooring procedure	Reduce risk of vessel collision and subsequent unplanned release of hydrocarbons causing potential harm to the marine environment by setting mooring distances to MODU
Errant vessel procedure	Defines the support vessel's response to potential incursions to the 500 m exclusion zone as well as the watch duties required specific to the drilling campaign
MODU and support vessel spill response plans	Effective management of an accidental hydrocarbon spill (discharge to sea) to reduce impact to the environment
Oil pollution emergency plan (OPEP), including the following potentially applicable strategies: • Source control; • Operational monitoring; • Shoreline protection (booming); • Shoreline clean-up; • Oiled wildlife response; and • Scientific monitoring	Refer **Table 8-1** for further detail.
Event : Hydrocarbon release (loss of containment)	
Potential Impacts	In the event of a loss of well control, oil could be floating, entrained or dissolved and impact on a number of receptors. Given the properties of Legendre hydrocarbon, it is expected that marine fauna, marine habitats, protected and significant areas and socio-economic receptors have the potential to be impacted by surface, entrained and DAH thresholds. *Surface oil* Surface oil impacts may include smothering of marine flora, fauna and habitats or ingestion by marine fauna. The degree to which impacts such as bleaching, mortality or reduced growth could occur will depend upon the level of coating (concentration of oil and/or loading of oil on shorelines) and how fresh the oil is. Shoreline habitats which have the potential to be smothered by stranded oil include intertidal coral reefs, cays, sandy shorelines, mangroves, rocky shorelines and intertidal mud/sandflats. Fauna associated with these can be exposed to toxic effects from ingestion as fauna attempt to clean themselves (e.g. preening of feathers or licking fur), reduced mobility and inability to thermoregulate due to oil coating, direct impact to eyes, noses and breathing apparatus (invertebrates) from oil coating can result in irritation and/or inability to breathe or see. Presence of surface oil can affect light qualities and the ability of macrophytes to photosynthesise. Reduced primary productivity could occur while surface oil is present. Near the sea surface, fish are able to detect and avoid contact with surface slicks meaning fish mortalities rarely occur in the event of a hydrocarbon spill in open waters (Kennish, 1997; Scholz et al., 1992). As a result, wide-ranging pelagic fish species of the open ocean generally are not highly susceptible to impacts from hydrocarbon spills. Assessment of the effects on Timor Sea fish following the Montara well release indicated that fish collected initially in Phase I and II of monitoring showed evidence of exposure to petroleum hydrocarbons at sites close to the West Atlas drilling rig, with samples collected one year after (Phase III) suggesting an ongoing trend toward a return to normal biochemistry/physiology (Gagnon and Rawson, 2011). Most reef fish are expected to be buffered from direct impacts from floating surface slicks by the overlying water column. For example, shallow water reef habitats extend to 15-20m depth along the Ningaloo Coast allowing reef fish species to seek refuge from floating oil slicks. Reef fish in the

	shallowest reefal areas are potentially more susceptible to hydrocarbon spill impacts however, as many reef fish are site attached residents on the reef and are unlikely to move away if their territory is impacted. Direct impacts may include reduced mobility and capacity for oxygen exchange, behavioural disruption or mortality. Whales, dolphins and dugongs are smooth skinned, hairless mammals so hydrocarbons tend not to stick to their skin therefore physical impacts from surface oil coating is unlikely. Pinnipeds are more susceptible to physical coating as hydrocarbons tend to adhere to rough surfaces, hair or calluses of animals. Irritation to eyes, ears, airways and/or skin may occur from direct contact with surface slicks. Physical impacts due to ingestion are applicable to surface slicks; however, the susceptibility of cetacean and pinnipeds species varies with feeding habits. Baleen whales are more likely to ingest surface slick hydrocarbon than "gulp feeders" such as toothed whales, and are particularly vulnerable to hydrocarbon ingestion while feeding. Oil may stick to the baleen while the whales "filter feed" near slicks. Humpback whales are more likely to occur in the area during the northern migration period in June/July and southern migration in Sep/Oct so a sea surface plume (>10 g/m^2) of oil might contact humpback whales as they migrate. Similarly blue whales may also encounter a sea surface plume (>10 g/m^2) as they pass through the area during their northern migration in May–August. Pinnipeds mostly feed on fish and cephalopods, and therefore may ingest surface oil indirectly via tainted food source. Marine mammals are at risk of inhaling volatile compounds evaporating from a spill if they surface to breathe in an oil slick (Geraci and St Aubin, 1990). Marine turtles and sea snakes when surfacing to breathe may be affected from surface slick hydrocarbons through damage to their airways and eyes. Turtles and sea snakes may also be affected by oil through tainted food source or by absorption through the skin. Risk of contact would likely be greatest along intertidal sections of nesting beaches or within shallow waters adjacent to nesting beaches. Contact might also occur within foraging areas, for example along the Ningaloo and Muiron Islands shorelines and Dampier CMR. Seabirds are highly susceptible to hydrocarbon spills and oiled birds may experience hypothermia due to matted feathers and an inability to fly. These impacts are primarily attributed to oiling of birds at the surface from slicks. Oiled birds may also experience decreased foraging success due to a decline in prey populations following a spill (Andres 1997, NRC 2003) or due to increased time preening to remove oil from their feathers (Burger 1997). During both winter and migration, shorebirds spend much of their time feeding and depend on nonbreeding habitats to provide the fuel necessary for migratory flight (Withers, 2002). Oil can reduce invertebrate abundance or alter the intertidal invertebrate community that provides food for nonbreeding shorebirds (Andres 1997, NRC 2003) such as in 80 Mile Beach and Roebuck Bay (Ramsar sites). Reduced abundance of a preferred food may cause shorebirds to move and forage in other—potentially lower-quality—habitats. Prey switching has not been documented in shorebirds following an oil spill. However, shorebirds will feed in alternative habitats when the intertidal zone alone cannot fulfil their energy requirements. A bird's inability to obtain adequate resources delays its pre-migratory fattening and can delay the departure for its breeding grounds. Birds arriving on their breeding grounds earlier realize higher reproductive success through increased clutch size and offspring survival (for a review, see Harrison et al. 2011). If coast habitats are sufficiently degraded by oil that pre-migratory fattening is slowed and birds delay departure for their breeding grounds, the individual effects could carry over into the breeding season and into distant breeding habitats (Henkel et al. 2012) Surface oil may impact upon socio-economic receptors including the oil and gas industry, commercial shipping, fisheries/aquaculture, recreation and tourism, resulting in an economic and social impact. For example, floating and stranded oil may be highly visible to the general public and have a resultant negative effect on tourism. Impacts on the values associated with Protected Areas (e.g. Ashmore Reef) may result in loss of fauna/habitat diversity and/or abundance, reduction in commercial/recreational/subsistence fishing (e.g. in the Australia/Indonesia MoU Box), loss of livelihood and loss of income from reduced tourism and commercial productivity. There are no thresholds identified at which smothering or volume ashore will result in an impact, however those shorelines with the highest load, and those identified as significant threatened or migratory fauna habitat are the most susceptible to impact. *Entrained oil* Total oil in the water column has the potential to coat benthic and susceptible shoreline habitats and organisms. The smothering of submerged benthic habitats and those within tidal zones from water

