East Spar Plug and Abandonment EP Summary

EA-66-RI-10009.03

PROJECT / FACILITY	East Spar	
REVIEW INTERVAL (MONTHS)	N/A	
SAFETY CRITICAL DOCUMENT	~~YES~~	NO

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ACRONYMS

Abbreviation	Description
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AHS	Australian Hydrographic Service
AIS	Automatic Identification System
ALARP	As Low as Reasonably Practicable
AMOSC	Australian Marine Oil Spill Centre
AMSA	Australian Maritime Safety Authority
APASA	Asia-Pacific Applied Sciences Association
APPEA	Australian Petroleum Production and Exploration Association
BIAs	Biologically Important Areas
BOP	Blowout Preventer
CFA	Commonwealth Fisheries Association
DAH	Dissolved Aromatic Hydrocarbons
dB	Decibels
DBCA	Department of Biodiversity, Conservation and Attractions
DER	Department of Environmental Regulation
DMIRS	Department of Mines, Industry Regulation and Safety
DoD	Department of Defence
DoEE	Department of Energy and Environment
DoF	Department of Fisheries (WA), now amalgamated to form DPIRD
DoT	Department of Transport (WA)
DPaW	Department of Parks and Wildlife (WA)
DPIRD	Department of Primary Industries and Regional Development
DWER	Department of Water and Environmental Regulation (formerly DER)
EF&LS	Exmouth Freight & Logistics Services
EMBA	Environment that May Be Affected
EP	Environment Plan
EPA	Environmental Protection Authority
EPBC	Environment Protection and Biodiversity Conservation
EPO	Environmental Performance Objective
EPSs	Environmental Performance Standards
GES	Greater East Spar

Abbreviation	Description
GHG	Greenhouse gas
g/m^2	Grams per square metre
HSE	Health Safety Environment
HSE MS	Health Safety Environment Management System
Hz	Hertz
IAPP	International Air Pollution Prevention
IMDG	International Maritime Dangerous Goods
IMS	Invasive Marine Species
IMT	Incident Management Team
IUCN	International Union for Conservation of Nature
JWM	Jetwave Marine
KEF	Key Ecological Feature
Khz	Kilo hertz
km	Kilometre
km/hr	Kilometres Per Hour
km^2	Square Kilometres
L	Litre
m	Metres
m/h	Metre per hour
m/s	Metres Per Second
m^3	Cubic Metres
WAF	Water Accommodated Fraction
MARPOL	International Convention for the Prevention of Pollution from Ships
MC	Measurement Criteria
MEG	Mono Ethylene Glycol
MGO	Marine Gas Oil
mm	Millimetres
MNES	Matters of National Environmental Significance
MOC	Management of Change
MODU	Mobile Offshore Drilling Unit
MOU	Memorandum of Understanding
MP	Marine Park
NEBA	Net Environmental Benefit Analysis

Abbreviation	Description
NMSC	National Marine Safety Committee
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NOx	Oxides of Nitrogen
NWA	North West Alliance
NWMR	North West Marine Region
NWS	North West Shelf
NWSTF	North West Slope Trawl Fishery
OCNS	Offshore Chemical Notification Scheme
ODS	Ozone Depleting Substance
OPEP	Oil Pollution Emergency Plan
OPGGS (E) R	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
OPMF	Onslow Prawn Managed Fishery
OSCP	Oil Spill Contingency Plan
OSRL	Oil Spill Response Limited
OWA	Oiled Wildlife Advisors
OWRP	Oiled Wildlife Response Plan
PAH	Poly Aromatic Hydrocarbons
PLEM	Pipeline End Manifold
PPA	Pearl Producers Association
PMS	Planned Maintenance System
ppb	Parts per Billion
ppm	Parts Per Million
psi	Pounds per square inch
QOA	Quadrant Oil Australia
ROV	Remote Operated Vehicle
SDS	Safety Data Sheet
SFRT	Subsea First Response Toolkit
SMPEP	Shipboard Marine Pollution Emergency Plan
SOLAS	Safety of Life at Sea
SOPEP	Shipboard Oil Pollution Emergency Plan
SOx	Oxides of Sulphur
VRASS	Vessel Risk Assessment
WA	Western Australia

Abbreviation	Description
WAFIC	Western Australian Fishing Industry Council
WAOWRP	WA Oiled Wildlife Response Plan
WDCS	Whale and Dolphin Conservation Society
WDTF	Western Deepwater Trawl Fishery
WOMP	Well Operations Management Plan
XT	Xmas Tree

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1. INTRODUCTION

Quadrant Oil Australia Pty Ltd (QOA) is the registered operator for Petroleum Production Licence (permit area) WA-13-L in offshore Commonwealth waters on the North West Shelf (NWS) of Western Australia. QOA is a 100% owned subsidiary of Quadrant Energy Australia Ltd (Quadrant). Quadrant proposes to plug and abandon two East Spar wells (East Spar-3 ST1 and East Spar-6 ST1) located in the permit area that forms part of the East Spar field (**Figure 2-1**).

The earliest date for commencement of the activity is 1st June 2018 with all activity scheduled to be completed no later than 31st December 2018.

1.1 Compliance

The overall purpose of the *East Spar Plug and Abandonment Environment Plan (EA-66-RI-10009.01)* (the EP) 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 28 March 2018. This EP summary has been prepared in accordance with the requirements of regulation 11 (4) of the OPGGS (E) Regulations.

1.2 Activity durations and timing

Activities will be conducted 24 hours per day, seven days per week. It is expected to take approximately 15 days per well to complete plug and abandonment activities, inclusive of mobile offshore drilling unit (MODU) positioning activities, dependent on weather, scheduling and well conditions. To account for potential weather and operational delays or schedule changes, the environmental assessment accounts for petroleum activities from June-December 2018. Activities may not be continuous during these timeframes, and the MODU may depart and return on numerous occasions during this period.

The earliest date for MODU arrival is 1st June 2018 with all activity scheduled to be completed no later than 31st December 2018.

2. ACTIVITY LOCATION

The East Spar wells are located in permit area WA-13-L, approximately 35 km west of Barrow Island and approximately 100 km northwest of Onslow (**Figure 2-1**). The nearest protected area is the Commonwealth Montebello Australian Marine Park located approximately 30 km to the east.

The location of the two wells is shown on **Figure 2-2** and the coordinates are provided in **Table 2-1**. The `operational area' defines the boundary within which activities associated with plug and abandonment activities will occur, this includes a 500 m radius safety exclusion zone around each of the well locations (**Figure 2-2**). The water depth within the operational area ranges between approximately 90 m to 100 m.

Table 2-1: Coordinates of the operational area and the East Spar wells

Parameter	Latitude	Longitude
Operational Area	20° 43' 11.112" S	114° 58' 09.626" E
	20° 43' 12.192" S	114° 59' 41.705" E
	20° 44' 18.401" S	114° 59' 40.833" E
	20° 44' 17.320" S	114° 58' 08.743" E
Well: East Spar-3	20° 44' 1.227" S	114° 58' 26.153" E
Well: East Spar-6	20° 43' 49.310" S	114° 59' 23.981" E

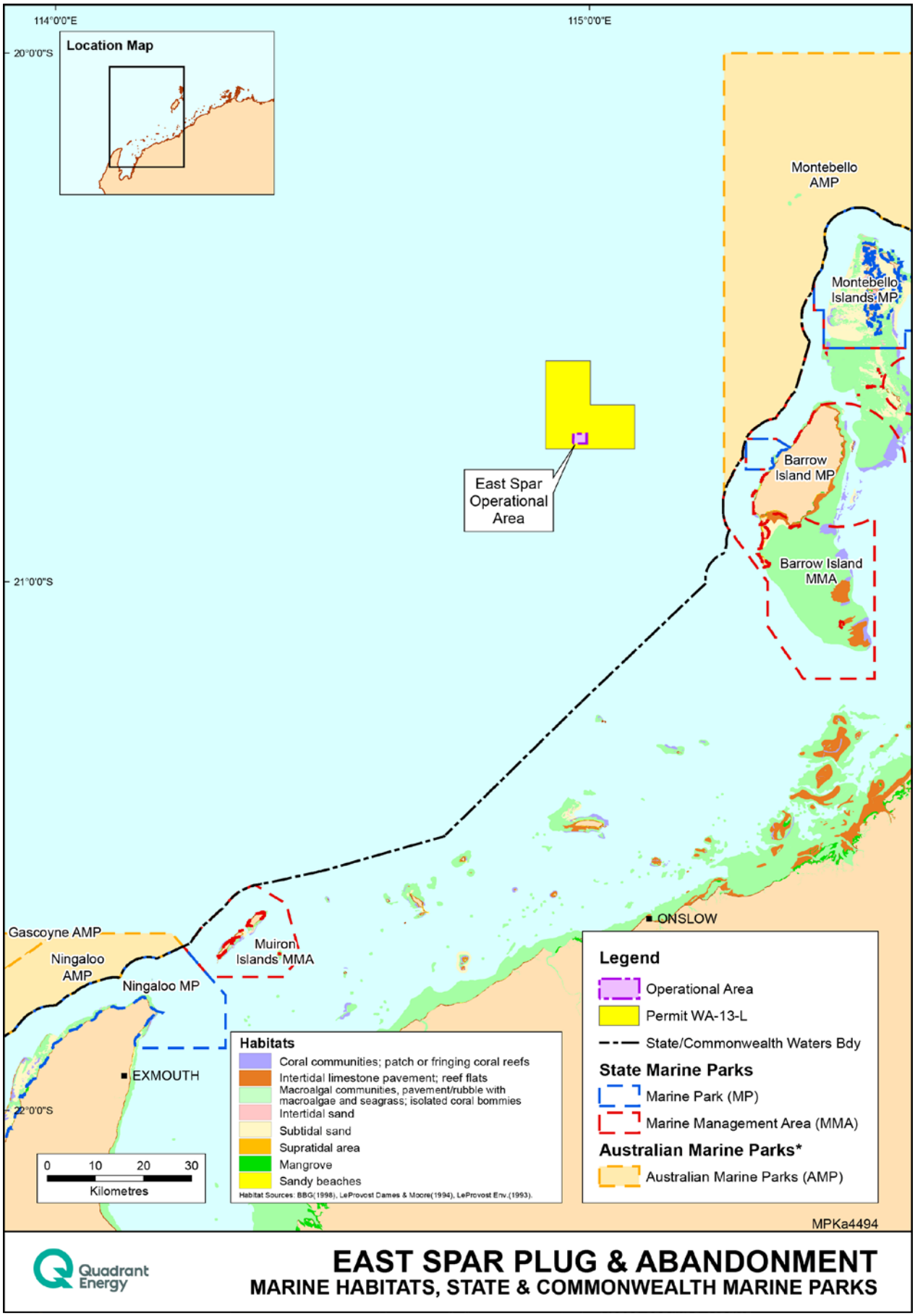

Figure 2-1: Location of the East Spar plug and abandonment operational area within permit WA-13-L

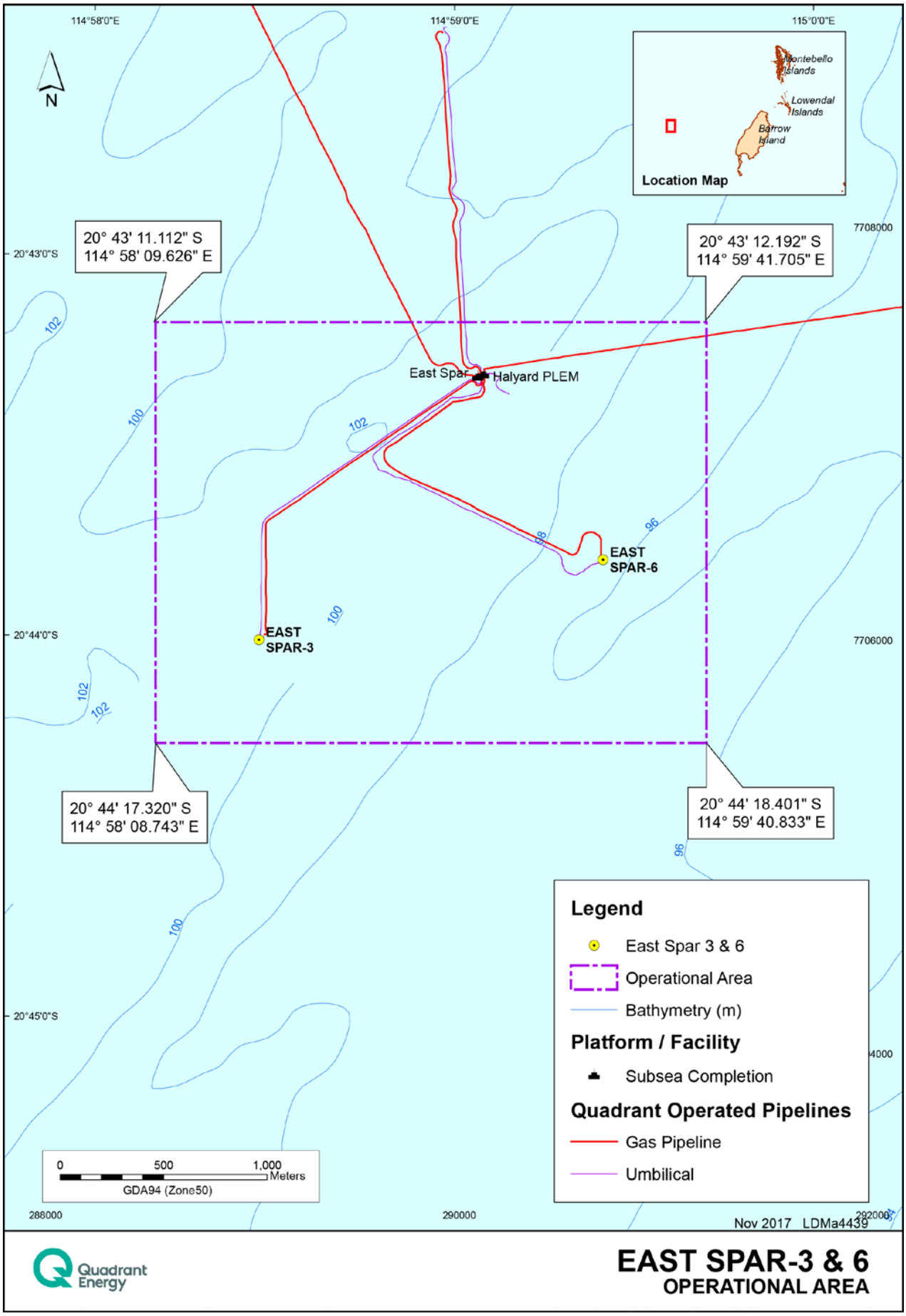

Figure 2-2: Location of the East Spar-3 and East Spar-6 wells within the operational area

3. DESCRIPTION OF THE ACTIVITY

3.1 Overview

A Jack-up Mobile Offshore Drilling Unit (MODU) will be used for conducting the plug and abandonment operations. The MODU will be assisted by up to three support vessels (used for towing, equipment and material transfers, standby operations and emergency response). The types will vary but are usually offshore multiple purpose or anchor handling vessels in the order of 80 metres long by 18 metres wide. The exact vessels are yet to be confirmed.

Equipment and material transfers may include, but are not limited to, crew supplies, hydrocarbons (diesel, engine oil, hydraulic fluids, grease, etc.), bulk drilling products, MODU and drilling equipment and parts, and waste. MODU cranes will be used for transfers between the MODU and support vessels.

Bulk products will also be transferred via hose from the support vessels and MODU. Such products include drilling fluids and solids, brine, drilling water, cement and fuel oil (diesel).

At least one support vessel will remain on standby to the MODU within the distance defined in the safety case (nominally 3 nautical miles).

Support vessels will not moor or anchor within the operational area during the activity.

MODU refuelling in the operational area may occur during the activity. Refuelling of support vessels or helicopters will not take place within the operational area. Helicopters will be used to transfer crew and equipment, and assist in Health Safety Environment (HSE) or operational emergencies as require.

3.2 Plug and Abandonment Activities

3.2.1 Pre-MODU positioning ROV survey

Prior to positioning of the MODU legs (cans) on the seabed at each of the well locations, a survey may be undertaken using a remotely operated vehicle (ROV) and/or sidescan sonar to understand the seabed conditions and minimise any potential risks caused by subsea hazards (e.g. infrastructure). This may be undertaken by a vessel in advance of the MODU arriving.

3.2.2 MODU move in and rig up

The MODU will be moved into position using up to three support vessels. The legs will be jacked up during rig positioning to avoid contact with the seabed or subsea infrastructure during the tow in. Once at the desired location and with the MODU stationary, the legs will be lowered to be fully in contact with the seabed and the MODU raises itself approximately 35 m above the sea surface. The cantilever will be skidded out and the bleed-off package will be rigged up.

3.2.3 Marine growth removal

Marine growth on the subsea wellheads/trees may require removal to facilitate well re-entry. If required, marine growth removal will be undertaken via ROV through the use of water jetting, vacuuming and/or non-aggressive brushing. In addition, a chemical wash may be used to clean any calcareous marine growth.

3.2.4 ROV surveys

During the activity, opportunistic ROV surveys may be completed from the MODU or vessels of the subsea infrastructure within the operational area.

3.2.5 Plug and abandonment

The following sequence of work will be followed for the abandonment of each well, once the MODU is on location and the high pressure riser and blowout preventer (BOP) installed.

- Install landing string, pull the XT crown plugs to allow access to the completion.

- Bullhead tubing with kill weight brine prior to setting deepset tubing or nipple plugs and cutting the tubing or releasing the packer.
- Circulate or lubricate-and-bleed production annulus to kill weight brine.
- Pull the XT internal tree cap, and then recover the completion.
- Conduct electric line logs (if required).
- Abandon well subsurface through setting of abandonment cement plugs as required to isolate hydrocarbons and permeable zones from surface.
- Nipple down BOP and pull high pressure riser.
- Install trash cap on XT.
- Valve manipulation on XTs throughout activity.
- Flare booms will be used to flare or cold vent recovered hydrocarbons after passing through a validated bleed-off package.

3.2.6 End of activity

The casing strings, wellhead and XT will be left in-situ following the completion of the sub-surface abandonment. The activity (and EP) ends once the plug and abandonment activity is completed and the MODU and all support vessels have departed the operational area.

4. DESCRIPTION OF ENVIRONMENT

4.1 Environment That May Be Affected (EMBA)

Stochastic hydrocarbon dispersion and fate modelling undertaken for the credible 'worst-case' hydrocarbon spill scenarios indicated that the largest spatial extent of potential impact to fauna and/or habitat would result from a vessel collision rupturing a fuel tank and releasing marine gas oil (MGO).

The spill trajectory area for this scenario was therefore considered to represent the greatest extent of the Environment That May Be Affected (EMBA) and was used to identify the environmental values and sensitivities within the existing environment that may be at risk, including by searches of the EPBC Act Protected Matters Database.

The existing environment within the operational area and EMBA is summarised in the following sections.

4.2 Physical Environment and Habitat

4.2.1 Physical environment

The operational area is situated within Commonwealth waters of the North-west Marine Region (DSEWPaC, 2008). The North-west Marine Region (NWMR) is further divided into eight provincial bioregions (DSEWPaC, 2008). The operational area and EMBA intersect the Northwest Shelf Province and Northwest Province bioregion as described below.

Northwest Shelf Province Bioregion

The Northwest Shelf Province Bioregion is located primarily on the shelf between North West Cape and Cape Bougainville. The bioregion has a total area of 238,759 km^2 and contributes to 19.6% of the total area of the NWMR. Water depths within the bioregion range from 0-200 m, with more than 45% of the bioregion having a depth of 50-100 m (DSEWPaC, 2008).

Northwest Province Bioregion

The Northwest Province Bioregion is located offshore between Exmouth and Port Hedland, covering an area of 178,651 km^2 and covers 16.7% of the total NWMR. Water depths of the bioregion predominantly range from 1,000 to 3,000 m, with a maximum depth of 5,170 m in the Exmouth Plateau (DSEWPaC, 2008).

The Northwest Province lies entirely on the continental slope and is comprised of muddy sediments. A number of distinguishing topological features occur, notably the Exmouth Plateau. Significantly, this bioregion contains the steepest shelf break of the NWMR, along the Cape Range Peninsula near Ningaloo Reef (DSEWPaC, 2008). As with many other bioregions, currents are dominated by the circulation of the Indonesian Throughflow. Circulation is subject to both seasonal and inter-annual variation. The most distinguishing oceanographic feature of the Northwest Province (compared to other bioregions further north) is the strengthening of the Leeuwin current resulting from the narrowing of the continental shelf at the North West Cape (DSEWPaC, 2008).

4.2.2 Habitats

Northwest Shelf Province Bioregion

Low density benthic communities of bryozoans, molluscs and echinoids are supported within the bioregion. Sponge communities are also sparsely distributed on the shelf and are found only in areas of hard substrate. However the region between Dampier and Port Hedland is a hotspot for sponge biodiversity. Other benthic and demersal species in the bioregion include sea cucumbers, urchins, prawns and squid. Benthic and pelagic fish communities are also highly diverse and strongly depth-related with a number of hotspots identified between Port Hedland and North West Cape. Numerous migratory species including humpback whales, whale sharks and dugongs travel through the bioregion. The bioregion also supports bottlenose and Indo-Pacific humpback dolphins, turtle nesting sites including green, hawksbill, flatback and loggerhead turtles, and several seabird breeding populations including wedge-tailed shearwaters, crested, bridled and sooty terns, brown boobies and lesser frigate birds (DSEWPaC, 2008).

Northwest Province Bioregion

Benthic communities are likely to include filter feeders and epifauna. Soft bottom environments are likely to support patchy distributions of mobile epibenthos. Pelagic species occurring in the bioregion are likely to include small pelagic fish attracted to seasonal upwellings as well as larger predators such as billfish, sharks and dolphins. A number of migratory species have been recorded in the bioregion including whale sharks, cetaceans and marine turtles.

4.2.3 Benthic habitats

The operational area does not contain any shoreline habitat; the nearest land is Barrow, Lowendal, Montebello islands located approximately 35 km, 56 km and 60 km respectively from the operational area.

Given the operational area is located in the Northwest Shelf Province bioregion, and the wider EMBA overlaps a portion of the Northwest Province bioregion, the benthic habitats within the operational area and the EMBA are expected to be similar with soft sediments and outcropping cemented sediments (hard substratum) and associated benthic fauna. Benthic primary producer habitat (e.g. areas of hard corals, seagrass or macroalgae) is unlikely to be present. The minimum depth of the water encompassed by the operational area is approximately ~95 m; at these depths benthic primary production, which relies on photosynthesis for energy production is limited due to insufficient light availability.

4.2.4 Soft sediments and benthic fauna

Soft sediment benthic fauna include animals living within the sediments (infauna) and those living on or above the seabed (sessile and mobile epifauna). This fauna comprises predominantly mobile burrowing species including molluscs, crustaceans (crabs, shrimps and smaller related species), polychaetes, sipunculid and platyhelminth worms, asteroids (sea stars), echinoids (sea urchins) and other small animals.

Quadrant has seabed survey data from geotechnical and biological seabed surveys undertaken in 1995 and 2011 within the permit area for the East Spar and Greater East Spar developments. The geotechnical

investigations revealed the seabed at the East Spar location to be composed of silty clay or loose carbonate silty sand (Dames and Moore, 1995 referenced in AEL, 2001). Survey reports from flexible flowlines in the permit suggest the seabed may be mobile resulting in some flowline embedment.

Seabed sampling undertaken between the Halyard PLEM and East Spar PLEM by RPS in October 2011 found the seabed to be featureless and relatively homogenous with a flat gradient, comprised of fine silt and mud sediments and dense bioturbation (mounds and burrows) that decreased with increasing water depth. Epibenthic biota was sparse (<5% cover abundance) and included invertebrates such as anemones, urchins, sea pens, sea whips and glass sponges (RPS, 2011). The survey did not identify any areas of coral, macroalgae or seagrass habitat (RPS, 2012); limited light availability at the depth of the operation area (~90-100 m) is likely to preclude the growth of these photosynthetic organisms.

Quadrant commissioned RPS to undertake a biological seabed survey for the Greater East Spar (GES) Development Project (RPS, 2011) just to the north of the East Spar plug and abandonment operational area, but within the same petroleum permit area (WA-13-L). The survey included the proposed GES Development subsea infrastructure footprints and flowline corridors. The survey showed the seabed in the area to be relatively flat comprising of fine silt and muddy sediments, with a gentle sloping gradient from east to west. These sediments were un-vegetated and densely bioturbated (<75%). Epibenthic biota was sparse (<5%) and included invertebrates, such as anemones, sponges and sea urchins.

4.2.5 Anthropogenic structures and epifauna

Anthropogenic structures in the northwest section of the permit area WA-13-L were surveyed during the GES seabed survey; these hard structures support a higher diversity and abundance of epifauna and fish than on areas comprising solely soft sediments (RPS, 2011b). Hard structures can be used as attachment points for sessile filter feeding invertebrates such as soft corals, gorgonians and sponges. These areas are also likely to be used by mobile invertebrates such as molluscs, crustaceans (crabs, shrimps and smaller related species), polychaetes, sipunculid and platyhelminth worms, asteroids (sea stars) and echinoids (sea urchins). Soft corals were found at the East Spar PLEM (95 m depth) and the Spar-2 wellhead (109 m depth) supported a variety of fish (RPS, 2011).

The filter feeding epifauna attached to anthropogenic structures in the area are similar to epifauna found elsewhere in the NWS region and are not considered regionally significant (RPS, 2011b).

4.3 **Protected/ Significant Areas**

The EMBA overlaps a portion of the Commonwealth Montebello Australian Marine Park, the Barrow Island Marine Park (State) and Barrow Island Marine Management Area (State) (refer **Figure 2-1**). Due to the close proximity of the EMBA to the State Montebello Island Marine Park and its high environmental value, this has also been included.

Montebello Australian Marine Park

The Marine Park, an IUCN VI zone (see **Table 4-1** for values), covers an area of approximately 3,413 km^2 and is designated due to the following values:

Major Conservation Values

- Foraging areas for migratory seabirds that are adjacent to important breeding areas;
- Areas used by vulnerable and migratory whale sharks for foraging;
- Foraging areas 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 15–150 m 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 for the region is the Ancient Coastline (a unique seafloor feature that provides areas of enhanced biological productivity).

This marine park is adjacent to the Barrow Island and the Montebello Island Marine Parks that have been nominated for National Heritage listing (Director of National Parks, 2017). Commercial tourism, commercial fishing, mining and recreation are important socio-economic values for the park.

Summary of Ecological Values

- Geomorphology: A complex seabed and island topography consisting of subtidal and intertidal reefs, sheltered lagoons, channels, beaches and cliffs;
- Sediment quality: The sediments of the reserves are generally pristine, which is essential to the maintenance of healthy marine ecosystems;
- Water quality: The waters of the marine parks are generally pristine, which is essential to the maintenance of healthy marine ecosystems;
- Coral reef communities: Undisturbed intertidal and subtidal coral reefs and bommies with a high diversity of hard corals;
- Macroalgal and seagrass communities: Extensive subtidal macroalgal and seagrass communities are important primary producers and refuge areas for fishes and invertebrates;
- Subtidal soft-bottom communities: Subtidal sand and silt habitats support a variety of fauna including burrowing invertebrates and filter-feeding communities;
- Marine mammals: Ten species of cetaceans are recorded from the reserves, with the humpback whale passing through the area during its annual migration (1 June through to 31 July (northward migration) and 1 September through to 31 October (southern migration). Dugongs are found in the shallow warm waters;
- Turtles: Green, flatback, hawksbill, loggerhead and leatherback turtles are found in the marine parks, with the Western Australian hawksbill population being the largest remaining in the Indian Ocean. Four species use sandy beaches in the reserves for nesting;
- Seabirds: The reserves provide important feeding and resting areas for migrating shorebirds. Islands within the marine parks are nesting areas for 15 species of seabirds;
- Finfishes: A rich finfish fauna with at least 456 species; and
- Invertebrates: A diverse marine invertebrate fauna comprising mostly tropical species.

Summary of Social Values

- Hydrocarbon exploration and production industry: The Montebello Marine Park is within the State's most productive petroleum area (for both oil and gas);
- Commercial fishing: The parks are used by commercial fishers targeting a variety of finfish, sharks and beche de mer; and
- Scientific research: The undisturbed nature and wide variety habitats and communities within the parks provide unique opportunities for scientific research.

Table 4-1: Australian IUCN reserve management principles (Schedule 8 of the EPBC Regulations 2000)

Category VI	IUCN principles	Evidence of addressing principles
Montebello Australian Marine Park	The reserve or zone should be managed mainly for the sustainable use of natural ecosystems based on the following principles.	Yes – Addressed throughout this table.
	The biological diversity and other natural values of the reserve or zone should be protected and maintained in the long-term.	Yes – Addressed through the control measures identified (refer **Section 6**)
	Management practices should be applied to ensure ecologically sustainable use of the reserve or zone.	Yes – addressed through the control measures identified (refer **Section 6**)
	Management of the reserve or zone should contribute to regional and national development to the extent that this is consistent with these principles.	N/A – Covered by park management (DoEE)

4.3.1 Key ecological features

No key ecological features (KEFs) intercept the East Spar plug and abandonment operational area. The closest KEF to the operational area is the Ancient Coastline at 125 m Contour located over 10 km away (**Figure 4-1**).

The EMBA overlaps with the following three KEFs:

Ancient Coastline at 125 m Contour

The shelf of the North-west Marine Region contains several terraces and steps, which reflect the gradual increase in sea level across the shelf that occurred during the Holocene (DSEWPaC, 2012). The most prominent of these occurs episodically as an escarpment through the Northwest Shelf Province and Northwest Shelf Transition, at a depth of approximately 125 m (DSEWPaC, 2012). Where the ancient submerged coastline provides areas of hard substrate it may contribute to higher diversity and enhanced species richness relative to soft sediment habitat (DSEWPaC, 2012).

The escarpment may facilitate increased availability of nutrients in particular locations off the Pilbara coast by disrupting internal waves thereby facilitating enhanced vertical mixing of water layers. Enhanced productivity may attract opportunistic feeding by larger marine life including humpback whales, whale sharks and large pelagic fish (DSEWPaC, 2012).

Although the ancient coastline adds additional habitat types to a representative system, the habitat types are not unique to the coastline as they are widespread on the upper shelf (Falkner *et al*., 2009). The Marine Bioregional Plan for the North-west Marine Region (DSEWPaC, 2012) states that most actions occurring along the ancient coastline at the 125 metre depth contour are unlikely to impact adversely on the ecosystem functioning and integrity of this key ecological feature.

Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula

Cape Range Peninsula and the Cuvier Abyssal Plain are linked by canyons, the largest of which are the Cape Range Canyon and Cloates Canyon. These two canyons are located along the southerly edge of Exmouth Plateau adjacent to Ningaloo Reef and are unique due to their close proximity to the North West Cape (DSEWPaC, 2012).

The Leeuwin Current interacts with the heads of the canyons to produce eddies resulting in delivery of higher nutrient, cool waters from the Antarctic intermediate water mass to the shelf (Brewer *et al*., 2007). Strong internal tides also create upwelling at the canyon heads (Brewer *et al*., 2007). Thus the canyons, the Exmouth Plateau and the Commonwealth waters adjacent to Ningaloo Reef interact to create the conditions for enhanced productivity seen in this region (Sleeman *et al*. 2007 in DSEWPaC 2012). The canyons are also repositories for particulate matter deposited from the shelf and sides of the canyons and serve as conduits for organic matter between the surface, shelf and abyssal plains (DSEWPaC, 2012).

The canyons that link the Cuvier Abyssal Plain with the continental slope off Cape Range Peninsula are believed to support the productivity and species richness of Ningaloo Reef (DSEWPaC, 2012).

Continental Slope Demersal Fish Communities

The Australian continental slope provides important habitat for demersal fish communities, characterised by high endemism and species diversity. Specifically, the continental slope between North West Cape and the Montebello Trough is the most diverse slope bioregion in Australia with more than 500 fish species, 76 of which are endemic (Last *et al*. 2005 in DSEWPaC 2012). The Timor Province and Northwest Transition bioregions are the second-richest areas for demersal fish across the entire continental slope (DSEWPaC, 2012).

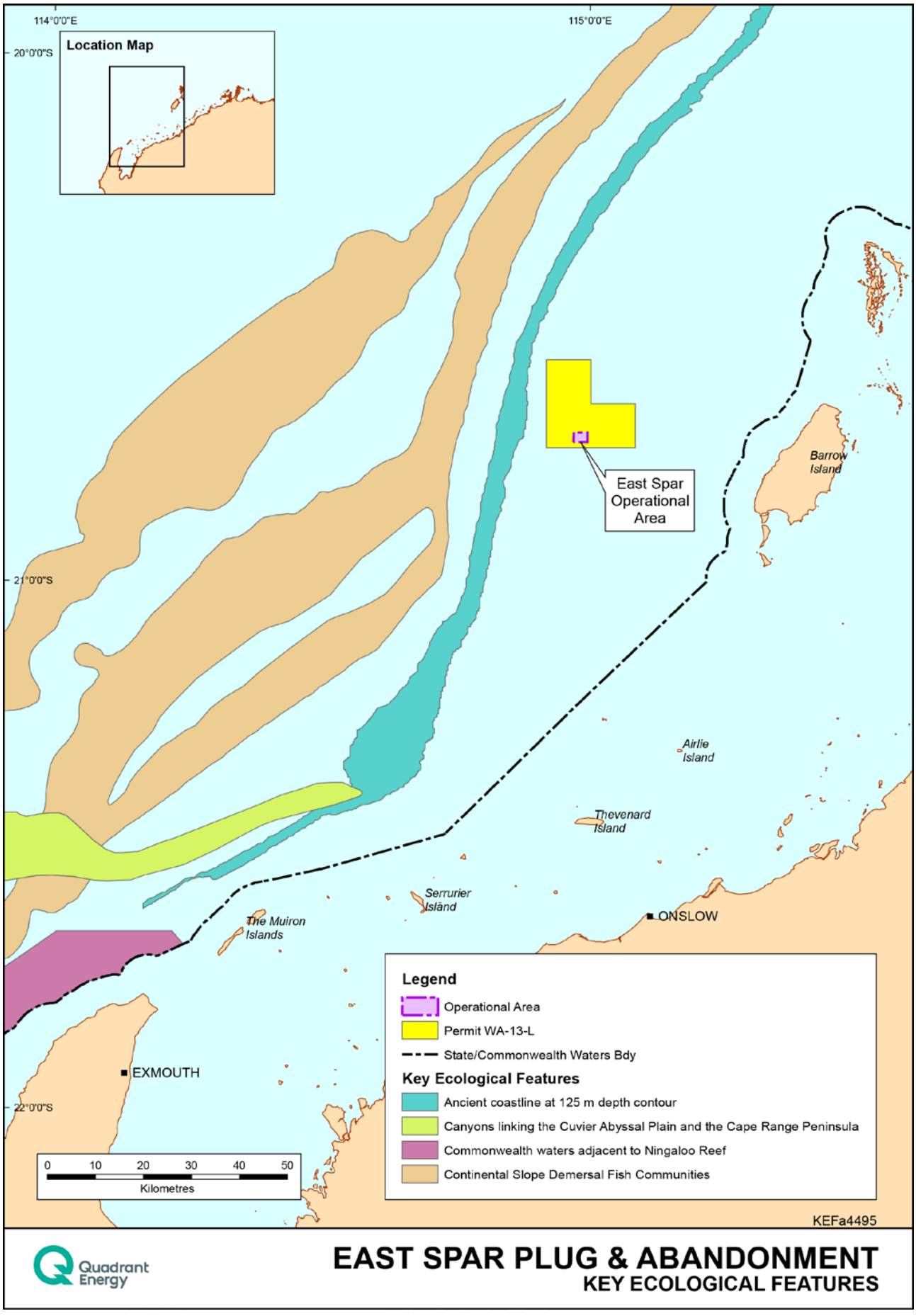

Figure 4-1: Key ecological features in the vicinity of the operational area

4.3.2 Threatened and migratory marine fauna

EPBC protected matters searches were conducted on the 22 December 2017 for the operational area and EMBA. The searches identified 23 `threatened' species of marine fauna within the operational area, 20 of which are also listed as `migratory' species (**Table 4-2**). The listed threatened marine fauna that may occur within the EMBA and their migratory characteristics are also given in **Table 4-2**. For each species identified, the nature of likely presence is provided, including any overlap with designated Biologically Important Areas (BIAs).