	column oil has only been reported where very large oil spill quantities have affected these habitats or very sticky oil slicks have encountered exposed coral surfaces or polyps. Where entrained oil reaches the shoreline habitats of intertidal zones, sub-lethal effects may occur, with mangroves and reef areas being the most sensitive. Waters that contain extensive fringing coral reef may experience impacts from entrained hydrocarbons as described below for benthic habitats. Reefs are often characterised by increased levels of biological productivity, which attracts commercially valuable fish species. Impacts from entrained hydrocarbons will be as described below for reef fish. Benthic habitats in the EMBA that may be impacted by entrained oil include soft sediments and benthic fauna, coral reef, macroalgae and seagrasses. There is a paucity of information on the long-term impacts on coral reefs of hydrocarbons entrained in the water column although NOAA (2001) indicate that some effects may be transient whilst others are long-lasting depending on the type of corals, reproduction period and health of the reef. Response to hydrocarbon exposure can include impaired feeding, fertilisation, larval settlement and metamorphosis, larval and tissue death and decreased growth rates (Villanueva *et al*., 2008). Entrained hydrocarbon concentrations below the parts per million (ppm) concentrations in marine waters have not been associated with any observed stress, degradation or death of corals. Macrophytes, including seagrasses and macroalgae, require light to photosynthesise. Presence of entrained hydrocarbon within the water column can affect light qualities and the ability of macrophytes to photosynthesise. Reduced primary productivity could occur while entrained hydrocarbons are present in the water column. Recovery of benthic habitats exposed to entrained hydrocarbons and experiencing impacts would be expected within weeks to months of return to normal water quality conditions. Several studies have indicated that rapid recovery rates may occur even in cases of heavy oiling (Burns *et al*., 1993; Dean *et al*., 1998). Mangrove communities may be impacted by exposure to entrained hydrocarbons, potentially through the sediment/mangrove root interface. Where entrained hydrocarbons include contaminants that may become persistent in the sediments (e.g. trace metals, PAHs), this can lead to direct effects on mangroves due to direct uptake, or indirect effects due to impacts on benthic infauna leading to reduced rates of bioturbation and subsequent oxygen stress on the plants' root systems (Lewis *et al*., 2011). It is the persistent fraction of the entrained hydrocarbons to which mangroves would be exposed in the spill scenario resulting from a loss of well control incident. As the time to contact shorelines where mangroves are present is 25 days to Eighty Mile Beach and 30 days to Roebuck Bay, hydrocarbon weathering will have seen low and semi-volatlie components evaporated/dispersed. Intertidal and subtidal zones may potentially be exposed to entrained hydrocarbons with impacts similar to coral reefs (refer benthic habitats above). Impacts may occur due to increased hydrocarbon levels in the nearshore waters and in sediments above the low water mark. Concentrations of hydrocarbons in nearshore waters and sediments, will fluctuate over short time scales (days to weeks), due to volatilisation, wave and tidal action, biological processes and potential arrival of more oil. Fauna associated with these habitats may experience sub-lethal effects. However, due to the expected weathering of the oil, the accessibility of PAHs to aquatic organisms is decreased. Similar to benthic habitats, recovery of shoreline habitats exposed to entrained hydrocarbons and experiencing impacts would be expected within weeks to months of return to normal water quality conditions. Reef fish with high site fidelity will experience protracted water quality conditions with entrained hydrocarbon concentrations >500 ppb within the EMBA. Hydrocarbon droplets can physically affect reef fish exposed for an extended duration (weeks to months) by coating of gills. This can lead to lethal and sub-lethal effects from reduced oxygen exchange and coating of body surfaces resulting in increased incidence of irritation and infection. Fish may also ingest hydrocarbon droplets or contaminated food leading to reduced growth (NRC, 2005). Lethal effects to reef fish may be observable within days to weeks. Sub-lethal effects of coral reef fish communities will take weeks to months to become measurable. Pelagic and demersal fish species (including sharks) exposed to entrained hydrocarbons can result in tainting and contamination of fish flesh by insoluble PAHs associated with the weathered hydrocarbon (refer 'Dissolved Aromatic Hydrocarbons' section below in this table for further information on tainting). Whale sharks feed on plankton, krill and bait fish near or on the water surface and it is possible that