Table 4-2: Threatened and migratory species and communities in the operational area and EMBA

Value/Sensitivity		EPBC Act Status CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory	Operational area presence	Particular values or sensitivities within operational area	EMBA presence	Particular values or sensitivities within EMBA	Relevant Events
Common Name	**Scientific Name**						
Protected Species and Communities: Fish and Sharks							
Whale shark	*Rhincodon typus*	V, M	✓	Foraging, feeding or related behaviour known to occur within area. Overlap with foraging BIA	✓	Foraging, feeding or related behaviour known to occur within area. Overlap with foraging BIA	<u>Planned</u> • Light emissions • Noise emissions • Drilling and cement discharges • Planned operational discharges • Spill response operations <u>Unplanned</u> • Hydrocarbon releases • Non-hydrocarbon releases • Marine fauna collisions • Introduction of invasive marine species
Grey nurse shark (west coast population)	*Carcharias taurus* (west coast population)	V	✓	Species or species habitat may occur within area	✓	Species or species habitat known to occur within area	
Great white shark	*Carcharodon carcharias*	V, M	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	
Dwarf sawfish	*Pristis clavata*	V, M	**X**	N/A	✓	Species or species habitat known to occur within area	
Green sawfish	*Pristis zijsron*	V, M	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	

Value/Sensitivity		EPBC Act Status CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory	Operational area presence	Particular values or sensitivities within operational area	EMBA presence	Particular values or sensitivities within EMBA	Relevant Events
Common Name	**Scientific Name**						
Protected Species and Communities: Marine Mammals							
Humpback whale	*Megaptera novaeangliae*	V, M	✓	Species or species habitat known to occur within area Overlap with BIA for migration	✓	Species or species habitat known to occur within area Overlap with BIA for migration	<u>Planned</u> • Noise emissions • Planned operational discharges • Drilling and cement discharges • Spill response operations <u>Unplanned</u> • Hydrocarbon releases • Non-hydrocarbon releases • Marine fauna collisions
Blue whale	*Balaenoptera musculus*	E, M	✓	Species or species habitat likely to occur within area	✓	Migration route known to occur within area Overlap with BIA for migration	
Sei whale	*Balaenoptera borealis*	V, M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	
Fin whale	*Balaenoptera physalus*	V, M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	
Southern right whale	*Eubalaena australis*	E, M	**X**	N/A	✓	Species or species habitat may occur within area	
Protected Species and Communities: Marine Reptiles							
Short-nosed seasnake	*Aipysurus apraefrontalis*	CE	**X**	N/A	✓	Species or species habitat likely to occur within area	<u>Planned</u> • Light emissions

Value/Sensitivity		EPBC Act Status CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory	Operational area presence	Particular values or sensitivities within operational area	EMBA presence	Particular values or sensitivities within EMBA	Relevant Events
Common Name	**Scientific Name**						
Loggerhead turtle	*Caretta caretta*	E, M	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area. Breeding known to occur within area	• Noise emissions • Planned operational discharges • Drilling and cement discharges • Spill response operations <u>Unplanned</u> • Hydrocarbon releases • Non-hydrocarbon releases • Marine fauna collisions
Green turtle	*Chelonia mydas*	V, M	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area. Breeding known to occur within area	
Leatherback turtle	*Dermochelys coriacea*	E, M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area. Breeding likely to occur within area	
Hawksbill turtle	*Eretmochelys imbricata*	V, M	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area. Breeding known to occur within area	
Flatback turtle	*Natator depressus*	V, M	✓	Congregation or aggregation known to occur within area Overlap with internesting habitat buffer critical to survival of species (60 km of Barrow Island)	✓	Congregation or aggregation known to occur within area. Breeding known to occur within area. Overlap with internesting habitat buffer critical to	

Value/Sensitivity		EPBC Act Status CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory	Operational area presence	Particular values or sensitivities within operational area	EMBA presence	Particular values or sensitivities within EMBA	Relevant Events
Common Name	**Scientific Name**						
						survival of species (60 km of Barrow Island)	
Protected Species and Communities: Marine Birds							
Curlew sandpiper	*Calidris ferruginea*	CE, M	✓	Species or species habitat may occur within area	✓	Species or species habitat known to occur within area	Planned • Light emissions • Noise emissions • Planned operational discharges • Drilling and cement discharges • Atmospheric emissions • Spill response operations Unplanned • Hydrocarbon releases • Non-hydrocarbon releases • Marine fauna collisions
Red knot	*Calidris canutus*	E, M	✓	Species or species habitat may occur within area	✓	Species or species habitat known to occur within area	
Southern giant petrel	*Macronectes giganteus*	E, M	✓	Species or species habitat may to occur within area	✓	Species or species habitat may occur within area	
Eastern curlew	*Numenius madagascariensis*	CE, M	✓	Species or species habitat may occur within area	✓	Species or species habitat known to occur within area	
Bar-tailed godwit	*Limosa lapponica baueri*	V, M	**X**	N/A	✓	Species or species habitat may occur within area	
Northern Siberian bar-tailed godwit	*Limosa lapponica menzbierii*	CE, M	**X**	N/A	✓	Species or species habitat may occur within area	
Australian fairy tern	*Sternula nereis nereis*	V	✓	Foraging, feeding or related behaviour likely to occur within area. Breeding known to occur within area.	✓	Foraging, feeding or related behaviour likely to occur within area. Breeding	

Value/Sensitivity		EPBC Act Status CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory	Operational area presence	Particular values or sensitivities within operational area	EMBA presence	Particular values or sensitivities within EMBA	Relevant Events
Common Name	**Scientific Name**						
						known likely to occur within area	

4.3.2.1 Marine mammals

A search of the EPBC Act Protected Matters Database identified 29 cetacean species that may occur within the operational area and EMBA. Of these, 11 are listed as migratory and five are listed as threatened under the EPBC Act.

4.3.2.2 Fish and sharks

A search of the EPBC Act Protected Matters Database identified five threatened fish species within the operational area and EMBA. Of these, four are listed also listed as migratory. The search also identified 32 listed marine fish (pipefish and seahorses).

4.3.2.3 Marine reptiles

A search of the EPBC Act Protected Matters Database identified five marine turtle species listed as threatened and migratory, and one seasnake listed as threatened, which may occur within the operational area and/or EMBA.

4.3.2.4 Marine seabirds

A search of the EPBC Act Protected Matters Database identified seven threatened marine bird species (six of which are also migratory) which have a recognised range that overlaps the operational area and/or EMBA.

4.3.3 Socio-economic receptors

The operational area is located approximately 180 km west from the Port of Dampier and 100 km north-west from Onslow. Smaller regional settlements are further away at Point Samson and Exmouth. Socio-economic activities that may occur within the operational area and surrounds include commercial fishing, oil and gas exploration and production; and to a lesser extent, recreational fishing and tourism as summarised in **Table 4-3.**

Table 4-4 identifies the relevant State and Commonwealth fisheries that overlap the operational area and EMBA. Active fisheries were identified in consultation with the Department of Primary Industries and Regional Development (DPIRD).

Table 4-3: Socio-economic activities in the vicinity of the operational area and EMBA

Value/ Sensitivity	Description	Operational area presence	Relevant events within operational area	Relevant events within EMBA
Shipping	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. The high area of activity in the vicinity of the operational activity is due to the operations at Quadrant's John Brookes facility. The proposed operational area does not overlap any major shipping, although heavy traffic may be encountered throughout the operational area as commercial vessels transit around the Montebello Islands and support vessel(s) conduct operations with the offshore infrastructure.	✓	Planned Interactions with other marine users	Unplanned Hydrocarbon release from loss of well containment and MGO spill from vessel collision

Recreational fishing	Within the operational area there are no known natural seabed features that would aggregate fishes and which are typically targeted by recreational fishers. Given the water depths and distance from the nearest mainland, it is unlikely recreational fishing would occur in the vicinity.	-	N/A	N/A
Defence	No known defence areas in the vicinity have been raised by the Department of Defence.	-	N/A	N/A
Shipwrecks	1 shipwreck (Lady Ann) lies within the EMBA.	-	N/A	<u>Unplanned</u> Hydrocarbon release from loss of well containment and MGO spill from vessel collision
Oil and gas	Various petroleum exploration and production activities have been undertaken within the northwest shelf, however there are none in the vicinity of the operational area. Vessels servicing oil and gas operations in the region may pass through the area *en route* to facilities, however, since vessel transit is not classed as a petroleum activity, potential impacts to vessels are discussed under 'Shipping' above. Oil and gas facilities occur within the EMBA as do permits operated by other titleholders. As such, oil and gas activities could be impacted by unplanned events.	-	N/A	<u>Unplanned</u> Hydrocarbon release from loss of well containment and MGO spill from vessel collision
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 Montebello Islands. These activities are concentrated in the vicinity of the population centres such as Exmouth, Dampier and Onslow. The socio-economic and heritage features in the region are of high value for the tourism industry. Owing to the water depths in the operational area, planned events are not predicted to have an impact on tourism. The EMBA overlaps a portion of the Montebello Marine Park and also the Barrow Island Marine Park, as such eco-tourism based on specific local values (whale sharks, game fish, nearshore reef snorkeling and diving) could be impacted by unplanned events.	-	N/A	<u>Unplanned</u> Hydrocarbon release from loss of well containment and MGO spill from vessel collision
Cultural Heritage	No known sites of Aboriginal Heritage significance within the operational area or EMBA.	-	N/A	N/A

Table 4-4: State and Commonwealth fisheries in the vicinity of the operational area and EMBA

Value/Sensitivity	Description	Operational area presence	EMBA presence	Relevant events within the operational area and 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).	X	✓	Historical effort within the EMBA, targeting scampi and prawns.
Southern Bluefin Tuna Fishery	No current effort on NWS.	✓	✓	No active commercial fishing within the area in the past years; however fisheries overlap the EMBA and therefore fishing vessels could be encountered in low density.
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 NWS	✓	✓	
Western Skipjack Tuna Fishery	No current effort on NWS.	✓	✓	
State Managed Fisheries (North Coast Bioregion)				
Pearl Oyster Managed Fishery	Mostly operate March to June. Operational area does occur within the boundaries of the fishery, but is restricted to shallow diving depths.	✓	✓	Given the water depths of the operational area, disruption to fishing activities are unlikely to occur Unplanned events which may occur in the operational area and EMBA could disrupt fishing activities, however the likelihood of these events is low.
Onslow Prawn Limited Entry Fishery	The boundaries of the OPMF are 'all the Western Australian waters between the Exmouth Prawn Fishery and the Nickol Bay prawn fishery east of 114º39.9' on the landward side of the 200 m depth isobath.	✓	✓	Significant disruption unlikely to occur due to vast area fished.
Pilbara Demersal Scalefish Fisheries - includes trap and trawl (zone 1) fisheries	Use a combination of vessels, effort allocations (time), gear limits, plus spatial zones (including extensive trawl closures) as management measures. The Trawl Fishery lands the largest component of the catch of demersal finfish in	✓	✓	The Trawl Fishery is seaward of the 50 m isobath and landward of the 200 m isobath. The Trap Fishery is seaward of the 30 m isobaths and landward of the 200 m isobaths.

Value/Sensitivity	Description	Operational area presence	EMBA presence	Relevant events within the operational area and EMBA
	the Pilbara (and North Coast Bioregion) comprising more than 50 scalefish species. In comparison, the trap fishery retains a subset of about 45 to 50 scalefish species, and while the Line Fishery catch comprises a similar number it also includes some deeper offshore species.			The Trawl Fishery (Zone 1) that intercepts the operational area is closed to fish trawling. As the maximum water depth in the operational area is ~100 m, significant impacts are not expected. Unplanned events which may occur in the operational area and EMBA could disrupt trap fishing activities, however the likelihood of these events is low.
State Managed Fisheries (Whole of State)				
Marine Aquarium Fish Fishery	All year. Effort within the operational area and EMBA is unknown, but is unlikely due to the depth and the dive-based method of collection. Unlikely to occur.	✓	✓	Disruption to fishing activities unlikely given water depths fisheries operate within. Unplanned events which may occur in the EMBA could disrupt fishing activities, however the likelihood of these events is low.
Specimen Shell Managed Fishery	All year. Effort within the operational area and EMBA is unknown, but it is unlikely due to the depth and the dive based method of collection Unlikely to occur.	✓	✓	
Beche-de-mer Fishery	All year. Although permitted to fish within the operational area and EMBA, the fishery is restricted to shallow coastal waters suitable for diving and wading Unlikely to occur.	✓	✓	
Mackerel Managed Fishery	Trolling or handline. Near-surface trolling gear from vessels in coastal areas around reefs, shoals and headlands.	✓	✓	The majority of the catch is taken in the Kimberley area and therefore disruption is unlikely.
Octopus	Caught as a by-product in region.	✓	✓	Fishery is in development phase. Effort within the operational area and EMBA is unknown, but is unlikely to be significant due to effort levels and pot collection method.
Abalone Managed Fishery	The commercial fishery harvest method is a single diver working off a 'hookah' (surface-supplied breathing apparatus) using an	✓	✓	Disruption is unlikely to occur in the operational area due to

Value/Sensitivity	Description	Operational area presence	EMBA presence	Relevant events within the operational area and EMBA
	abalone 'iron' to prise the shellfish off rocks.			depths and method of collection. Unplanned events which may occur in the EMBA could disrupt fishing activities, however the likelihood of these events is low.

4.4 Windows of Sensitivity

Timing of peak activity for threatened species and other relevant, significant sensitivities is given in **Table 4-5**.

Table 4-5: Windows of sensitivity in the vicinity of the EMBA

CATEGORY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Benthic Habitats												
Non-coral benthic invertebrates												
Fauna												
Plankton												
Fish/sharks	Timing of spawning activity varies between species.											
Whale shark												
Short-nosed sea snake	Can occur at low density year round.											
Hawksbill turtles resident adult and juveniles[1]	Widespread throughout NW Shelf waters, highest density of adults and juveniles over hard bottom habitat (coral reef, rocky reef, pipelines etc.).											
Hawksbill turtle mating aggregations[1]												
Hawksbill turtle nesting and internesting[1]												
Hawksbill turtle hatching[1]												
Flatback turtles resident adult and juveniles[1]	Widespread throughout NW Shelf waters, increased density over soft bottom habitat 10 – 60 m deep, post hatchling age classes and juveniles spread across shelf waters.											
Flatback turtle mating aggregations[1]												
Flatback turtle nesting and internesting[1]												
Flatback turtle hatching[1]												

CATEGORY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Flatback turtle nesting[1]												
Green turtles resident adult and juveniles[1]	Widespread throughout the NW Shelf waters, highest density associated with seagrass beds and macro algae communities, high density juveniles in shallow waters off beaches, amongst mangroves and in creeks.											
Green turtle mating aggregations[1]												
Green turtle nesting and internesting[1]												
Green turtle hatching[1]												
Loggerhead turtles resident adult and juveniles[1]	Widespread throughout the NW Shelf waters, increased density associated with soft bottom habitat supporting their bivalve food source, juveniles associated with nearshore reef habitat.											
Loggerhead turtle mating aggregations[1]												
Loggerhead turtle nesting and internesting[1]												
Loggerhead turtle hatching[1]												
Leatherback turtles	Can occur at low density across the NWS year round.											
Humpback whale migration						northern			southern			
Blue whale migration					northern							southern
Southern giant petrels	breeding							breeding				
Australian fairy tern	breeding							breeding				
Socio-economic												
Commercial Managed Fisheries												
Oil and gas												
Shipping												
Tourism/ recreational fishing (none applicable)												
KEY / NOTES												
	Peak activity, presence reliable and predictable					[1]Information provided by K. Pendoley						

CATEGORY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	Lower level of abundance/activity/presence											
	Very low activity/presence											
	Activity can occur throughout year											

5. STAKEHOLDER CONSULTATION

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

To allow an informed assessment by stakeholders of the potential impact of Quadrant's activities, Quadrant 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 the EP, a standardised approach was applied to identify key stakeholders for the activity, 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 was used to identify relevant persons on an activity-by-activity basis, and will be used throughout the duration of the EP. The key stakeholders identified for the activity are based on the operational area and EMBA and are provided in **Table 5-1**.

5.1 Summary

Stakeholders (refer **Table 5-1**) were informed of activities covered by the EP via an activity specific consultation package distributed by email on December 8, 2017. A wider stakeholder group was informed of the proposed activity in Quadrant's Quarterly Consultation Update edition distributed on December 22, 2017.

Quadrant is active in the area, operating the Varanus Island Hub since 1993, therefore it is reasonable to expect stakeholders are familiar with Quadrant's presence in the region. This includes recent consultation for an installation activity completed under the *Greater East Spar Installation and Commissioning EP (GE-35-RI-10002.01)*. Quadrant considers that consultation with regulators and key stakeholders has been adequate (further detailed in **Table 5-2**). No stakeholder has objected to the activity covered under this EP nor claimed that the environmental impacts or risks are unacceptable. Given the short (15 days per well) duration and nature of the activity, Quadrant anticipates minimal interaction with mariners. Despite this Quadrant will provide relevant marine notices detailed in **Table 5-2**.

All correspondence with external stakeholders is recorded and Quadrant will remain available before, during and after the activity. Consultation material and feedback received will be provided to the appropriate internal Quadrant personnel when relevant.

Many stakeholders have stated that they will contact Quadrant by exception, that is, if upon receiving the stakeholder information package they feel the activity poses a risk to them, they will contact Quadrant.

Consultation, agreements or contracts that support Quadrant's oil spill response strategies and tactics have been put into place with agencies and organisations throughout the development of the OPEP so that roles and responsibilities are understood and accepted. These are outlined in **Table 5-3.**

Quadrant 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.);
- The Department of Primary Industries and Regional Development (DPIRD) fishing license holder database will be sourced annually and used to update the Quadrant database. License holders potentially affected by Quadrant's offshore interests will be contacted, provided with a current summary of current Quadrant activities and asked to indicate their interest in receiving future consultation material outlining the impacts of Quadrant operations and activities;
- Active participation in industry bodies (e.g. APPEA and Australian Marine Oil Spill Centre, AMOSC); and
- Records from previous consultation activities in the area.

Table 5-1: Summary of stakeholders consulted

Group	Stakeholder
Fishing bodies	• Australian Fisheries Management Authority (AFMA) • Commonwealth Fisheries Association (CFA) • Marine Tourism WA • Recfishwest • Western Australian Fishing Industry Council (WAFIC)
Karratha/Port Hedland Stakeholder Reference Group	• Chevron Australia Pty Ltd • Pilbara Port Authority
Marine conservation	• Department of Primary Industries and Regional Development (DPIRD) • Department of Biodiversity, Conservation and Attractions (DBCA)
Shipping safety and security	• Australian Maritime Safety Authority (AMSA) • Department of Defence (DoD) • Department of Transport (DoT)
Adjacent regulator	• Department of Mines, Industry Regulation and Safety (DMIRS)
Commonwealth Government departments	• Department of Agriculture and Water Resources – Biosecurity • Department of Agriculture and Water Resources – Fisheries

Table 5-2: Consultation summary for activity

Stakeholder	Assessment of Consultation Undertaken
Fishing bodies	
Australian Fisheries Management Authority	This stakeholder was provided the East Spar Plug and Abandonment drilling consultation package on December 8, 2017, and receive all Quadrant's Quarterly Consultation Update documents. No response regarding the activity has been received to date. No action arising from this consultation for the EP.
Commonwealth Fishing Association	This stakeholder was provided the East Spar Plug and Abandonment drilling consultation package on December 8, 2017, and receive all Quadrant's Quarterly Consultation Update documents. No response regarding the activity has been received to date. No action arising from this consultation for the EP.
Marine Tourism WA	This stakeholder was provided the East Spar Plug and Abandonment drilling consultation package on December 8, 2017, and receive all Quadrant's Quarterly Consultation Update documents. No comment has been received to date relating to the EP; previous interaction with stakeholder has reassured Quadrant that a response would only be received in the event of concern regarding the activity.
Recfishwest	This stakeholder was provided the East Spar Plug and Abandonment drilling consultation package on December 8, 2017, and receive all Quadrant's Quarterly Consultation Update documents. No response regarding the activity has been received to date. No action arising from this consultation for the EP.

Stakeholder	Assessment of Consultation Undertaken
Western Australian Fishing Industry Council	This stakeholder was provided the East Spar Plug and Abandonment drilling consultation package on December 8, 2017, and receive all Quadrant's Quarterly Consultation Update documents. No response regarding the activity has been received to date. No action arising from this consultation for the EP.
Karratha/Dampier Stakeholder Reference Group	
Chevron Australia Pty Ltd	Chevron are a neighbouring operator to this activity and received consultation material by email on January 9, 2018, and responded noting consultation was received with an updated email contact for future consultation. No further action required for the EP.
Pilbara Port Authority	This stakeholder was provided the East Spar Plug and Abandonment drilling consultation package on December 8, 2017, and receive all Quadrant's Quarterly Consultation Update documents. No response regarding the activity has been received to date. No action arising from this consultation for the EP.
Marine Conservation	
Department of Primary Industries and Regional Development (DPIRD)	This stakeholder was provided the East Spar Plug and Abandonment drilling consultation package on December 8, 2017, and receive all Quadrant's Quarterly Consultation Update documents. No response regarding the activity has been received to date, however in the development of the EP Quadrant referred to information provided by the former Department of Fisheries (DoF) in response to the Greater East Spar Installation activity, over the same area, received via email on May 10, 2017. Quadrant updated relevant sections of the EP including fishing activities, fish spawning grounds in the area, pollution emergency plan advice and biosecurity, accordingly.
Department of Biodiversity, Conservation and Attractions (DBCA)	This stakeholder was provided the East Spar Plug and Abandonment drilling consultation package on December 8, 2017, and receive all Quadrant's Quarterly Consultation Update documents. No response regarding the activity has been received to date. No action arising from this consultation for the EP.
Shipping safety and security	
Australian Maritime Safety Authority	This stakeholder was provided the East Spar Plug and Abandonment drilling consultation package on December 8, 2017, and receive all Quadrant's Quarterly Consultation Update documents. AMSA provided shipping traffic plots via email on December 14, 2017, which indicates most vessel traffic encountered would be industry traffic. Following advice from AMSA, Quadrant commits to relevant marine notices as per DC-CM-ALARP-001.
Department of Defence	This stakeholder was provided the East Spar Plug and Abandonment drilling consultation package on December 8, 2017, and receive all Quadrant's Quarterly Consultation Update documents. The Department responded to consultation on January 9, 2018, noting no concern with the activity and requested AHO branch of the Department receive notifications - as per DC-CM-ALARP-001.
Department of Transport	This stakeholder was provided the East Spar Plug and Abandonment drilling consultation package on December 8, 2017, and receive all Quadrant's Quarterly Consultation Update documents. Quadrant provided the activity OPEP with additional consultation information as per DoT's Industry Guidance Note on January 9, 2018. Quadrant commits to

Stakeholder	Assessment of Consultation Undertaken
	ongoing consultation with DoT on all Quadrant activities as per DoT's Industry Guidance Note.
Adjacent Regulators	
State Department of Mines, Industry Regulation and Safety (DMIRS)	DMIRS were provided the East Spar Consultation Plug and Abandonment drilling consultation package on December 8, 2017 and receive all Quadrant's Quarterly Consultation Update documents. DMIRS responded via email on December 11, 2017, acknowledging the activity would occur in Commonwealth Waters under NOPSEMA's regulation. DMIRS requested no further information, and requested timing confirmation before activity commencement as per the Department's Consultation Guidelines.
Commonwealth Government Departments	
Department of Agriculture and Water Resources – Biosecurity	This stakeholder was provided the East Spar Plug and Abandonment drilling consultation package on December 8, 2017, as requested in the Australian Government Guidance on Offshore Petroleum and Greenhouse Gas Activities Consultation. No response had been received at the time of the EP submission, and is not anticipated as Quadrant has consulted regularly with the State agency DPIRD.
Department of Agriculture and Water Resources – Fisheries	This stakeholder was provided the East Spar Plug and Abandonment drilling consultation package on December 8, 2017, as requested in the Australian Government Guidance on Offshore Petroleum and Greenhouse Gas Activities Consultation. The Department responded with thanks on January 11, 2018, noting they have no concern with the activity and requesting Quadrant consults with fishing bodies including AFMA. Quadrant responded confirming AFMA and additional fishing representative bodies are regularly consulted on Quadrant's offshore activities.

5.2 Ongoing consultation

Consultation associated with the activities covered by the EP comprises three tiers, the Activity Consultation Package distributed prior to EP acceptance (sent on December 8, 2017), a notification prior to activity commencement when timing and other details are confirmed, and within Quadrant's Quarterly Consultation Updates (last issued March 2018, next planned for June 2018).

Stakeholder consultation will be ongoing and Quadrant will work with stakeholders to address any future concerns if they arise throughout the duration of the 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 activity notifications.

5.2.1 Stakeholder notifications

Prior to mobilisation, Quadrant will provide a notification to relevant stakeholders. Stakeholders who receive this notification document will be based on Quadrant's stakeholder list at the time, which may include additional stakeholders to those listed in **Table 5-1** if they have been identified by Quadrant, or have specifically requested the information through consultation.

If the MODU departs and returns to the operational area after the initial notifications, relevant stakeholders will be notified as appropriate.

5.2.2 Quarterly consultation update

Activities covered under the EP will be included in Quadrant's Quarterly Consultation Updates until they can be listed as a 'completed activity', with updates scheduled for approximately June, September, December and March annually.

The East Spar plug and abandonment activity was including in Quadrant's Quarterly Consultation Update editions distributed in December 2017 and March 2018. No comments regarding East Spar were received in response to this consultation.

5.3 OPEP consultation

In preparing oil pollution emergency plans (OPEP), a number of parties are identified to provide spill response services and actions to support the implementation of the OPEP. These OPEP stakeholders are identified through evaluation of the activity and spill potential for all Quadrant OPEPs, including the *East Spar Plug and Abandonment OPEP (EA-66-RI-10009.02)*.

Consultation, agreements or contracts have been put into place with agencies and organisations throughout the development of Quadrant oil spill response strategies and tactics so that roles and responsibilities are understood and accepted as outlined in **Table 5-3.**

Table 5-3: OPEP consultation summary

Engaged with		Assessment of Consultation Undertaken
Function	**Stakeholder**	
Australian Marine Oil Spill Centre (AMOSC)		Historically AMOSC reviewed Oil Spill Contingency Plans (OSCPs) and OPEPs and are satisfied with the description of their support. AMOSC now request to only view OPEPs once they are accepted by the regulator and before the activity commences. Roles and responsibilities defined in the OPEP reflect the arrangements established under contract conditions as a Participating Member of AMOSC under the AMOSC Plan.
Australian Marine Safety Authority (AMSA)		Historically AMSA reviewed OPEPs and are satisfied with the description of their support. AMSA now request to only view OPEPs once they are accepted by the regulator and before the activity commences. Roles and responsibilities defined in the OPEP reflect the arrangements established within a Memorandum of Understanding (MOU) between AMSA and Quadrant. Quadrant continue to undertake an annual workshop with AMSA as required under Sections 22 and 24 of the Quadrant/AMSA MOU. This enables the open flow of information relevant to the oil spill response arrangements: *Ongoing consultation and cooperation* AMSA and the titleholder will nominate contact points for the ongoing management of this MOU. AMSA and the Titleholder agree to maintain a cooperative approach to preparing and responding to marine pollution incidents, including the open exchange of information and technical advice. AMSA will facilitate an annual workshop to provide an open forum to exchange information on best practice and review and update operational procedure.
Logistics provider	CH Robinson	CH Robinson provide a global freight forwarding service under contract conditions to Quadrant. All arrangements defined in the OPEP reflecting freight forwarding services reflect contracted services.
	Toll Logistics	Toll Logistics operate under contract conditions with Quadrant. All arrangements defined in the OPEP nominating Toll Logistics reflect contracted services.
Field support organisation	Exmouth Freight & Logistics Services (EF&LS)	EF&LS operate under contract conditions with Quadrant. All arrangements defined in the OPEP nominating EF&LS reflect contracted services.

Engaged with		Assessment of Consultation Undertaken
Function	**Stakeholder**	
Department of Environmental Regulation (DER) (Waste Management Branch)		The DER Waste Management Branch have reviewed and have had input in defining the Waste Management Plan contained in Quadrant OSCP/OPEPs. The waste management processes do not change between OPEPs, so the original consultation is sufficient for the OPEP.
Department of Biodiversity, Conservation and Attractions (DBCA)		DBCA were contributors to development of the WA Oiled Wildlife Response Plan (OWRP) defined in the OPEP. Descriptions of the Quadrant interface with the WAOWRP contained within the OPEP are consistent with the intent of DBCA (and AMOSC) for oiled wildlife response. No further consultation is required.
Department of Transport (Hazard Management Authority)		All roles and responsibilities defined within the OPEP for DoT reflect the arrangements for the Westplan MOP as further defined by the DoT Offshore Petroleum Industry Guidance Note, Marine Oil Pollution: Response and Consultation Arrangements. Consultation was conducted with the DoT as per their Industry Guidance Note on January 9, 2018, and Quadrant continues ongoing consultation with DoT on all Quadrant activities as per DoT's Industry Guidance Note.
Subsea response service provider	Oceaneering	Oceaneering operate under contract conditions with Quadrant. All arrangements defined in the OPEP nominating Oceaneering reflect contracted services.
Oil Spill Response Limited (OSRL)		OSRL operate under contract conditions with Quadrant. All arrangements defined in the OPEP nominating OSRL reflect contracted services.
Vessel providers	Go Marine	Go Marine operate under contract conditions with Quadrant. All arrangements defined in the OPEP nominating Go Marine reflect contracted services.
	Jet Wave Marine (JWM)	JWM operate under contract conditions with Quadrant. All arrangements defined in the OPEP nominating JWM reflect contracted services.
	Bhagwan Marine	Bhagwan Marine operate under contract conditions with Quadrant. All arrangements defined in the OPEP nominating Bhagwan Marine reflect contracted services.
Aircraft providers		Aircraft providers operate under contract conditions with Quadrant. All arrangements defined in the OPEP nominating aircraft providers reflect contracted services.
Spill modelling provider	RPS-APASA	APASA operate under contract conditions with Quadrant. All arrangements defined in the OPEP nominating APASA reflect contracted services.
Waste contractor	North West Alliance (NWA)	NWA operate under contract conditions with Quadrant. All arrangements defined in the OPEP nominating NWA reflect contracted services.

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** below.

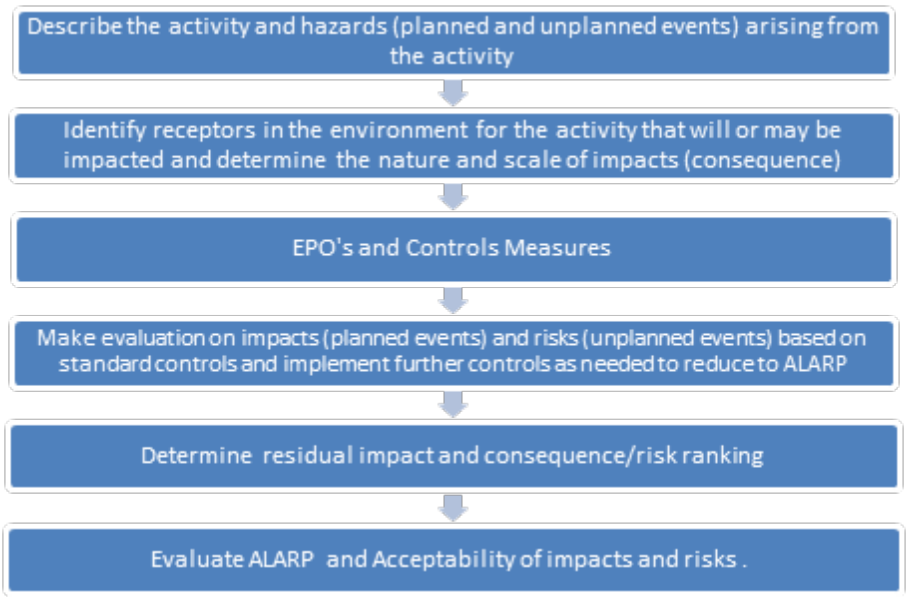

Figure 6-1: Environmental impact and risk assessment process

An assessment against the activity was undertaken and the environmental hazards or aspects were then identified. The risk assessment identified seven potential unplanned events and eight planned events.

The extent of actual or potential impacts from each planned or unplanned event is assessed using the description of the activity and known information on impacts (published industry reports and scientific studies) and in some circumstances, where required, predictive information such as modelling (e.g. hydrocarbon spills). Impact mechanisms and thresholds for impacts 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's Risk Matrix as shown in **Table 6-2** below.

Table 6-2: Likelihood description

No.	Matrix	Description
5	Probable	1. Event has occurred frequently within the Company. 2. Between 1 and 10 incidents every 10 years (i.e. up to frequency 1/year).
4	Likely	1. Event has occurred frequently within the Industry. 2. Between 1 and 10 incidents every 100 years (i.e. up to frequency 10^{-1}/year).
3	Unlikely	1. Event has occurred occasionally within the Company. 2. Between 1 and 10 incidents every 1000 years (i.e. up to frequency 10^{-2}/year).
2	Very Unlikely	1. Has occasionally occurred within the Industry. 2. Between 1 and 10 incidents every 10,000 years (i.e. up to frequency 10^{-3}/ year).
1	Rare	1. Could happen under exceptional circumstances only. 2. Between 1 and 10 incidents every 100,000 years (i.e. up to frequency 10^{-4}/ year).

Risk rankings (consequence x likelihood) are assigned in accordance with Quadrant Energy's Risk Matrix as shown below.

		SEVERITY				
		1. Negligible	2. Minor	3. Moderate	4. Major	5. Critical
LIKELIHOOD	5. Probable					
	4. Likely					
	3. Unlikely					
	2. Very Unlikely					
	1. Rare					

High Risk - reduction of risk required

Medium Risk - reduction of risk required based on ALARP principle

Low Risk - deemed acceptable based on standard risk controls in place

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 impact (consequence level) or risk to ALARP. This process relies on demonstrating that further potential control measures would require a disproportionate level of cost/effort in order to reduce the level of impact or risk. If this cannot be demonstrated then further controls are adopted. The level of detail included within the ALARP assessment is based upon the nature and scale of the potential impact or risk.