	they may come into direct contact with entrained oil, or ingest entrained oil if a large-scale spill occurred when they (and their prey) were present in the region (Woodside, 2005). Whale sharks are known to transit the NW coast and aggregate from late March to June in the vicinity of the Ningaloo coast, (generally peaks in April). If a loss of well control event overlapped with this time period, whale sharks may experience entrained hydrocarbon concentrations >500 ppb. While whale sharks may be exposed to entrained hydrocarbons they could be migrating to aggregation areas beyond the impact zone, in which case exposure would be short term and confined to the EMBA and spill duration/dispersion periods. Impacts to marine mammals from entrained hydrocarbons could result in behavioural (e.g. deviating from migratory routes or commonly frequented feeding grounds) impacts. These impacts may affect individuals within or transiting the spill area during migration. Whales, dolphins and dugongs are smooth skinned, hairless mammals so hydrocarbons tend not to stick to their skin therefore physical impacts from entrained oil coating is unlikely. Pinnipeds are more susceptible as hydrocarbons tend to adhere to rough surfaces, hair or calluses of animals. Irritation to eyes, ears, airways and/or skin may occur from direct contact with entrained oil. Impacts from ingested hydrocarbon can be lethal or sub-lethal. However, the susceptibility of marine mammal species varies with feeding habits as with surface oil (described previously). Entrained oil attached to seagrass can also be ingested by dugongs. Oil may foul sensory hairs around the mouth and/or contact eyes while surfacing to breathe which may cause inflammation and infections. Similar to cetaceans, inhalation of volatile compounds evaporating from a spill may also result in physiological impacts to dugongs. Turtles and seasnakes may be affected by oil through tainted food source or by absorption through the skin. Turtle hatchlings and turtle/seasnake adults may be exposed to hydrocarbon through direct ingestion of entrained hydrocarbons and tainted food source. These effects may cause physiological effects such as disruption of digestion. As for other megafauna that may be exposed to entrained hydrocarbons, acute impacts due to exposure to adult turtles are not expected. Seabirds may come into contact with entrained oil while searching for food (diving) below the sea surface, exposure times would be very short in this scenario limiting the opportunity for oiling of feathers. Short-term physiological effects due to ingestion of entrained oil or contaminated prey may also occur. Ingested oil can have several sublethal toxicological effects, including hemolytic anemia, reduced reproduction, and immunosuppression. Impacts to fish may result in tainted flesh and fishery closure resulting in an economic impact on commercial and subsitence fishing. Entrained oil can also lead to impacts on aquaculture (e.g. pearls, seaweed) due to a decrease in water quality and reduced stock. Reduced marketability of products (perceived or real) could occur for target species. Tourism may be impacted by real or perceived reduction in health or mortality of habitats that support tourism activities. *Dissolved aromatic hydrocarbons* While there is some debate in the scientific literature (Barron *et al*., 1999), the main component of oil generally thought to be responsible for the majority of toxicity to wildlife is the Dissolved Aromatic Hydrocarbons (DAH) compounds that dissolve into the water column following a spill. Various studies indicate that the toxic effects of aromatic compounds result from the narcosis caused in biological receptors following exposure to low molecular weight aromatics including compounds from the BTEX group and 2−4 ring PAHs (French, 2000). Accumulation of petroleum hydrocarbons by marine organisms is dependent on the bioavailability of the hydrocarbons, the length of exposure, and the organism's capacity for metabolic transformations of specific compounds. Actual toxicity depends on both concentration and the duration of exposure, being a balance between acute and chronic effects. Values associated with protected areas with the KEF (such as the Rowley Shoals or the Ancient Coastline at 125 m KEF) may be impacted by DAH in the event of a loss of well control. Potential impacts to marine fauna are further detailed below. <u>Acute toxicity</u> Toxicity to wildlife increases with increased length of exposure; marine organisms can typically tolerate high concentrations of toxic hydrocarbons over short durations (French 2000; Pace *et al*., 1995). DAHs have a narcotic effect on organisms, resulting from interference with cell function that occurs as hydrocarbons are absorbed across cell membranes (French-McCay, 2002). The narcotic effect varies among specific hydrocarbon compounds, with these variations thought to be attributable to the lipid solubility of the compounds. Over periods of hours to a few days, the narcotic effect has been found to be additive, both in severity and the number of different soluble hydrocarbons that are present (French, 2000; NRC, 2005; Di Toro *et al*., 2007).