6.2 Acceptability Evaluation

Quadrant considers an impact or risk associated with the proposed activity to be acceptable if the following criteria are met:

- The 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;
- An assessment has been completed to determine if further information/studies are required to support or validate the consequence assessment;
- Performance standards are consistent with legal and regulatory requirements;
- Performance standards are consistent with Quadrant Environmental Management Policy;
- Performance standards are consistent with industry standards and best practice guidance (e.g. National Biofouling Guidance for the Petroleum Industry);
- Performance standards are consistent with stakeholder expectations, and
- Performance standards have been demonstrated to reduce the impact or risk to ALARP

6.3 Environmental Risk Treatment Summary for Planned Events

6.3.1 Interaction with other marine users

Event: Interactions with Other Marine Users	Interactions with other users of the sea through undertaking the activity. The MODU and support vessels will be continually operating 24-hours a day, seven days a week for the duration of the activity. The presence of MODU and support vessels in the operational area could potentially inhibit marine user groups, commercial shipping, fishing and other oil and gas activities and their presence could pose a collision risk and inconvenience to fishing practices for the duration of the activity.
Potential Receptors	Marine user groups, commercial fishers, tourism, shipping traffic and other oil and gas activities
Potential Impacts	Three Commonwealth fisheries and nine state fisheries have zones that overlap the operational area. Potential impacts to commercial fisheries are a temporary loss of access to fishing grounds when the MODU and support vessels are in the operational area, which could potentially result in reduced catches and income. An analysis of the current fishery closures, depth range of activity, historical fishing effort data, fishing methods and consultation feedback (refer to **Section 5**) has revealed that there is a low potential for interaction with commercial fisheries. None of the Commonwealth fisheries identified in **Section 4.3.3** are likely to be active in the operational area during the proposed East Spar plug and abandonment activities. For state-managed fisheries, the Pilbara Trap Managed Fishery and the Pilbara Line Fishery of the Pilbara Demersal Scalefish Fishery may access the operational area. The Pilbara Trap Managed Fishery is seaward of the 50 m isobath and landward of the 200 m isobaths; there are six licenses with the allocation consolidated onto three

	vessels (DoF, 2012). The Pilbara Line Fishery licensees are permitted to operate anywhere in Pilbara waters over a restricted season; there are nine licences in this fishery. Tourism activities are not expected to occur in the operational area given the water depths and distance from shore. As such, impact to tourism is not expected. There are no recognised shipping routes in or near the operational area with the nearest designated shipping routes located approximately 75 km northwest and 65 km east. However, analysis of historical AUSREP shipping data indicates that commercial vessels do use the general area, most likely vessels in the oil and gas industry. Should commercial vessels need to deviate from planned routes to avoid the MODU and support vessels, this may slightly increase transit times and fuel consumption. As the operational area is in open waters with no grounding or navigational hazards, it is not likely that any such deviation would increase the potential for vessel collision or grounding.
Impact Assessment	
Receptors	**Consequence**
Socio-economic Receptors	A review of shipping data received in consultation notes a well trafficked shipping route for vessels transiting between North West Cape and the Montebello Islands which primarily consists of cargo and offshore support vessels. Vessels could be expected to divert around the operational area but this would be a temporary exclusion given the duration of the activity. Tourism activity in the area is expected to be low given the distance to the mainland. There may be some commercial fishing activities occurring in the area. Marine users currently plan their activities in consideration of other petroleum activities and other marine users (fisheries and shipping) in the region. There are no recorded seabed aboriginal sites in the waters of the Montebello and Barrow Island marine reserves (DEC, 2007). Subsistence fishing and traditional hunting may occur in waters close to shorelines and is not expected within the operational area.
Overall Consequence Ranking	A – Negligible
Management Control	**Effectiveness of Control**
Maritime notices	Ensure other marine users are aware of the presence of the MODU and support vessels and are provided with information on timings of the activity including MODU arrival and departure, so that the maritime industry is aware of the petroleum activities (including how the site is left.
Quadrant Stakeholder Consultation	
Standby vessel	Support vessel equipped with Automatic Identification System (AIS) to aid in its detection at sea, and radar to aid in the detection of approaching third party vessels. Reduces risk of environmental impact from vessel collisions.
MODU identification system	MODU has a RACON (radar transponder) or AIS to aid in its detection at sea. Reduces risk of environmental impact from vessel collisions.

6.3.2 Seabed disturbance

Event: Seabed Disturbance	Disturbance to the seabed and associated benthic habitats will result from the positioning of the MODU (spudding of MODU legs) at each well location. During the activity, the MODU will not require anchoring and there will be no anchoring or mooring of support vessels within the operational area.

	During the activity, additional potential seabed disturbance may also occur in the operational area due to dropped objects (e.g. riser, tote tanks, etc.). For solid objects that may be accidentally dropped overboard and are heavy enough to sink through the water column and subsequently land on the seabed, see unplanned events section. For other potential risks associated with dropped objects, for instance damage to subsea infrastructure, with potential for release of hydrocarbons, refer to unplanned events section.
Potential Receptors	Benthic habitats
Potential Impacts	Positioning of the MODU spud cans (legs) may result in the following impacts: • Direct physical disturbance of approximately 750 m^2 area per well of benthic and seabed habitat; • Indirect disturbance to benthic habitats and associated marine fauna by sedimentation; • Increased turbidity of the near-seabed water column. It is noted that Quadrant has previously disturbed the seabed in the vicinity of the proposed activity through the development of the field, and therefore the seabed has previously been impacted, and the activity was considered acceptable.
Impact Assessment	
Receptor	**Consequence**
Threatened / Migratory/ Local Fauna	No sensitive seabed features have been identified in any of the surveys conducted within the operational area or in similar water depths within the permit area. Disturbance to the seabed may have indirect impacts to protected fauna if the disturbance leads to a reduction on habitat quality or food availability. The areas of seabed that are expected to be impacted included soft sediments with little epifauna. These sediments are un-vegetated and densely bioturbated (mounds and burrows), epibenthic biota is sparse (<5% cover abundance) and includes invertebrates, such as anemones, urchins, anthozoans and glass sponges. Therefore significant loss of habitat is not expected. Marine invertebrates may inhabit soft sediments and can contribute to the diet of some fauna. The area of soft sediment habitat that is potentially impacted is small compared to the amount of habitat available and therefore the disturbance is not expected to affect prey availability, and therefore protected fauna species, significantly. Habitat modification is identified as a potential threat to a number of marine fauna species in relevant Recovery Plans and Conservation Advice. However the area potentially impacted has been previously disturbed and is small compared to the size of the areas used by these species for foraging and therefore no long-term impacts to these species is expected. No decrease in local population size, area of occupancy of species, loss or disruption of habitat critical or disruption to the breeding cycle of any of these protected matters is expected.
Physical Environment/ Habitat	The physical environment and habitat has been previously disturbed due to Quadrant's activities, and will be further impacted during the proposed activities. However, the area impacted is small compared to the wider environment and in the majority of cases the disturbed area is expected to recolonise. As such, long-term disturbance and negative impacts to the wider ecosystem are not expected.
Socio-economic Receptors	No stakeholder concerns have been raised regarding this aspect.
Overall Consequence Ranking	A – Negligible

Management Control	Effectiveness of Control
MODU move procedure	No accidental contact with the seabed and subsea infrastructure during the MODU move limiting seabed disturbance.
MODU/Vessel anchoring restrictions	No anchoring of vessels or MODU within operational area reduces seabed disturbance area as no anchor or anchor chain drag/placement.

6.3.3 Light emissions

Event: Light Emissions	During the activity, safety and navigational lighting on the vessels will generate light emissions that may potentially affect marine fauna behaviour. Spot lighting may also be used on an as-needed basis e.g., ROV deployment and retrieval. Lighting will typically consist of bright white (i.e., metal halide, halogen, fluorescent) lights. Minimum lighting is required for safety and navigational purposes on board the MODU and support vessels so it cannot be eliminated if the proposed activity is to proceed. Light will also be generated from flaring activities, if required. The amount of light produced is dependent on the flare flow rate.
Potential Receptors	Threatened / Migratory Fauna – Fish, marine turtles and seabirds
Potential Impacts	Continuous lighting in the same location for an extended period of time whilst the MODU and support vessels are on location at the well sites may result in alterations to normal marine fauna behaviour, as discussed below for each fauna group. The combination of colour, intensity, closeness, direction and persistence of a light source are key factors in determining the magnitude of environmental impact (EPA, 2010). Given the distance of the operational area and the closest turtle nesting site, e.g. 35 km and 60 km away from Barrow and Montebello Islands respectively, lights (and light glow) are not visible from the beaches or surrounding sea. <u>Fish</u> The response of fish to light emissions varies according to species and habitat. Experiments using light traps have found that some fish and zooplankton species are attracted to light sources (Meekan *et al*., 2001), with traps drawing catches from up to 90 m away (Milicich *et al*., 1992). Lindquist *et al*. (2005) concluded from a study that artificial lighting associated with offshore oil and gas activities resulted in an increased abundance of clupeids (herring and sardines) and engraulids (anchovies); these species are known to be highly photopositive. The artificial light serves to focus their marine plankton prey and consequently leads to enhanced foraging success. Overall, a short-term localised increase in fish activity as a result of MODU and support vessel lighting is expected to occur, however with negligible impacts to the local fish populations. <u>Marine turtles</u> Light pollution reaching turtle nesting beaches is widely considered detrimental owing to its ability to alter important nocturnal activities including choice of nesting sites and orientation/navigation to the sea by post-nesting females and hatchlings (Witherington and Martin, 2003). Light pollution is also highlighted in the new Recovery Plan for Marine Turtles in Australia as a factor requiring management for successful marine turtle nesting (Commonwealth of Australia, 2017). The most significant risk posed to marine turtles from artificial lighting is the potential disorientation of hatchlings following their emergence from nests, although breeding adult turtles can also be disoriented (Rich and Longcore, 2006 in EPA 2010). Once in the ocean, hatchlings are

	thought to remain close to the surface, orient by wave fronts and swim into deep offshore waters for several days to escape the more predator-filled shallow inshore waters. During this period, light spill from coastal port infrastructure and ships may 'entrap' hatchling swimming behaviour, reducing the success of their seaward dispersion and potentially increasing their exposure to predation via silhouetting (Salmon *et al*., 1992). It is possible that individual juvenile and adult flatback turtles may be encountered in the operational area, particularly due to overlap with the flatback internesting habitat buffer zone (60 km of Barrow Island). The potential impacts of light emissions to flatback turtles from the activity are expected to be restricted to localised attraction and temporary disorientation but with no long-term or residual impact due to the activity's short duration. The plug and abandonment activities will not overlap with peak flatback turtle hatching (January-February). In addition, as flatback internesting season peaks in December and January (**Table 4-5**), impacts generated by East Spar plug and abandonment activity on adult flatback turtles are expected to be minimal. The WA Environmental Protection Authority (EPA) conservatively estimates there is only a light influence on marine turtles if the light source is within 1.5 km of the nesting beach (EPA, 2010). Given the activity is located 35 km and 60 km away from Barrow and Montebello Islands, impacts to turtles from activity lighting is considered negligible. <u>Seabirds</u> 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). The light sources associated with the vessels may also provide enhanced capability for seabirds to forage at night. The MODU is only anticipated to be stationary for a maximum of approximately 15 days per well. Worst-case, the MODU and the support vessels will be stationary in the operational area for approximately 45 days, and so unlikely to attract large numbers of seabirds to one fixed location. <u>Other marine fauna</u> 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 thought to be unlikely.
Impact Assessment	
Receptors	**Consequence**
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. Sensitive receptors that may be impacted include fish at surface, marine turtles, marine mammals and seabirds. Given that the activity will be a once off, for a limited duration, and is located ~35 km from the nearest coastline (island), at these distances lighting is unlikely to be at a level that could impact nesting turtles. Given the operational area is located within the flatback turtle internesting habitat buffer zone (60 km from Barrow Island), individual adults may occur in the operational area although large numbers are not expected. Flatback hatchlings are not considered at risk of impact from light emissions from the activities as peak hatchling numbers occur in January-February which is outside the plug and abandonment activity schedule. Cetaceans, adult turtles and marine mammals are not known to be significantly attracted to light sources at sea and therefore disturbances to behaviour are unlikely to occur.

	Fish and birds have been shown to be attracted to artificial light sources, however, the short duration of the activity is unlikely to lead to large scale changes in species abundance or distribution. Impacts to transient fish and seabirds will therefore be limited to short-term behavioural effects with no decrease in local population size, area of occupancy of species or loss or disruption of habitat critical / disruption to the breeding cycle.
Overall Consequence Ranking	A – Negligible
Management Control	**Effectiveness of Control**
Navigation equipment and procedures	Reduces risk of environmental impact from vessel collisions due to ensuring safety requirements are fulfilled. Light emissions are considered as low as reasonably practicable whilst meeting navigational and safety requirements.

6.3.4 Noise emissions

Event: Noise Emissions	The operation of the MODU and support vessels will introduce a range of underwater noises into the surrounding water column that will propagate through the water and contribute to and/or exceed ambient noise levels in area. Helicopters will be used during the activity for crew change requirements and will generate noise. Noise emissions will also be generated by flaring (during bleed-off operations) and ROV activities.
Potential Receptors	Threatened / Migratory Fauna – Cetaceans, marine turtles and fish; Physical Environment/ Habitat; Socio-Economic Receptors
Potential Impacts	Reactions of cetaceans to circling aircraft (fixed wing or helicopter) are sometimes conspicuous if the aircraft is below an altitude of 300 m, uncommon at 460 m and generally undetectable at 600 m (NMFS, 2001). Baleen whales sometimes dive or turn away during over-flights, but sensitivity seems to vary depending on the activity of the animals. The effects on cetaceans seem transient, and occasional over-flights probably have no long-term consequences on cetaceans. Observations by Richardson and Malme (1993) indicate that, for bowhead whales, most individuals are unlikely to react significantly to occasional single-pass low-flying helicopters transporting personnel and equipment at altitudes above 150 m. Leatherwood *et al.* (1982) observed that minke whales responded to helicopters at an altitude of 230 m by changing course or slowly diving. Turtle hearing is most sensitive in the frequency range of 100 – 700 Hz (DoIR, 2007), which overlaps with the sound frequencies produced by vessels and helicopters. It is likely that turtles would be able to hear these activities at distance and would experience some disturbance. Studies indicate that marine turtles may begin to show behavioural responses to received sound levels of approximately 166 dB re 1 µPa and avoidance at around 175 dB re 1 µPa (McCauley *et al*., 2000). No recognised breeding or resting area for cetaceans, turtles or shark species are known to occur in the area potentially impacted by noise emissions, although a flatback turtle internesting habitat buffer zone (60 km of Barrow Island) and whale shark foraging BIA overlaps the operational area so individuals are expected to pass through the area. Noise interference from anthropogenic noise sources including industrial noise and shipping is identified as a potential threat to marine turtles in the Recovery Plan (Commonwealth of Australia, 2017) and the Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015a). Noise emitted by the MODU, support vessels and helicopters during the activity will be short in duration and

	is likely to be reduced to background levels within kilometres to tens of kilometres. As such, any potential related marine fauna behavioural impacts are expected to be temporary and short ranged and is not expected to lead to long-term changes in individual behaviour (e.g. migration) or lead to changes at the population level.
Impact Assessment	
Receptors	**Consequence**
Threatened / Migratory / Protected Fauna	Noise generated from the MODU, support vessels, helicopters and associated activities (i.e. ROV operations) may result in physiological or behavioural impacts to marine fauna, especially to cetacean species who use sound for navigation and communication. Sensitive receptors that may be impacted include fish at surface, marine turtles and mammals, and seabirds. Given that the activity will be for a limited duration, marine fauna potentially affected by acoustic noise are expected to exhibit avoidance behaviour to noise. Avoidance behaviour is likely to be localised within the area of the activity (due to small spatial extent of proposed activities) and temporary, i.e. for the duration of the activity only. Noise interference identified in the Recovery Plan for Marine Turtles in Australia (2003) and Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) is related to seismic or piling activities where the sound emitted is at levels that could cause injury or mortality for marine turtles or humpback whale. The proposed activity will not produce noise emissions at these levels. In the new Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017) noise interference to marine turtles is separated depending on whether the exposure is short (acute) or long-term (chronic), with activities such as pile driving, seismic activity and some forms of dredging generating acute noise, and sources of chronic noise identified as including shipping channels and the operation of some oil and gas infrastructure. The level of noise generated by this activity is acute, temporary and may result in behavioural impacts to marine turtles. Given the low level of noise expected from the MODU support vessels and helicopter activities, and the short duration of noise emissions, significant impacts to threatened or migratory species are not expected. Some behavioural response may be expected from the noise levels emitted, but not at levels that could cause mortality or injury to marine fauna, or cause a decrease in local population size / area of occupancy of species / loss or disruption of habitat critical or disruption to the breeding cycle.
Physical Environment/ Habitat	Likely habitats to be impacted from noise in the area are benthic habitats which have non-coral invertebrates (such as sea fans and gorgonians) which are not significantly impacted by noise emissions. No or negligible reduction in physical environment/ habitat area or function is expected.
Socio-economic Receptors	Noise levels are not expected to impact on socio-economic receptors due to their low activity level within the vicinity of the operational area. Impacts to fish may result in indirect impacts to fisheries in the area. However, given the short duration of the activity, the available area for commercial fishermen to catch and the area over which commercial species spawn, impacts to fisheries are considered negligible.
Overall Consequence Ranking	A – Negligible
Management Control	**Effectiveness of Control**
Procedure for interacting with marine fauna	Reduces risk of physical and behavioural impacts to marine fauna from support vessels and helicopters.

6.3.5 Atmospheric emissions

Event: Atmospheric Emissions	This aspect provides for the combustion of fuel and generation of atmospheric emissions while incinerating, operating engines and machinery, during the activity. The use of fuel to power the MODU and vessel engines, helicopters, generators, mobile and fixed plant and equipment, will result in emissions of 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). The MODU and support vessels may utilise ozone-depleting substances (ODS) in closed-system rechargeable refrigeration systems. When transferring dry bulk produced /used for well abandonment activities (e.g. barite, cement), tank venting is necessary to prevent tank over-pressure. The vent air from tank venting will contain minor quantities of product particles, which will suspend in the air or settle on the sea surface. Flaring will be required to de-pressurise any trapped gas or condensate returns. In the event that gas is unable to be flared it will be cold vented to the atmosphere. Indicative worst-case vented/flared gas volumes are ~40,000 sm^3 (~20,000 sm^3 per well). The indicative worst-case condensate volume to be flared is up to 20 m^3 (~10 m^3 per well).
Potential Receptors	Seabirds and humans
Potential Impacts	Hydrocarbon combustion may result in a temporary, localised reduction of air quality in the environment immediately surrounding the discharge point during the activity. Non-GHG emissions, such as NO_X and SO_X, and GHG emissions can lead to a reduction in local air quality which can impact humans and seabirds in the immediate vicinity and add to the national GHG loadings. As the activity will occur in offshore waters, the combustion of fuels in such a remote location will not impact on air quality in coastal towns, the nearest being Onslow (100 km to the south-southeast). The quantities of gaseous emissions are relatively small and will quickly dissipate into the surrounding atmosphere. Air emissions will be similar to other vessels operating in the region for both petroleum and non-petroleum activities. Maintenance of refrigeration systems containing ODS is on a routine, but infrequent basis, and with control measures implemented, the likelihood of an accidental ODS release of material volume is considered rare. Tank venting is a necessary safety control, and any dust emissions will be negligible and limited to the immediate vicinity of the MODU and support vessels.
Impact Assessment	
Receptors	**Consequence**
Threatened / Migratory / Local Fauna	Short-term behavioural impacts to seabirds could be expected if they overfly the location; they may avoid the area. No decrease in local population size / area of occupancy of species / loss or disruption of habitat critical / disruption to the breeding cycle / introduction of disease.
Socio-economic Receptors	As the activity occurs in offshore waters, the combustion of fuels in such remote locations will not impact on air quality in coastal towns. The quantities of gaseous emissions are relatively small and will under normal circumstances, quickly dissipate into the surrounding atmosphere. The highly dispersive nature of local winds (i.e. strong and consistent) is expected to reduce potentially harmful or 'noticeable' gaseous concentrations within a short distance from the MODU/vessels and therefore not impact on other marine users in the vicinity.
Overall Consequence Ranking	A – Negligible

Management Control	Effectiveness of Control
Bulk solid transfer procedure – tank venting during bulk product (powder) transfer	Nil. Health and safety requirement to prevent tank over-pressure.
Air pollution prevention certification	Reduces probability of potential impacts to air quality due to ODS emissions, high NOx, SOx emissions.
Ozone-depleting substance handling procedures	Reduces probability of potential impacts to air quality due to ODS emissions.
Bleed-off procedures	Reduces the risk of poor quality incineration of hydrocarbons entering the atmosphere.

6.3.6 Drilling and cement discharges

Event: Drilling and Cement Discharges	During the East Spar plug and abandonment activities, drilling discharges will be generated and discharged at the sea surface or subsea. Discharges may include kill weight fluid, old *in-situ* completion fluid, solid additives (e.g. barite), brine, cement, cementing chemicals, cement spacer, lost circulation materials, bleed-off operations chemicals, tracer dyes and the potential for residual hydrocarbons to be circulated out from the annulus. Explosive or chemical based tools may be deployed in the wells to carry out various operations such as tubing cutting or punching circulation holes in the tubing. Once detonated, the tools are retrieved to the MODU. Drilling fluid, in-situ completion fluid and residual hydrocarbons Kill weight fluid circulated in the annulus to remove any residual hydrocarbons will be returned to the MODU. Returns will include completion fluid currently *in-situ* in the annulus. Any hydrocarbons returned to the MODU will be either vented or flared (refer to **Section 6.3.5**). Oily water and completion fluid will be filtered and discharged overboard from the MODU if the oil-in-water concentration is <30 ppm prior to discharging. Kill weight fluid in excess to demand will also be discharged to sea. Cementing Cement is used during well plug and abandonment activities to install deep set cement plugs to act as permanent barriers in the well bore. The majority of cement remains downhole but minor volumes may be discharged to the environment, including: • After setting the cement plugs, the work string, cement unit and surface lines are flushed with either seawater or kill weight fluid to prevent curing inside the cement unit and pipework after each cement job is completed; • Cement and/or cement additives mixed for use not subsequently required during unplanned interruptions (e.g. emergency shutdown) or equipment malfunction requires recirculation to the surface/cleaning of pumping system and tanks with disposal overboard to prevent system blockages. Cementing fluids generally consist of Portland cement and additives such as spacer pills, inorganic salts, lignins, bentonite, barite, defoamers and surfactants.

	Bleed-off Operations Methanol and monoethylene glycol (MEG) will be used during bleed-off operations. These chemicals may be discharged to sea during the activity. Lost Circulation Materials Lost-circulation material (LCM) will be pumped downhole at times. These materials may be lost to the geological formation, remain downhole, or be discharged from the MODU. Dyes Tracer dyes may also be used during cementing operations and for equipment leak detection. Bulks Quadrant intends to keep unmixed bulk cement, brine and bulk solid additives (e.g. barite) on-board the MODU at the end of the program, unless this is the final well in Quadrant's rig schedule, then these substances will be disposed of in accordance with the Quadrant's decision-making framework for management of left-over bulk products.
Potential Receptors	Fish (pelagic) and sharks, marine mammals and marine turtles.
Potential Impacts	Drilling and cement-related discharges will be intermittent during the activity, with volumes dependent on a range of variables. Their discharge to the marine environment will result in a localised reduction in water quality. This would be expected to be temporary (minutes to hours) and localised around the discharge point. The discharges are expected to be dispersed and diluted rapidly, with concentrations significantly dropping with distance from the discharge point. Changes to ambient water quality outside of the operational area are considered unlikely to occur. Explosive based tools utilised downhole are not considered to result in impacts due to the noise produced given the depth of discharge occurring well below the seabed. The use of drilling fluids, cement, cementing chemicals, bleed-off operations chemicals, solid additives, and the generation of drilling and cementing-related discharges is an unavoidable part of the permanent plug and abandonment activities. Water quality impacts will be highly localised and largely concentrated immediately around the MODU. The operational area is not located close to any shoreline habitat; the nearest land is Barrow Island located approximately 35 km away. No sensitive seabed features have been identified in any of the surveys conducted at similar water depths within the permit area. As such, the potential impacts from drilling and cementing-related discharges to marine fauna and seabed habitat is predicted to be negligible. The application of Quadrant's chemical selection procedure for drilling and cementing chemicals is an important control measure for reducing the toxicity of drilling and cementing discharges to the marine environment. In accordance with the procedure, CHARM-rated Gold/Silver and non-CHARM grouped E/D chemicals managed under the OCNS, or PLONOR substances listed by OSPAR, or chemicals risk assessed by Quadrant and deemed environmentally-acceptable, will be selected for the plug and abandonment program. With Quadrant's proposed control measures in place, an acceptable level of environmental impact is achieved.
Impact Assessment	
Receptors	**Consequence**
Threatened / Migratory / Local Fauna	No sensitive seabed features have been identified in any of the surveys conducted within the operational area or in similar water depths within the permit area. In addition, the area has previously been disturbed during the development of the field, through installation of infrastructure, and drilling of wells.

	Disturbance to the seabed may have indirect impacts to protected fauna if the disturbance leads to a reduction on habitat quality or food availability. The areas of seabed that are expected to be impacted included soft sediments with little epifauna. These sediments are un-vegetated and densely bioturbated (mounds and burrows), epibenthic biota is sparse (<5% cover abundance) and includes invertebrates, such as anemones, urchins, anthozoans and glass sponges. Therefore loss of habitat is not expected. The area of soft sediment habitat that is potentially impacted is small compared to the amount of habitat available and therefore the disturbance is not expected to affect prey availability, and therefore protected fauna species, significantly. 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. 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. Toxic impacts from the oil content in completions fluids is expected to be very localised following treatment by filtration to less than 30 ppm. Any toxic effects that might potentially occur 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. Given the very short duration of the activity and the duration of oily water discharges, the depth of waters and the high degree of dispersal and dilution, seabed loadings of contaminants are not predicted to reach levels of concern. Habitat modification is identified as a potential threat to a number of marine fauna species in relevant Recovery Plans and Conservation Advice. However the area potentially impacted is small compared to the size of the areas used by these species for foraging and therefore no long-term impacts to these species is expected. No decrease in local population size, area of occupancy of species, loss or disruption of habitat critical or disruption to the breeding cycle of any of these protected matters is expected.
Physical Environment/ Habitat	The physical environment and habitat could be disturbed during the proposed activities. However, the area potentially impacted is small compared to the wider environment and in the majority of cases the disturbed area is expected to recolonise. As such, long-term disturbance and negative impacts to the wider ecosystem are not expected. Discharges at the sea surface will lead to an increase in turbidity in the immediate vicinity of the discharge, resulting in potential smothering of fauna in the area. However, the effects will be short term during the discharge period. Discharges at the sea surface are not expected to have a significant impact as the discharge is quickly dissipated in the surrounding water due to the currents and wave action. Discharge of cement at the sea surface has not demonstrated significant harm to water column flora and fauna (Neff, 2005). No or negligible reduction in physical environment/ habitat area or function is expected.
Overall Consequence Ranking	A – Negligible

Management Control	Effectiveness of Control
Chemical selection procedure for drilling and cementing chemicals	Aids in the process of chemical management that reduces the impact of drilling discharges to sea. Only environmentally acceptable chemicals are used.
Inventory control procedure	Restricts the type and volume of drilling discharges, and includes a decision-making framework for managing left-over bulk products.

6.3.7 Planned discharges

Event: Planned Discharges	In order to operate the MODU and support vessels, a number of planned routine discharges to the marine environment will be required as outlined below. <u>Sewage, grey water and food waste</u> The volume of sewage, grey water and food waste is directly proportional to the number of persons on-board the MODU and support vessels. Up to 30-40 L of sewage/greywater will be generated per person per day. Treated sewage will be disposed in accordance with MARPOL Annex IV. Putrescible waste will consist of approximately 1 L of food waste per person per day. The MODU and support vessels will discharge food waste in accordance with MARPOL requirements. <u>Desalination plant effluent (brine) and backwash water discharge</u> Effluents from the water supply systems on-board the MODU and support vessels will be discharged to the ocean at a salinity of approximately 10% higher than seawater. The volume of the discharge is dependent on the requirement for fresh (or potable) water and would vary between the MODU/vessels and the number of people on-board. The effluent may contain scale inhibitors such as Alpacon that controls inorganic scale formation, such as the formation of calcium carbonate and magnesium hydroxide, in water-making plants. Other water purification chemicals such as chlorine may also be added to the potable water. Other water-making plant cleaning chemicals such as Ameroyal or Saf Acid may be used and discharged to sea after completion of the cleaning process. <u>Cooling water</u> Seawater is used as a heat exchange medium for the cooling of machinery engines. Seawater is drawn from the ocean and flows counter-current through closed-circuit heat exchangers, transferring heat from the vessel engines and machinery to the seawater. The seawater is then discharged to the ocean (i.e. it is a once-through system). Cooling water temperatures vary dependent upon the vessels engines work load and activity. <u>Deck drainage</u> Deck drainage from rainfall or wash-down operations would discharge to the marine environment. The deck drainage would contain particulate matter and residual chemicals such as cleaning chemicals, oil and grease. Assessment of the spillage of hydrocarbons and other environmentally hazardous chemicals and liquid waste are discussed in the unplanned events section. <u>Oily water (i.e. bilge water) discharges</u> While in the operational area, the MODU and support vessels may discharge oily water after treatment to 15 ppm in a MARPOL approved oily water filter system.

	Hydraulic fluids and chemicals Small amounts of hydraulic fluids, corrosion inhibitor, anti-scale and biocides are likely to enter the subsea marine environment during the planned activities. During function testing of valves on the trees and the use of ROVs, small volumes of hydraulic fluid (typically the water-based hydraulic fluid Transaqua HT2) will be released (approximately 10 L). The removal of corrosion, external coating or marine growth from the subsea wellhead/trees will be carried out using ROVs to facilitate well re-entry. The cleaning process releases inert materials and marine growth into the marine environment which will either fall to the seabed floor or is dispersed with the prevailing currents. An acid wash chemical (such as citric acid, calcium wash or sulfamic acid) may be discharged to the marine environment during the calcareous marine growth removal if water jetting is not sufficient. Discharges downhole Refer to **Section 6.3.6** for drilling and cementing discharges.
Potential Receptors	Fish (pelagic) & sharks, marine mammals, marine turtles and seabirds
Potential Impacts	Planned non-hazardous discharges will be small and continuous, with volumes dependent on a range of variables. The discharge of non-hazardous wastes to the marine environment may result in a localised reduction in water quality. This would be expected to be temporary (minutes to hours), localised and limited to surface waters (<5 m), with the exception of hydraulic fluids and acid wash chemicals associated with function testing of valves on the trees and marine growth removal which will be discharged several metres above the seabed. The discharges are expected to be dispersed and diluted rapidly, with concentrations of wastes significantly dropping with distance from the discharge point. Changes to ambient water quality outside of the operational area are considered unlikely to occur. Deteriorating water quality is identified as a potential threat to turtles in the Marine Turtle Recovery Plan (Commonwealth of Australia, 2017), and some bird and shark species. However, the operational discharges are not expected to significantly impact the receiving environment with control measures proposed and therefore the activity will be conducted in a manner that is considered acceptable and in a manner consistent with identified Recovery Plans and conservation advice.
Impact assessment	
Receptors	**Consequence**
Threatened / Migratory / Local Fauna **Physical Environment/ Habitat** **Socio-economic Receptors**	Operational discharges in the same location for an extended period of time may result in significant water quality perturbations and alteration to marine fauna behaviour. Sensitive receptors that may be impacted include fish at surface, marine turtles and mammals, and seabirds. Discharges several metres above the seabed (hydraulic fluids and acid wash chemicals) associated with function testing of valves on the trees and marine growth removal, will be rapidly diluted by prevailing currents. Any effects on water quality are expected to have a negligible effect on sparse seabed biota that may be present. Given that the activity will be for a limited duration, and is located 35 km from the nearest shoreline, impacts will be limited to short-term water quality impacts and temporary behavioural effects observed in fish and seabirds. Impacts to water quality will be experienced in the discharge mixing zone which will be localised and will occur only as long as the discharges occur (i.e. no sustained impacts), therefore recovery will be measured in hours to days. Therefore only short-term behavioural impacts are expected with no decrease in local population size / area of occupancy of species / loss or disruption of habitat critical / disruption to the breeding cycle / introduction of disease. No physical environments and/or habitats identified in the area over which operational discharges are expected to disperse other than open water.

Overall Consequence Ranking	A - Negligible
Management Control	**Effectiveness of Control**
Waste (garbage) management procedure	Reduces probability of garbage being discharged to sea, reducing potential impacts to marine fauna. Stipulates putrescible waste disposal conditions and limitations. Ensure compliance with MARPOL requirements.
Deck cleaning product selection procedure	Improves water quality discharge (reduce toxicity) to the marine environment. Only environmentally acceptable chemicals would be released overboard.
Sewage treatment system	Reduces potential impacts of inappropriate discharge of sewage. Ensures compliance with MARPOL requirements.
Oily water treatment system	Reduces potential impacts of planned discharge of oily water to the environment. Ensures compliance with MARPOL requirements.
Chemical selection procedure for drilling and completions chemicals (chemical used for cleaning subsea trees)	Reduces potential impacts of chemicals used for cleaning subsea trees to the environment.

6.3.8 Spill response operations

Event: Spill Response Operations	In the event of a hydrocarbon spill, response strategies will be implemented where possible to reduce environmental impacts to ALARP. The selection of strategies will be undertaken through the Net Environmental Benefit Analysis (NEBA) process, outlined in the OPEP. Spill response will be under the direction of the relevant Controlling Agency, which may be Quadrant and/or another agency. In all instances, Quadrant will undertake a 'first-strike' spill response and will act as the Controlling Agency until the designated Controlling Agency assumes control. The response strategies deemed appropriate for the worst-case oil spill scenarios identified for the activity comprise: • Source control; • Operational monitoring; • Mechanical dispersion; • Shoreline protection; • Shoreline clean-up; • Oiled wildlife response; • Scientific monitoring; and • Waste management. Given spill response operations will be within offshore waters using vessels and aircraft, the type of impacts are consistent with vessel and aircraft operations described within the EP for the routine operations. The greatest potential for impacts additional to those described for routine operations is from shoreline clean-up and oiled wildlife response operations where coastal and shoreline habitat damage and fauna disturbance may occur.
Potential Receptors	Threatened / Migratory / Local Fauna - Fish, marine mammals, marine turtles and seabirds. Protected Areas. Socio-economic Receptors.
Potential Impacts	Light emissions

	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. Previous **Section 6.3.3** provides further detail on the nature of impacts to fish, birds and marine turtles. Spill response activities which require lighting may take place in protected areas important to turtles and birds, for example shoreline locations of Ningaloo Reef and Muiron Islands are seasonally important for turtles. As a consequence of impacts to fauna, lighting has the potential to impact supported industries such as tourism. <u>Noise emissions</u> 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 short term 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. **Section 6.3.4** provides further detail on these impacts from vessels. 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 Ningaloo World Heritage Area. 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 turtles. Shoreline activities involving the use of noise generating equipment may take place in important nesting areas for turtles and/or roosting/feeding areas for shorebirds. 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. <u>Atmospheric emissions</u> 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. <u>Operational discharges</u> 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 (i.e. receptors anywhere within the EMBA), which support a more diverse faunal community, however discharges will be very localised and temporary. Cleaning of oil contaminated equipment, vehicles and vessels, has the potential to spread oil from contaminated areas to those areas 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 of 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. Physical presence and disturbance The use of vessels may disturb benthic habitats in coastal waters including corals, seagrass, macroalgae and mangroves. Impacts to habitats from vessels include damage through the deployment of anchor/chain, nearshore booms and grounding. Vessel use in shallow coastal waters also increases the chance of contact or physical disturbance with marine megafauna such as turtles and dugongs. Booms create a physical barrier on the surface waters that has the potential to injure or entangle passing marine fauna that are either surface breathing or feeding. Vehicles, equipment and personnel used during shoreline response activities have the potential to damage coastal habitats such as dune vegetation, 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. The presence of camp areas, although relatively short-term may disrupt normal behaviour of coastal species such as shorebirds and turtles, and could potentially interfere with nesting and feeding behaviours. 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 life-cycle processes, hampering recovery and in the worst instance increasing levels of mortality. 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 may have a relatively undisturbed flora and fauna community. Disruption to other users of marine and coastal areas and townships The disturbance to marine and coastal natural habitat, as well as the potential for disruption to culturally sensitive areas, which may occur in specially protected areas, may have flow on impacts to socio-economic values and industry (e.g. tourism, fisheries). The use of vessels in the nearshore and offshore environment and the undertaking of spill response activities at shoreline locations may exclude general public and industry use of the affected environment. As well as impacting leisure activities of the general public this may impact on revenue with respect to industries such as tourism and commercial fishing. The mobilisation of personnel to small communities has the potential to affect the local community through demands on local accommodation and business, reducing the availability of services to members of the public.
Impact Assessment	
Receptors	**Consequence**