	Because the toxicity of DAH to aquatic organisms increases with time of exposure, organisms may be unaffected by brief exposures to a given concentration but affected at long exposures to the same concentration (French-McCay, 2002). This is due to the fact that the concentrations of hydrocarbons build up in the tissues of biological receptors from either long-term exposure or repeated exposure to sub-lethal concentrations. Chronic toxicity and accumulation There is sparse data available on the chronic effects of PAHs in the marine environment. A review of the processes controlling the uptake and persistence of PAH in marine organisms, especially under chronic exposure conditions, highlighted differential mechanisms of uptake, tissue distribution, and elimination (Meador *et al*., 1995). While vertebrates have a high capacity for metabolising aromatic hydrocarbons including PAHs (through cytochrome P450 1A mediated oxidation), PAHs can accumulate in the body of invertebrates (as they lack a cytochrome P450 1A mediated oxidation system). Organisms that may experience chronic effects include plankton, fish, marine mammals and marine reptiles. Pelagic fish are highly mobile and comprise species such as sharks and migratory whale sharks. The likelihood of pelagic fish being continuously exposed to DAHs for >96 hours is unlikely therefore acute/lethal effects are not predicted (Luyeye, 2005). However, chronic/non-lethal effects may be experienced. As a chronic action of PAHs is a neurotoxic effect, chronic exposure of pelagic fish may cause delayed predatory/avoidance response times, disorientation, swimming action/ efficiency. Whale sharks migrate along the NW coast from late March to September. If a loss of well control event overlapped with this time period, whale sharks may experience exposure above the DAH threshold as they migrate through the area. Tainting by DAHs of commercially targeted pelagic fish species may occur. Tainting can have a range of effects from affecting edible quality of the fish and have economic consequences, to containing toxic levels above recommended human consumption guidelines. While tainted pelagic fish will recover naturally over time (months) once water quality conditions have returned to normal, re-opening of a fishery will require an understanding of when recovery from tainting has occurred for the target species of interest. Marine mammals that may occur within the EMBA for DAHs include whales and dolphins in offshore waters. According to Geraci and St Aubin (1990), inhalation of volatile compounds evaporating from a spill at sea surface is the greater risk to cetaceans when surfacing to breathe. For these marine mammals the potential for chemical effects due to exposure is considered unlikely, particularly for highly mobile species such as dolphins because it is very unlikely that these animals will be constantly exposed to high concentrations for continuous durations (e.g. >96 hours) that would lead to toxic effects. The majority of publicly-available information detailing potential impacts to turtles and seasnakes due to exposure to hydrocarbons is based on impacts due to heavy oils. Impacts due to exposure to DAHs are less understood. One information source provides a case study detailing a spill of 440,000 gallons of aviation gasoline nearby to an island supporting approximately 1,000 green turtles that aggregate and nest at the atoll in the west Pacific Ocean annually (Yender and Mearns, n.d.). Timing of the spill was of concern as it coincided with expected peak hatchling emergence. Population comparisons with a census that had been completed just prior to the spill were undertaken to evaluate impacts; no impacts were reported during the spill response and population effects were not detected. For marine reptiles that may be exposed to DAHs dosages that exceed the threshold, acute impacts to turtles and seasnakes are not expected. Impacts to turtle hatchlings may occur however due to the risk of them becoming entrained in a parcel of water allowing them to be continuously exposed to toxic hydrocarbons for an extended period. Socio-economic receptors will be affected by hydrocarbon exposure in three key ways: Loss of Income (e.g. reduction in catch for commercial fisheries), restriction of access and reduction in aesthetic values. Impacts to fish may result in tainted flesh and fishery closure resulting in an economic impact on commercial fishing. DAH in the water column can also lead to impacts on aquaculture (e.g. pearls, seaweed) due to a decrease in water quality and reduced stock. Reduced marketability of products (perceived or real) could occur for target species. Tourism may be impacted by real or perceived reduction in health or mortality of habitats that support tourism activities.
Consequence	ALARP

Ranking	
Management Controls	**Effectiveness of control**
Maritime notifications.	Information provided on MODU arrival and departure so that the maritime industry is aware of petroleum activities to reduce risk of vessel collision with the MODU or equipment
Standby Vessel	Monitor the 500m exclusion zone and is located within 3nM of the MODU at all times and be equipped with an AIS to reduce risk of vessel collision and subsequent unplanned release of hydrocarbons causing potential harm to the marine environment
Well Operations Management System	Well integrity control measures reduce the risk of unplanned discharges to the marine environment
MODU identification system	MODU has a RACON (radar transponder) or Automatic Identification System (AIS) to aid in its detection at sea. If MODU located <5nM from shipping fairway AtoN will be installed on the MODU
MODU station keeping system	Maintains the MODU at the desired location reduce risks to petroleum infrastructure in situ whilst drilling and subsequent unplanned release of hydrocarbons causing potential harm to the marine environment
Well test procedures	Includes control measures that reduce the risk of hydrocarbons from entering the marine environment
Oil pollution emergency plan (OPEP), including the following potentially applicable strategies: • Source control; • Operational monitoring; • Chemical dispersant application; • Offshore containment and recovery; • Shoreline protection (booming); • Shoreline clean-up; • Oiled wildlife response; and • Scientific monitoring.	Refer **Table 8-1** for further detail.

7. MANAGEMENT APPROACH

The Bedout Basin drilling activity will be managed in compliance with all measures and controls detailed within the EP accepted by NOPSEMA under the OPGGS (E) Regulations, other environmental legislation and Quadrant Energy's Management System (e.g. Environmental Management Policy).

The objective of the EP is to ensure that potential adverse environmental impacts associated with unplanned events and planned events associated with the survey, are identified and assessed, and to stipulate mitigation measures to avoid and/or reduce any adverse impacts to the environment to ALARP.

The EP details specific performance objectives, standards and procedures, and identifies the range of controls to be implemented (consistent with the standards) to achieve the performance objectives. The EP also identifies the specific measurement criteria and records to be kept to demonstrate the achievement of each performance objective.

As described in the EP, the implementation strategy includes the relevant details of the following:

1. Environmental Management System;
2. Environmental management policy;
3. Leadership, Accountability and Responsibility;
4. Workforce training and competency;
5. Hazard Identification, Risk and Impact Assessment and Controls;
6. Environmental performance standards and outcomes;
7. Workforce involvement and stakeholder communications;
8. Information management and document control; and
9. Operations management.

During the period that activities described in the EP are undertaken, Quadrant Energy will ensure environmental performance is managed through an inspection and monitoring regime undertaken by Quadrant Energy representatives or delegates based on the MODU or vessels.

Environmental compliance of an activity with the EP (and the EPO's) is measured using planned and systematic audits or inspections to identify weaknesses and non-conformances in the system and processes so that they can be identified. Improvement opportunities identified through monitoring, audits and incident investigations are implemented in a controlled manner and communicated to all relevant workforce, contractors and relevant third parties. Audits and inspections are in place to identify possible incidents and actions taken to prevent them from happening.

Non-conformances found are addressed and resolved by a systematic corrective action process and are reported to NOPSEMA where relevant.