Threatened / Migratory / Local Fauna	Light emissions The receptors considered most sensitive to lighting from vessel and shoreline operations are seabirds/shorebirds and marine turtles, particularly over summer months with respect to marine turtles where emerging hatchlings are sensitive to light spill onto beaches. Following restrictions on night time operations by spill response vessels, which will demobilise to mooring areas offshore with safety lighting only, impacts from vessels are considered to be negligible. The positioning of temporary camps will be done at direction of DoT/ DBCA and following control measures on lighting colour and direction the consequence of shoreline lighting is considered negligible. These species are likely to be values of the protected area they occur in (e.g. Ningaloo Reef), and the impact to the protected area from light is also considered negligible. Noise emissions The receptor considered most sensitive to vessel noise disturbance are humpback whales during migration season. However, following the adoption of control measures to limit close interaction with cetaceans (i.e. EPBC Act Regulation 8), a temporary behavioural disturbance is expected only with a consequence of negligible. With respect to noise from onshore operations (mobile equipment and vehicles), nesting, roosting or feeding birds are considered to be the most sensitive to noise. The equipment used is not considered to have excessive sound levels and following direction by DoT and DBCA on the location of temporary camp areas, the consequence to birds from noise is expected to be negligible. Shorebirds may be official values of the protected area they occur in, and the impact to the protected area from noise is also considered negligible. Atmospheric emissions Atmospheric emissions from spill response equipment will be localised and impacts to even the most sensitive fauna, such as birds, are expected to be negligible. Because of the localised and low level of emissions impacts to protected area values are predicted to be negligible. Operational discharges Operational discharges from vessels may create a localised and temporary reduction in marine water quality, which has the potential to impact shallow coastal habitats in particular, however, following the adoption of regulatory requirements for vessel discharges, which prevent discharges close to shorelines, discharges will have a negligible impact to habitats, fauna or protected area values. Furthermore, washing of vessels and equipment will take place only in defined offshore hot zones preventing impacts to shallow coastal habitats. Onshore, the use of flushing water has the potential to damage sensitive shoreline and intertidal habitats, e.g. mangroves, however low pressure flushing only will be used, preventing further damage to habitats or erosion of sediments. For sensitive habitats the deployment of booms will be considered to retain flushed hydrocarbons, if this presents a net benefit. Following these control measures the use of flushing to clean shorelines and intertidal habitats is seen to have a negligible additional impact to habitats, fauna or protected area values. The cleaning of contaminated vehicles and equipment onshore has the potential to spread oily waste and damage habitats if not contained. Decontamination units will be used during the spill response thus containing waste and preventing any secondary contamination. The consequence of cleaning discharges is therefore ranked as negligible in terms of impacts to habitats, fauna or protected area values. Sewage, putrescible and municipal waste generated onshore will be stored disposed of at approved locations. There will be no discharges of this waste to the marine or coastal environment and the likelihood of an unplanned discharge is considered unlikely following the

	implementation of control measures. In the event that those control measures failed and secondary contamination or loss of municipal waste occurred the additional consequence to coastal habitat has been assessed as minor. The risk ranking for an Unlikely event with a minor consequence is low. Physical presence and disturbance The use of vessels and nearshore booms has the potential to disturb benthic habitats including sensitive habitats in coastal waters such as corals, seagrass, macroalgae and mangroves. A review of shoreline and shallow water habitats, and bathymetry, and the establishment of demarcated areas for access and anchoring (along with other control measures will reduce the level of impact to negligible. The use and movement of vehicles, equipment and personnel during shoreline response activities has the potential to disturb coastal habitats such as dune vegetation, samphire and mangroves, and important habitats of threatened and migratory fauna including nests of turtles and birds and bird roosting areas. Furthermore, clean-up can involve physical removal of substrates that could cause impact habitats, fauna and alter coastal hydrodynamics. As with vessel use, an assessment of appropriate vehicles and equipment to reduce habitat damage, along with the establishment of access routes/demarcation zones, and operational restrictions on equipment/vehicles use will limit sensitive habitat damage and damage to important fauna areas. The establishment of temporary camp areas will be done under direction of DoT and DBCA with suitable advice sought if access is needed to culturally significant areas. Following these and other control measures the resultant consequence to the physical environment and habitat is assessed as minor, indicating that there may be a detectable reduction in habitat area from response activities (as separate from spill impacts), but recovery will be relatively rapid once spill response activities cease. As with all spill response activities this disturbance will only occur if there is a net benefit to accessing and cleaning shoreline areas. The main direct disturbance to fauna would be the hazing, capture, handling, transportation, cleaning and release of wildlife susceptible to oiling impacts, such as birds and marine turtles. This would only be done if this intervention were to deliver a net benefit to the species, but may result in a minor consequence following compliance with the WA Oiled Wildlife Response Plan and the Pilbara Region Oiled Wildlife Response Plan. These habitats/environments are likely to be values of the protected area they occur in, and the impact to the protected area from physical disturbance is also considered minor. The mobilisation of vessels, vehicles and equipment into sensitive nearshore and coastal habitats brings the potential for non-indigenous and potentially invasive species, either attached as biofouling, in the case of vessels or as seeds/plant propagules or invasive fauna within equipment and vehicles. The release of such species is an unplanned event which is considered to have a likelihood of rare following vessel risk assessments and pre-cleaning and quarantine inspections of onshore equipment. Furthermore no international vessels are required for spill response activities reducing potential for invasive species introduction. The consequence of an outbreak of an invasive marine species is considered major in the nearshore/coastal environment, which is more conducive to establishment of invasive marine species than deeper offshore waters. Given the rare likelihood, the Risk Ranking is medium. Disruption to other users of marine and coastal areas and townships The use of vessels in the nearshore and offshore environment and spill response activities at shoreline locations, and within townships, may exclude general public and industry use. It should be noted that this is distinct from the socio-economic impact of a spill itself which would have a far greater detrimental impact to industry and recreation. Following the application of control measures it is considered that the additional impact of spill response activities on affected industries would be minor.

Overall Consequence Ranking	A – Negligible (Light, noise and atmospheric emissions; Operational discharges and wastes)
	B – Minor (Physical presence and disturbance; Disruption to other users of marine and coastal areas and townships)
Management Control	**Effectiveness of Control**
Competent IMT and Oil Spill Responder personnel	Ensures that spill response strategy selection and operational activities consider the potential for additional environmental impacts.
Use of competent vessel crew/personnel	Reduces potential for environmental impacts from vessel usage.
Spill response activities selected on basis of a Net Environmental Benefit Analysis (NEBA)	Provides a systematic and repeatable process for evaluating strategies with net least environmental impact.
Noise and atmospheric emissions	
Support vessel and aircraft compliance with EPBC Act Regulation 8 (cetacean interactions)	Reduces potential for behavioural disturbance to cetaceans.
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	
Vessels meet applicable MARPOL sewage disposal requirements	Reduces potential for water quality impacts.
Vessel meet applicable MARPOL requirements for oily water (bilge) discharges	Reduces potential for water quality impacts.
Ballast water management plan for international	Improve water quality discharge to marine environment to ALARP. Reduce risk of introduced marine species.

vessels	
Compliance with controlled waste, unauthorised discharge and landfill regulations	Ensures correct handling and disposal of oily wastes.
Physical presence and disturbance	
Support vessel and aircraft compliance with EPBC Act Regulation 8 (cetacean interactions)	Reduces potential for behavioural disturbance to cetaceans.
Vessel Risk Assessment Score sheet (VRASS) completed for interstate and international spill response vessels (only).	Reduces risk for introduction of invasive marine species as part of vessel biofouling.
Use of shallow draft vessels for shoreline and nearshore operations	Reduces seabed and shoreline disturbance.
Oil Spill Response Team (OSRT) Team Leader assessment/ selection of vehicle appropriate to shoreline conditions	Reduces coastal habitat and fauna disturbance.
Conduct shoreline/ nearshore habitat/bathymetry assessment	Reduces shoreline habitat disturbance.
Establish demarcation zones for vehicle and personnel movement considering sensitive vegetation, bird nesting/roosting areas and turtle nesting habitat	Reduces coastal habitat and fauna disturbance.
Operational restriction of vehicle and personnel	Reduces coastal habitat erosion and compactions.

movement to limit erosion and compaction	
Prioritise use of existing roads and tracts	Reduces coastal habitat and fauna disturbance.
Selection of temporary base camps in consultation with DoT and DBCA	Reduces coastal habitat and fauna disturbance.
Soil profile assessment prior to earthworks	Reduces habitat disruption and erosion.
Pre-cleaning and inspection of equipment (quarantine)	Prevents introduction of invasive species.
Use of Heritage Advisor if spill response activities overlap with potential areas of cultural significance	Reduces disturbance to culturally significant sites.
Adhere to WA Oiled Wildlife Response Plan and Pilbara Regional Oiled Wildlife Response Plan	Oiled wildlife hazing, capture, handling and rehabilitation meet minimum standards as outlined within the WA Oiled Wildlife Response Plan.
Disruption to other users of marine and coastal area and townships	
Stakeholder consultation	Early awareness of spill response activities which reduces potential disruption.
Utility resource assessment and support to be conducted if 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	Reduces potential for security treat causing disruptions in the response activities.
Transport Management Plan	Reduces potential for traffic disruptions.

6.4 Environmental Risk Treatment Summary – Unplanned Events

Quadrant's environmental risk identification procedure identified seven potential sources of environmental impacts associated with the unplanned events.

6.4.1 Hydrocarbon spill from a loss of well control

Event: Hydrocarbon spill from a loss of well control	During plug and abandonment activities, a loss of well control may result in the release of gas-condensate to the marine environment, with the release points at either the MODU floor or seabed. A loss of well control may occur due to a number of reasons, including: • Well barrier failure; • Wellhead damage due to dropped object impact; • Riser damage from vessel collision; and • Downhole explosive-based tools damaging riser or punching through the landing string. The likelihood of explosive-based tools damaging the riser or landing string is considered rare since the East Spar wells will be killed prior to the deployment of these downhole tools, if required, and they are also normally pressured at this point. Accidental dropped objects could occur from operations including lifting/moving of objects and equipment needed to complete plug and abandonment activities. Equipment and other items lost at sea could be caused by crane failure, adverse weather, human error, rigging failure, unsecured equipment on deck and vessel motions. An accidental release of production hydrocarbons could potentially occur from the East Spar Pipeline. The pipelines in the operational area are suspended and therefore if a dropped object on the subsea pipeline resulted in a loss of pipeline integrity, a worst case release of the entire pipeline contents (production fluids i.e. condensate) could occur. However, the conservative release volume is assumed to be <161 m^3 of condensate (full pipeline inventory). Given this volume is significantly less than that considered for a loss of well control scenario, this section describes the potential impacts from a loss of well control scenario only; the potential impacts from a loss of pipeline integrity are well within the EMBA described for this activity. Further detail on the loss of pipeline integrity is described in the NOPSEMA accepted Varanus Island Hub Operations Environment Plan for Commonwealth Waters (John Brookes, Greater East Spar and associated Facilities) EA-66-RI-10003. The worst-case credible spill was predicted by selecting the most optimistic hydrocarbon flow parameters from the East Spar-3 and East Spar-6 wells to yield the credible maximum blowout volumes and rates (i.e. environmentally credible worst-case volume and rate) from both subsurface (seabed) and surface (MODU floor) unplanned releases. Key parameters for input to this 'worst-case' blowout were classified as either well design specific or subsurface specific and are summarised in Quadrant's Blowout Modelling Technical File Note Rev 1 (Quadrant, 2017). All parameters were taken from key Quadrant well design documents, suitable analogues, WDAS, latest reservoir models, or Quadrant best estimates where information was unavailable. The Technical File Note (Quadrant, 2017) was developed by reservoir engineers to define the single, composite worst-case blowout from the East Spar-3 and East Spar-6 well. Quadrant analysis determined that a blowout from the East Spar-6 well would generate the largest blowout, primarily due to the larger liner and casing, allowing for increased flow rates (Quadrant, 2017). In the loss of well control scenario, moderate quantities of gas-condensate may be released to the marine environment until well control can be re-established. Re-establishment of well control can take up to 11 weeks while drilling a relief well.
Potential Receptors	Marine fauna - Fish, sharks, marine mammals, marine reptiles and seabirds; Protected areas; Physical environment and habitats;

	Socio-economic receptors.
Potential Impacts	Hydrocarbon spills will cause a decline in water quality and can cause chemical (e.g. toxic) and physical (e.g. coating of emergent habitats, oiling of wildlife at sea surface) impacts to marine species (refer **Table 6-3**). The severity of the impact of a hydrocarbon spill depends on the magnitude of the hydrocarbon spill (i.e. extent, duration) and sensitivity of the receptor. The magnitude of potential environmental impact from a condensate release (which behaves in a similar manner in the marine environment to MGO) is dependent on multiple factors including hydrocarbon type, release volume and rate, and ocean and weather conditions. <u>Surface oil</u> Smothering of marine flora, fauna and habitats or ingestion of surface oil by marine fauna. The degree to which impacts could occur will depend upon the level of coating (concentration of oil and/or loading of oil on shorelines) and how fresh or weathered the oil is. Physical shoreline habitats have the potential to be smothered by stranded oil. Persistent weathered hydrocarbons and shoreline fauna can be exposed to toxic effects from ingestion. There are no thresholds identified at which smothering or volume ashore will result in an impact, however those shorelines with the highest loadings, and those identified as significant threatened or migratory fauna habitat are the most susceptible to impact. Surface oil occurring in coastal waters (of 1 g/m^2) and accumulating on shorelines may also reduce the visual amenity of an area diminishing the natural, historic and indigenous heritage values of a place. <u>Total WAF</u> Total oil in the water column has the potential to coat benthic and susceptible shoreline habitats and organisms. The phenomena of 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. Owing to the predicted high volatility and lack of persistent compounds associated with the East Spar condensate, it is not expected to be a sticky hydrocarbon and hence the potential for physical coasting of marine fauna and benthic habitats is relatively low. <u>Dissolved WAF</u> 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 are 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. <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; 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). Socio-economic receptors will be affected by hydrocarbon exposure in three key ways: 1. Loss of income (e.g. reduction in catch for commercial fisheries). 2. Restriction of access. 3. Reduction in aesthetic value.
Impact Assessment	
Receptors	**Consequence**
Threatened / Migratory / Local Fauna; **Protected Areas;** **Physical Environment and Habitats;** **Socio-Economic Receptors**	In the event of a loss of well control there is a moderate geographical area that has the potential to be exposed to hydrocarbon impacts. Physical Environment and Habitats In the event of a loss of well control, hydrocarbons reaching nearshore environments have the potential for effects on benthic coral reefs and mangrove areas which may result in a moderate-term decrease in ecological values given toxicity impacts associated with hydrocarbon exposure. Threatened / Migratory / Local Fauna Deteriorating water quality is identified as a potential threat to turtles in the marine turtle recovery plan, and some bird and shark species. Habitat modification/degradation/disruption, pollution and/or loss of habitat are also identified as threats to sharks, birds, cetaceans and turtles in conservation management and recovery plans. However, the potential hydrocarbon releases as a result of a loss of well control are not expected to significantly impact the receiving environment given the nature of the condensate and with control measures proposed. Additionally, long-term impacts resulting in complete habitat loss or degradation are not considered likely given the low volumes of shoreline loading and with control measures proposed to prevent releases. Given the location of the source, and moderate volume of potential hydrocarbon loss, it is expected that a loss of well control has the potential to result in an insignificant disruption to the breeding cycle for marine mammals, but has the potential to modify, or decrease the availability of quality habitat (shorelines/subsurface). Due to the low shoreline loadings (per unit area) there is unlikely to be any long-term decline in local populations of seabirds and/or turtles; or any long-term decrease in local population size of marine fishes or sharks. Protected Areas Many of these receptors are values of protected areas and there could be moderate-term effects to them.

	Socio-Economic Receptors The socio-economic and heritage features in the region are of high value. Recreational fishing hotspots, including the Montebello Islands, Barrow Island and the Muiron Islands, are of high value to recreational fishers. The potentially affected area is of high value for tourism and social amenities including camping locations and other beachside recreational activities. Some loss of value could occur to the local industry in the event of a loss of well control and a short-term reduction of key natural features or populations supporting the local activity. Heritage values are not predicted to be impacted by floating hydrocarbons although in the short-term there would be an impact on the aesthetic value of the area. Pearling leases have been identified in the region, these are currently inactive and no stakeholder concerns have been raised. However, if these leases were to become active within the life of the EP, then some loss of value of the local industry could occur in the event of a loss of well control. On the basis of the assessments above, a loss of well control has the potential to impact an array of receptors. Given the moderate extent, the worst-case consequence is considered to be **moderate**.		
Likelihood	The likelihood of a loss of well control event occurring during the activity is extremely low when considering industry statistics, Quadrant statistics and the preventative control measures in place. Wells are designed with essential engineering and safety control measures to prevent a loss of containment occurring. Additional industry standard and activity-specific control measures to reduce the chance of a loss of containment event have also implemented including (but not limited to) procedures such as the WOMP, Safety Case, crew training and awareness and a spill response plan (OPEP). These control measures are considered to reduce the risk of a loss of containment (and minimise impacts) occurring to a level that is acceptable. The likelihood of a loss of well control releasing hydrocarbons to the environment which results in a Moderate consequence is considered to be **rare**.		
Likelihood Ranking	1- Rare	**Consequence ranking**	C - Moderate
Residual Risk	Medium		
Management Control	**Effectiveness of Control**		
Well operations management system - Well operations management plan (WOMP), and MODU Safety Case	Includes control measures for well integrity and well control, and MODU Safety Case that reduce the risk of unplanned discharges to the marine environment.		
Bleed-off procedure	Includes control measures for bleed-off operations that reduce the risk of unplanned release of hydrocarbons.		
MODU identification system	MODU has a RACON (radar transponder) or AIS to aid in its detection at sea. Reduces risk of environmental impact from vessel collisions. Ensures safety requirements are fulfilled.		
Maritime notices	Ensures other marine users are aware of the presence of the MODU and support vessels and are provided with information on timings of the activity including MODU arrival and departure, so that the maritime industry is aware of the petroleum activities (including how the site is left).		