Senior Quadrant Energy and vessel contractor personnel will be accountable for ensuring conformance with environmental performance outcomes and standards and all personnel will be empowered to 'stop-the-job' to ensure the activity is being implemented in an environmentally responsible manner. The EP identifies specific responsibilities for each role during the activity.

Incident notification and reporting to NOPSEMA and other regulators will be conducted as per the OPGGS(E)R, as detailed within the EP. Reported HSE incidents and hazards will be communicated to personnel during daily operational meetings.

7.1 Management of Change

Quadrant Energy's *Environmental Management of Change Procedure* (EA-91-IQ-10001) (MOC) process provides a systematic approach to initiate, assess, document, approve, communicate and implement changes to EPs and OPEPs (currently in force) whilst meeting the requirements of the OPGGS (E) R.

The MoC process considers Regulation 7, 8 and 17 of the OPGGS(E) Regulations, and determines if a proposed change can proceed and the manner in which it can proceed, or if a revision of the EP and OPEP needs to be submitted to NOPSEMA for a determination on whether it can proceed. For a change to proceed, the associated environmental impacts and risks must be demonstrated to be acceptable and as ALARP. Additional stakeholder consultation may be required depending on the nature and scale of the change. Additional information on the MoC process is provided in **Figure 7-1.**

Accepted MoCs become part of the in force EP or OPEP, will be tracked on a register and made available on Quadrant Energy's intranet. Where appropriate, Quadrant Energy's environmental compliance register will be updated to ensure control measure or environmental performance standard changes are communicated to the workforce and implemented.

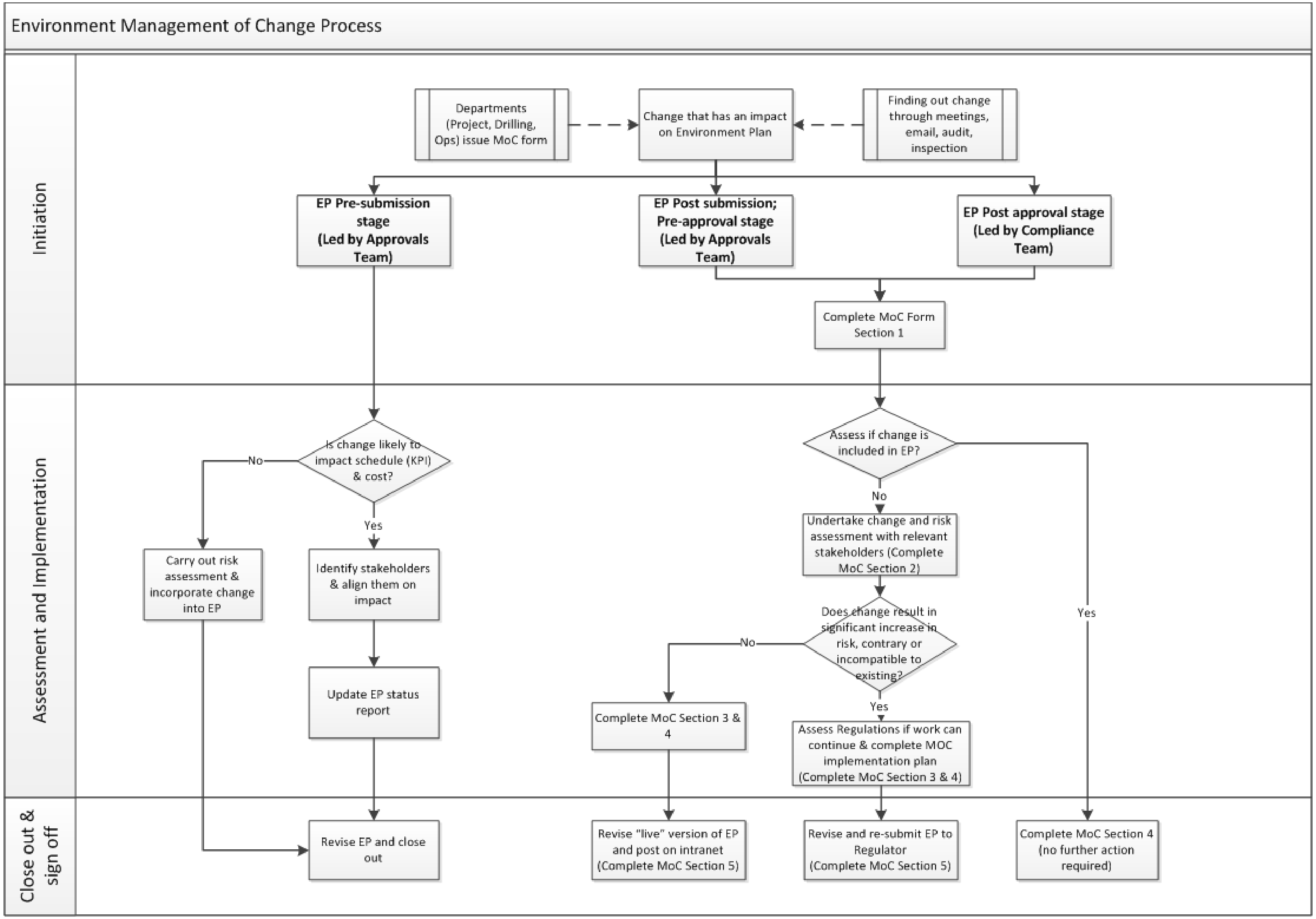

Figure 7-1: Environment Management of Change Process

8. HYDROCARBON SPILL RESPONSE ARRANGEMENTS

Credible hydrocarbon spill scenarios are identified in **Table 4-1**. In the event of a spill, initial actions will be undertaken by the Rig OIM/Vessel Master in line with the MODU/ vessel Shipboard Oil Pollution Emergency Plan (SOPEP). Should the spill require further action, such responsibilities will be taken over by the Combat Agency, in this instance Quadrant Energy in accordance with the Bedout Basin Exploration Drilling Oil Pollution Emergency Plan (OPEP) (EA-00-RI-10076.02).

The following response strategies may be applicable to the identified credible spill scenarios:

- Operational Monitoring, including:
  - Vessel surveillance;
  - Aerial surveillance;
  - Tracking buoys;
  - Satellite imagery;
  - Unmanned aerial vehicles;
  - Entrained oil surveillance;
  - Oil sampling and analysis;
  - Operational water quality monitoring; and
  - Spill fate modelling.
- Source Control activities, including the following strategies applicable for a loss of well control:
  - Subsea first response toolkit (SFRT) deployment including subsea dispersant application,
  - Capping Stack deployment; and
  - Relief well drilling.
- Offshore containment and recovery of oil;
- Application of chemical dispersants at surface (aerial and vessel application) and/or subsea (SFRT);
- Deployment of booms for shoreline protection;
- Shoreline clean-up operations;
- Wildlife response operations including hazing and capture and rehabilitation; and
- Scientific monitoring to assess oil impact and recovery.

8.1 Preparedness and Implementation of Response Arrangements

Quadrant Energy will implement its OPEP in the event of a significant hydrocarbon spill (tier 2 or 3). In order to maintain a state of oil spill preparedness, personnel with OPEP responsibilities will be made aware of their obligations, oil spill response equipment will be maintained, contracts with critical equipment and personnel suppliers will be managed, and agreements will be in place with national regulatory agencies for support in oil spill response. Quadrant Energy will also implement its oil spill response exercise and training schedule.

Following acceptance of an OPEP, the arrangements of the plan are tested by the Emergency & Oil Spill Coordinator through testing and exercising of personnel, organisations and suppliers with roles defined within the plan, including a pre-start Communications Test. The external agencies and companies/suppliers are notified of the start-up schedule of the activity and are evaluated for the preparedness to deliver on their committed function. The Communications Tests are repeated annually for activities that extend longer than 1 year, and are repeated if the response arrangements change over time.

Table 8-1: Spill response strategies considered for the mitigation of contact from hydrocarbon spills

Strategy	Description	Environmental Benefits	Adopted/ Reject
Source control	As part of a source control plan for loss of well control, the key controls include: • deployment of subsea first response toolkit (SFRT); • installation of a capping stack (for subsea wells only); and • drilling a relief well (Note: Oil spill (diesel) due to a loss of containment at the vessel or rig can also be reduced by controlling the source of the release and this will primarily involve implementation of the vessel SOPEP and other control measures)	The drilling of relief well is considered to be the primary control in event of a loss of well control and will be implemented regardless of any other controls in place. This control when implemented successfully will prevent further loss of hydrocarbon to the environment, benefitting every Hot Spot and all other receptors in general. Installation of a capping stack may be feasible for a subsea release during drilling with a semi-submersible drilling rig. A capping stack may be used to divert well fluids to the surface for collection and/or restrict the flow of well fluids prior to completion of a relief well. A capping stack will be mobilised with a subsea first response toolkit (SFRT) and called back if circumstances does not allow installation. The SFRT includes equipment that gives the ability to clear the area around the wellhead, to enable intervention and prepare for relief well drilling. This also includes the subsea dispersant kit, which will be utilised for subsea chemical dispersant application; see 'Subsea Chemical Dispersant' below for its details.	**Adopt**
Operational Monitoring	Surveillance actions are used to monitor and evaluate the trajectory and fate of the released hydrocarbon, to determine the effectiveness of response strategies and to identify and report on any potential/actual contacts to flora, fauna, or any other sensitive receptor that occurs. Surveillance results are used to assist in escalating or de-escalating response strategies as required.	There are various specific control measures (vessel/aerial surveillance, tracking buoys, entrained oil monitoring, oil spill modelling, remote sensing/satellite imagery) within this response strategy which may be suitable. Their use, in combination or individually, will be determined based on the spill distribution as well as other considerations such as access to locations, environmental and metocean conditions. This strategy is vital to ensure that there is sufficient information to gain situational awareness and make informed decisions on response planning and execution.	**Adopt**
Subsea chemical dispersant	Subsurface chemical dispersant involves dispersant applied directly into the wellhead location at the release point. Subsea chemical dispersant injection is used to disperse the oil either to enable safe implementation of the subsequent controls (e.g. capping stack installation) and/or to enhance dispersion in the water column and	Subsea chemical dispersant injection can result in less chemical dispersant being used (in comparison to surface application) as the application is more targeted and concentrated, as well as the potential to avoid/reduce shoreline contact. The opportunity to allow a higher proportion of oil mass to evaporate at surface is reduced with the subsea dispersant application. Since the application of chemical dispersants does not reduce the total amount of oil	**Adopt**

Strategy	Description	Environmental Benefits	Adopted/ Reject
	avoid/reduce surface oil reaching shorelines.	entering the marine environment, additional entrained hydrocarbon in water column will be the result. Subsea chemical dispersant application is considered a suitable response strategy for a subsea blowout scenario. Modelling of selected deterministic spill trajectories with and without subsea dispersants added indicates dispersants applied subsea can reduce the level of surface oil reaching shorelines with a resultant level of shoreline loading. This modelling also indicates increased concentrations of entrained oil and dissolved aromatic hydrocarbons in the water column adjacent to dispersant operations. The decision for application of this response will be subject to a NEBA. If a subsea release involves a high proportion of gas and a fine droplet size of entrained oil subsea dispersant may not provide any additional benefit.	
Surface chemical dispersion	Chemical dispersant is applied to break down the hydrocarbons and allow/enhance dispersion into the water column, thereby preventing/reducing potential shoreline contact and increasing biodegradation.	Surface chemical dispersant may be viable, either by vessel or plane. Quadrant Energy considers Legendre crude to be the closest analogue hydrocarbon during a loss of containment event from the Activity. Legendre crude is light crude with relatively low initial viscosity and low asphaltene content and volatilisation or evaporation is its preferred fate. There is a window of 30-72 hours post optimal evaporation time and prior to weathering beyond the ability of potential effective chemical dispersion, in which surface chemical dispersant could be applied. Chemical dispersants applied at sea surface reduce the amount of floating oil but increases the oil concentrations in the water column increasing the risk of exposure to organisms that live in the water column. Modelling of selected deterministic spill trajectories with and without dispersants added at the sea surface indicates dispersants applied subsea can reduce the level of surface oil reaching shorelines with a resultant level of shoreline loading. This modelling also indicates increased concentrations of entrained oil and dissolved aromatic hydrocarbons in the water column adjacent to dispersant operations. Chemical dispersion will only be considered when there is a net environmental benefit. Applicability of chemical dispersant is limited to the conditions and circumstances described in the OPEP	**Adopt**

Strategy	Description	Environmental Benefits	Adopted/ Reject
Physical dispersion	Physical dispersion is undertaken by running vessels through the hydrocarbon plume and using the turbulence developed by the propellers or hydro-blasting from vessel hydrants to break up the slick. Once dispersed in the water column in the form of smaller droplet sizes, biodegradation processes are enhanced.	In general, this strategy is considered to be an opportunistic strategy; used on targeted, small, breakaway areas, especially patches close to shorelines. Given that oil is expected to solidify by the time it approaches shorelines, and chemical dispersant application would be preferred as a means of dispersing bulk oil this strategy has limited effectiveness, and is not considered to be a strategy requiring further planning and associated control measures.	**Reject**
Containment and recovery	Containment and recovery of hydrocarbons can offer a preventive form of protection to sensitive receptors. Skimmers (mechanical) and booms will be used at sea. This strategy is only effective in calm conditions.	For a spill resulting from the Activity, volatilisation/evaporation is the preferred way to remove hydrocarbons from the water surface before the risk of contacting shorelines/sensitive receptors. Containment and recovery may be applicable once evaporation of highly volatile components has occurred. Based on the Legendre crude oil analogue, a waxy solidified residual is expected which can be collected using containment and recovery methods. Given that shoreline booming and shoreline clean-up are expected to be very difficult across many shorelines within the EMBA (e.g. Kimberley coastlines) this strategy is considered important to the overall spill response.	**Adopt**
Protection and deflection	Protection and deflection activities involve the use of booms to: 1. Protect sensitive receptors; 2. Deflect spills away from sensitive receptors or shorelines; or 3. Deflect spills to an area that provides increased opportunity for recovery activities. This strategy is typically not effective in areas experiencing large tidal variations and associated currents.	Activities are focused on areas of high protection value in low energy environments based upon real time operational surveillance provided the environmental and metocean conditions are favourable for an effective implementation. Consequently, this strategy may not be applicable across all shorelines identified as being contacted by oil.	**Adopt**
Shoreline clean-up	During a spill response, clean-up of the oiled shorelines will be implemented using suitable methods, provided it will be beneficial to the environment based on the NEBA performed on the affected areas based on actual site conditions.	Contacted shorelines will be assessed for their shoreline clean-up potential. This response has the potential to cause secondary disturbance associated with the clean-up, so applicability of the strategy is based on aerial surveillance reconnaissance, shoreline assessments and NEBA in the shoreline clean-up assessment.	**Adopt**

Strategy	Description	Environmental Benefits	Adopted/ Reject
Oiled wildlife response (OWR)	Responding to an oiled wildlife incident will involve an attempt to prevent wildlife from becoming oiled and/or the treatment of animals that do become oiled.	As various Hot Spots with importance for marine wildlife have been identified to be threatened by the oil spill, mobilisation of a wildlife response will likely be necessary. Mobilisation of experts, trained work forces, facilities and equipment will then be needed. Wildlife response activities may take place at sea, on shorelines and in specialised facilities further inland. Options for wildlife management have to be considered and a strategy determined guided by the Western Australian Oiled Wildlife Response Plan (WAOWRP).	**Adopt**
In-situ burning	In situ burning is a technique sometimes used in responding to an oil spill. In situ burning involves the controlled burning of oil that has spilled (from a vessel or a facility), at the location of the spill. When conditions are favourable and conducted properly, in situ burning will reduce the amount of oil on the water.	Operational constraints expected during a spill from the Activities suggest in-situ burning is not applicable. For in-situ burning to be undertaken oil has to be thicker than 1-2 mm but light crude (Legendre oil) and diesel tend to have high evaporation rates and spread into very thin films rapidly. In addition, in-situ burning requires containment. Containment limitations are listed above (refer 'Containment and Recovery' strategy). Due to operational constraints and the expected hydrocarbon not being suitable for in-situ burning, this response strategy is deemed inapplicable for the Activity.	**Reject**
Scientific Monitoring	This is the main tool for determining the extent, severity and persistence of environmental impacts from an oil spill and allows operators to determine whether their environmental protection outcomes have been met (via scientific monitoring activities). This strategy also evaluates the recovery from the spill.	Scientific monitoring is especially beneficial for the purpose of monitoring entrained and dissolved oil impacts as response strategies are generally targeted to manage the surface oil impacts.	**Adopt**

8.2 Net Environmental Benefit Analysis

During any response incident, there is a documented decision making process to ensure that response strategies are identified and evaluated prior to implementation via the Incident Action Plan (IAP). The Incident Control Team use a Net Environmental Benefit Analysis (NEBA) process to inform the development and refinement of the IAPs, to ensure the most effective response strategies with the least detrimental environmental impacts are identified, documented and executed. The Environmental Team Lead is responsible for reviewing the priority receptors identified within the EP and the OPEP, and with real time knowledge of the fate and transport of the spill, apply the NEBA.

The application of the NEBA is to:

- Identify sensitivities within the area potentially affected by a spill at that time of the year;
- Assist in prioritising and allocating resources to sensitivities with a higher ranking; and
- Assist in determining appropriate response strategies.

8.3 Oil Spill Response Resources

Oil spill response equipment and resources are a combination of Quadrant, AMOSC (Australian Marine Oil Spill Centre Pty Ltd), AMSA, DoT, National Plan (NatPlan), OSRL (Oil Spill Response Limited), and other operator resources available through the AMOSPlan mutual aid arrangements. Under the Memorandum of Understanding (MOU) between AMSA and Quadrant, AMSA will provide all resources available through NatPlan to support a Quadrant spill response. The DoT coordinates the State Response Team (SRT) oil spill response personnel and equipment resources. The DoT will work with Quadrant in an oil spill response and will define termination criteria for the shoreline operations designed to reduce the environmental impacts and risk to as low as reasonably practicable (ALARP) in State waters. Where oil contacts shorelines in Commonwealth waters, Quadrant will work with the Department of the Environment to establish shoreline clean-up priorities, activities and termination criteria.

In the event of an oiled wildlife response, Quadrant will activate the West Australian Oiled Wildlife Response Plan (WAOWRP) and work with DPaW in determining resources and capability requirements. DPaW and Industry (AMOSC) Oiled Wildlife Advisors (OWAs) ensure minimum standards for oiled wildlife response, as outlined within the WAOWRP, are met and ensure timely mobilisation of appropriate resources (equipment and personnel) through communication with the wildlife logistics team. Quadrant are able to access:

- AMOSC core group responders;
- DPaW staff and approved volunteers/subject matter experts;
- Additional local resources under current contracts and suppliers; and
- Access international support through Wildlife Response Services.

During and post-spill scientific response monitoring activities require resources external to Quadrant and include specialist technical capabilities. Astron Environmental Services Pty Ltd (Astron) is contracted as Quadrant’s primary control support agency for scientific response monitoring activities. If additional support is required, Quadrant has Master Service Agreements with other service providers to support scientific response monitoring activities.

9. CONTACT DETAILS

Further information about the Bedout Basin drilling Activity can be obtained from:

Ashlee Crabbe

Consultation Coordinator

100 St Georges Terrace, Perth, 6000

6218 4972

consultation@quadrantenergy.com.au

10. REFERENCES

AMSA (2014). National Plan for Maritime Environmental Emergencies, Australian Maritime Safety Authority 2014

Apache 2014. "Phoenix Area [Bedout Basin] EP Blowout Modelling Report". Unpublished/Internal document.

Baker C, Potter A, Tran M, Heap AD (2008) Geomorphology and sedimentology of the North-west Marine Region of Australia. Record 2008/07, Geoscience Australia, Canberra

BHPB 2005. Pyrenees Development. Draft EIS. BHP Billiton Petroleum. Perth.

Chevron Australia 2010. Draft Environmental Impact Statement/Environmental Review and Management Programme for the Proposed Wheatstone Project Volume 1 (Chapters 1 to 6), 6.0 Overview of Existing Environment. Chevron Australia Pty Ltd, Perth, Western Australia

DEC (2007a) Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves 2007–2017: Management Plan No. 55. Department of Environment and Conservation, Perth, Western Australia.

DEC (2007b) Management Plan for the Rowley Shoals Marine Park 2007–2017: Management Plan No. 56. Department of Environment and Conservation, Perth, Western Australia.

DPaW (2014) Eighty Mile Beach Marine Park Management Plan 2014-2024. Management Plan No. 80. Department of Parks and Wildlife, Perth, Western Australia.

DEWHA 2008. The North-west Marine Bioregional Plan: Bioregional profile: A Description of the Ecosystems, Conservation Values and Uses of the North-West Marine Region. Department of the Environment Water, Heritage and the Arts, Canberra, ACT

DSEWPaC (2012) Marine bioregional plan for the North-west Marine Region. Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT. 269 pp.

DoE (2014) Commonwealth marine reserves. Department of the Environment, Canberra, Act. Available at http://www.environment.gov.au/topics/marine/marine-reserves

EA 2000. Mermaid Reef Marine National Nature Reserve Plan of Management 2000-2007. Environment Australia, Canberra, Australian Capital Territory

Fugro (2016). Noble Tom Prosser Geophysical Site Surveys, Roc-1 Field Report. Report No. GP1512_FR03. Issued to Quadrant Energy 08/07/15

Holloway, PE and Nye, HC 1985 Leeuwin current and wind distributions on the southern part of the Australian North West Shelf between January 1982 and July 1983. Australian Journal of Marine and Freshwater Research 36(2): 123–137

SSE 1993. Review of oceanography of North West Shelf and Timor Sea regions pertaining to the environmental impact of the offshore oil and gas industry. Vol I prepared for Woodside Offshore Petroleum and the APPEA Review Project of Environmental Consequences of Development Related to the Petroleum Production in the Marine Environment: Review of Scientific Research, Report E1379, October 1993

WNI 1995. Preliminary report on ambient and non-cyclonic design criteria for the Stag location. WNI Science & Engineering. December 1995

WNI 1996. Metocean Conditions on the North West Shelf of Australia, Cape Lambert to the North West Cape Relating to Jack-up Drilling Operation. (DR-50-ED-001). July 1996

Woodside (2005). The Vincent Development. Draft EIS. EPBC Referral 2005/2110.