Standby vessel	Standby vessel equipped with AIS to aid in its detection at sea, and radar to aid in the detection of approaching third party vessels. Reduces risk of environmental impact from vessel collisions. Ensures safety requirements are fulfilled.
Oil pollution emergency plan (OPEP)	Implements response plans to deal with an unplanned hydrocarbon release quickly and efficiently in order to reduce impacts to the marine environment.
MODU and support vessel spill response plans	

Table 6-3: Impacts of East Spar condensate on sensitive receptors found within the EMBA

Receptor	Impacts of East Spar condensate from a loss of well control	
	Total WAF and dissolved WAF in the water column	**Surface hydrocarbons**
Marine fauna		
Plankton (including zooplankton; fish and coral larvae)	There is potential for localised mortality of plankton due to reduced water quality and toxicity. Effects will be greatest in the upper 10 m of the water column and areas close to the spill source where hydrocarbon concentrations are likely to be highest.	Surface condensate will have a negligible impact on plankton.
	The operational area has the potential to overlap with spawning of some fish species given the year round spawning of some species. In the unlikely event of a spill occurring, fish larvae may be impacted by hydrocarbons entrained in the water column with effects greatest in the upper 10 m of the water column and closest to the spill source. However, following release, the condensate will rapidly evaporate, disperse and degrade in the offshore environment, reducing the concentration and toxicity of the spill. Given duration of fish spawning periods, lack of suitable habitat for aggregating fish populations near the surface, combined with the quick evaporation and dispersion of condensate, impacts to overall fish populations are not expected to be significant.	
Marine mammals	Lethal or sub-lethal physical and toxic effects such as irritation of eyes/mouth and potential illness. It is commonly thought that condensate does not cause problems for wildlife due to the lack of visible oiling however may be toxic (WAOWRP, 2014).	At risk of direct contact with condensate due to chance of surfacing within slick. Effects include irritation of eyes/mouth and potential illness. Surface respiration could lead to accidental ingestion of hydrocarbons or result in the coating of sensitive epidermal surfaces.
	Eleven migratory cetacean species were identified by the EPBC Protected Matters search (**Section 4.3.2**). Of these, five are listed as threatened: Humpback whale: The operational area overlaps the humpback whale migration BIA and the activity may overlap with the humpback whale migratory period. In the unlikely event of condensate spill from a loss of well control, migrating humpback whales or female whale and calf resting at Montebello Islands and transiting in the offshore Ningaloo area may encounter condensate on the surface or in the water column. However, given the rapid evaporation of condensate, significant numbers are not expected to be impacted. Blue whales: The EMBA overlaps with the blue whale migratory path. Since blue whales show preference for water depths >500 m, a small number of individuals may encounter condensate at the sea surface and within the water column. However, the absence of any known feeding, resting or breeding areas in operational area or EMBA means significant numbers are unlikely to be impacted. Southern right whales: Neither the operational area nor the EMBA overlap with the southern right whale migration path. In the unlikely event of a condensate spill, transient individuals may encounter condensate on the surface or in the water column. However, the absence of any known feeding, resting or breeding areas means significant numbers are unlikely to be impacted. Fin whale: Fin whales have a worldwide distribution generally in deeper waters and their distribution in Australia is not clear due to the sparse sightings. Given the absence of any known feeding, resting or breeding areas, significant numbers are unlikely to be impacted. Sei whale: Sei whales move between Australian waters and Antarctic feeding areas however they are only infrequently recorded in Australian waters (Bannister *et al*. 1996) and their movements and distribution in Australian waters is not well known (DoE, 2014). Given the absence of any known	

	feeding, resting or breeding areas, significant numbers are unlikely to be impacted. Other migratory cetaceans may encounter either condensate at the sea surface or in the water column, however, the absence of any known feeding, resting or breeding areas means significant numbers are unlikely to be impacted.	
Marine reptiles	Lethal or sub-lethal physical and toxic effects such as irritation of eyes/mouth and potential illness. It is commonly thought that condensate does not cause problems for wildlife due to the lack of visible oiling however may be toxic (WAOWRP, 2014).	At risk of direct contact with condensate due to chance of surfacing within slick. Effects include irritation of eyes/mouth and potential illness. Surface respiration could lead to accidental ingestion of hydrocarbons or result in the coating of sensitive epidermal surfaces.
	Six species of threatened marine reptile were identified as possibly being impacted by a spill. Short-nosed seasnake, flatback, hawksbill, leatherback, green and loggerhead turtles are widely dispersed at low densities across the NWS and in the unlikely event of a condensate spill occurring, individuals traversing open water may come into contact with water column or surface condensate. The operational area and EMBA overlaps with the flatback turtles internesting buffer critical to the survival of the species (60 km of Barrow Island). The activities will not overlap with peak flatback turtle hatching periods. The results of the spill modelling indicating the highest concentration of floating oil near shorelines being 3 g/m^2 (Barrow Island) and maximum shoreline loading of (<32.5 m^3, Barrow Island), as such there is risk of transient adults encountering condensate.	
Seabirds and shorebirds	Lethal or sub-lethal physical and toxic effects such as irritation of eyes/mouth and potential illness. It is commonly thought that condensate does not cause problems for wildlife due to the lack of visible oiling however may be toxic (WAOWRP, 2014). Seabirds may encounter entrained condensate while diving and foraging. Shorebirds may encounter condensate accumulating on shorelines at feeding, roosting and breeding sites.	Particularly vulnerable to surface condensate. As most fish survive beneath floating slicks, they will continue to attract foraging seabirds, which typically do not exhibit avoidance behaviour. Smothering can lead to reduced water proofing of feathers and ingestion while preening. In addition, condensate can erode feathers causing chemical damage to the feather structure that subsequently affects ability to thermoregulate and maintain buoyancy on water.
	Seven threatened species, as identified by the EPBC Protected Matters database search, may be encountered during the plug and abandonment activities and may have foraging or feeding habitat in the vicinity of the EMBA. The Australian fairy tern has foraging habitat in the area and so may be impacted by surface and water column while foraging (dive and skim feeding). Higher numbers would be expected during the breeding period of July to September. Due to the quick evaporation and dispersion of condensate, significant impacts are not anticipated. While the southern giant petrel, bar-tailed godwit, northern Siberian bar-tailed godwit, eastern curlew, red knot, and soft-plumaged petrel may occur in the area, no BIAs are designated for breeding or foraging within the EMBA so significant numbers are not expected and any impacts would be limited to transient individuals. Therefore the risk of surface and water column MGO to seabirds and shorebirds is considered low.	
Fish and sharks	Hydrocarbon droplets can physically affect fish and sharks exposed for an extended duration (weeks to months). Smothering through coating of gills can lead to the lethal and sub-lethal effects of reduced oxygen exchange, and coating of body surfaces may lead to increased incidence of irritation and infection. Fish may also ingest hydrocarbon droplets or contaminated food leading to reduced growth.	While fish and sharks do not generally break the sea surface, individuals may feed at the surface. However, since the condensate is expected to quickly dispersed and evaporated (modelling results indicate a significant proportion of the oil mass from the water surface evaporates within 24 hours at moderate wind speeds), the probability of prolonged exposure to a surface slick by fish and shark species is low.

	The operational area overlaps with the whale shark foraging BIA. However, given the distance to whale shark aggregation location (Ningaloo Marine Park, ~130 km southwest of the operational area) and activity being conducted outside the main whale shark aggregation period (May – June) significant impacts to whale shark are not expected should a spill occur. There is potential for localised mortality of fish eggs and larva due to reduced water quality and toxicity. Effects will be greatest in the upper 10 m of the water column and areas close to the spill source where hydrocarbon concentrations are likely to be highest and therefore demersal fish communities are not expected to be impacted.	
	The NWS supports a diverse assemblage of fish, including 456 species of finfish, particularly in shallower water near the mainland and islands. Threatened species identified by the EPBC protected matters search include the great white shark, whale shark, grey nurse shark and green and dwarf sawfish which may be present in the affected area. However given the absence of critical habitat for most of these species, significant numbers are not expected to be impacted. The only BIA overlapping the operational area and EMBA is for the whale shark. While this is for foraging it is not for high density prey where congregations are expected so impacts would be limited to transient migrating individuals. Grey nurse sharks could be present at low densities all year round within the operational area and EMBA, however, the absence of any known feeding, resting or breeding areas means significant numbers are unlikely to be impacted if an unplanned release were to occur.	
Socio-economic		
Fisheries	Condensate in the water column can have toxic effects on fish (as outlined above) reducing catch rates and rendering fish unsafe for consumption.	In addition to the effects of total WAF and dissolved WAF, exclusion zones surrounding a spill can directly impact fisheries by restricting access for fishermen.
	Both water column and surface condensate have the potential to lead to temporary financial losses.	
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 around the Montebello Islands but are concentrated in the vicinity of the population centres such as Exmouth, Dampier and Onslow. In the waters immediately surrounding the operational area, tourism activities are expected to be low, however exclusion zones surrounding a spill will reduce access for vessels for the duration of the response undertaken for spill clean-up (if applicable).	
Shipping	Hydrocarbons in the water column will have no effect on shipping.	Exclusion zones surrounding a spill will reduce access for shipping vessels for the duration of the response undertaken for spill clean-up (if applicable); vessel may have to take large detours leading to potential delays and increased costs.
Defence	The level of defence activities carried out in the vicinity of operational area is low , if any, and therefore interference of defence activities due to a condensate spill are likely to be minimal.	
Shipwrecks	Surface hydrocarbons will have no impact on shipwrecks. Hydrocarbons in the water column from a vessel collision will remain in the surface waters	

	and is therefore unlikely to have an impact on shipwrecks.
Indigenous	The level of activities undertaken by indigenous users is expected to be low, if any, therefore interference due to an condensate spill are likely to be minimal, however in event there is a requirement for land based response activities/ disturbance relevant representatives (identified in **Section 5**) will be contacted as outlined in Section 5 of the OPEP.
Existing oil and gas activity	Exclusion zones surrounding spills will reduce access potentially leading to delays to work schedules with subsequent financial implications. Chevron undertake a number of activities on Barrow Island and therefore may be impacted in the event of an unplanned spill event through exclusion from undertaking activities.
Protected areas	Protected areas are described in **Section 4.3** but are summarised below. *Montebello Marine Park* Includes habitat for foraging and breeding for seabirds and marine turtles. *Barrow Island Marine Park, Barrow Island Marine Management Area and Montebello Islands Marine Park* Includes foraging and nesting areas for marine turtles, and feeding/resting/breeding areas for seabirds and migratory shorebirds
	As discussed above, seabirds, shorebirds and marine reptiles are at risk of direct contact with contact with hydrocarbons on shorelines. Effects include irritation of eyes/mouth and potential illness from ingestions.
KEFs	KEFs are described in **Section 4.3.1** but are summarised below *Ancient Coastline at 125 m Contour* Contributes to higher diversity and enhanced species richness relative to soft sediment habitat Attracts opportunistic feeding by larger marine life including humpback whales, whale sharks and large pelagic fish *Continental Slope Demersal Fish Communities* Provides important habitat for demersal fish communities, characterised by high endemism and species diversity.
	A condensate spill from a loss of well control would result in a localised reduction in water quality in the upper surface waters of the water column. Based on the water depth of these KEFs, impacts from in water hydrocarbons are not predicted. Potential impacts to sensitive receptors associated with these KEFs are described previously above.

6.4.2 Marine gas oil release from vessel collision (surface)

Event: Hydrocarbon spill from a ruptured vessel fuel tank as result of a collision, a MODU refuelling incident or other minor diesel spills	Diesel spills have the potential to impact on the marine environment through reductions in water quality and exposure to fauna and habitats. Worst-credible MGO spill There is a possibility of a vessel collision occurring within the operational area between the support vessels, between a support vessel and the MODU, or between a passing 3rd party vessel and the MODU/support vessels. The worst-case environmental incident resulting from a vessel collision is the rupturing of a vessel fuel tank resulting in the release of marine gas oil (MGO) to the environment. Vessel collision could occur due to factors such as human error, poor navigation, vessel equipment failure or poor weather. A maximum credible spill volume has been determined based on technical guidance provided by AMSA (AMSA, 2015). This guidance states that for a vessel other than an oil tanker, the maximum credible spill from a collision can be determined from the volume of the largest single fuel tank. In reviewing the general arrangements and fuel tank capacities of typical vessels likely to be utilised for the East Spar plug and abandonment activities, the largest single fuel tank capacity identified was no greater than ~250 m^3 of MGO for a support vessel. Refuelling incident There will be no helicopter refuelling on the MODU and no support vessel refuelling within the operational area during the activity. The second most significant MGO spill scenario identified is a MODU refuelling incident (fuel hose failure/rupture, coupling failure or tank overfilling) where fuel bunkering would need to be stopped manually. Fuel released prior to the cessation of pumping as well as fuel remaining in the transfer line may escape to the environment. The AMSA (2015) *Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities* provides guidance for calculating a maximum credible spill volume for a refuelling spill. The guidance provided by AMSA (2015) for a refuelling spill under continuous supervision is considered appropriate given refuelling will be constantly supervised. The maximum credible spill volume during refuelling is calculated as: transfer rate (150 m^3/ hr) x 15 minutes of flow. The detection time of 15 minutes is seen as conservative but applicable following failure of multiple barriers followed by manual detection and isolation of the fuel supply. Other minor diesel spills Other potential diesel spills with significantly lower volumes (<1 m^3) include: • Failure of infrastructure containing diesel on support vessels or MODU; • Lifting – dropped objects damaging diesel infrastructure (hoses, pipes, tanks, etc.).
Potential Receptors	Fish, sharks, cetaceans, dugong, marine reptiles and seabirds. Shoreline habitats and associated fauna and flora
Potential Impacts	Spills of MGO would result in a localised reduction in water quality that may be harmful to marine fauna in surface waters and upper layers (~1 m) of the water column. • At the surface concentration environmental impact threshold of 10 g/m^2, the potential extent of floating MGO is approximately a maximum of 150 km from the release site in any season. Surface MGO at this concentration is predicted to contact Barrow Island. • Total water accommodated fraction (WAF) in the water column above an impact threshold of 500 ppb is predicted to occur within a region up to 60 km from the release site. No receptor is predicted to be contacted by entrained oil plumes with a concentration greater than 500 ppb

	• Dissolved WAF in the water column above an impact threshold of 100 ppb is predicted to occur up 100 km from the release site. No receptor is predicted to be contacted by dissolved. • The only mainland coastal waters that recorded hydrocarbons ashore were at the Ningaloo region. For offshore islands, hydrocarbons were recorded at Barrow Island, the Montebello Islands and Lowendal Islands. The maximum loading recorded at any of these receptors was negligible (<1 tonne) with either 1% or <1% probability of contact. The potential impacts to the environment will be greatest in the immediate vicinity of the spill when the toxic aromatic components of the fuel will be at their greatest concentration and when the hydrocarbon is at its thickest on the surface of the receiving waters. The potential sensitive receptors in the immediate areas of the spill will include fish, cetaceans, marine reptiles and seabirds at the sea surface, which may ingest the MGO or become coated. Entrained MGO may pose different risks to habitats and fauna compared to a surface slick. However, as a result of the dilution of entrained oil in the water column, toxic impacts of entrained MGO are likely to be less than that of a surface slick. As the entrained hydrocarbons will be in the surface waters only, the extent of entrained hydrocarbons is predicted to be the same as that as the surface hydrocarbon spread. <u>Toxic effects</u> The short exposure times likely to be experienced by potential receptors, minimal impacts from exposure to toxic hydrocarbons are anticipated and the rapid evaporation and loss of the more toxic aromatic components of the MGO results in a reducing toxicity threat to marine fauna with time. Passive / low mobility fauna such as plankton and small fish in the surface water are most likely to be affected by the MGO. Significant impacts to larger marine fauna species such as marine mammals, fish (sharks), marine reptiles and seabirds are unlikely (but possible) given the relatively small area of impact anticipated and the short duration of the spill. <u>Physical effects</u> In the immediate spill area, marine fauna interacting with surface waters may be exposed to hydrocarbons on the surface at concentrations about the threshold of 10 g/m^2 used for oiling impacts to sensitive receptors, but given the low adhesive potential of the hydrocarbon, significant impacts are not anticipated. Impacts are not expected to be significant at the sea surface with the high volatility and low adhesive potential of the hydrocarbon resulting in low persistence in the environment. Details of environmental impacts of entrained and surface MGO on sensitive receptors found within the EMBA are presented in **Table 6-4**.
Impact Assessment	
Receptors	**Consequence**
Threatened / Migratory / Local Fauna; **Protected Areas;** **Socio-economic Receptors**	In the event of a vessel collision, the volume of hydrocarbons released would be a finite amount limited to the maximum credible spill of a full tank inventory release. Given the nature of the MGO and the distance from shorelines, dilution and dispersion from natural weathering processes such as ocean currents indicate that the extent of exposure will be limited in area and duration. The susceptibility of marine fauna to hydrocarbons is dependent on hydrocarbon type and exposure duration however given that exposures would be limited in extent and duration, exposure to marine fauna from this hazard is not expected to result in a fauna fatality. Habitat modification/degradation/disruption/loss, deteriorating water quality and marine pollution are identified as potential threats to a number of marine fauna species in relevant Recovery Plans and Conservation Advice. With the control measures in place, in line with the relevant actions prescribed in Recovery Plan for Marine Turtles

	and Conservation Advice for Humpback Whales and Whale Sharks, the activity will be conducted in a manner that reduces potential impacts to ALARP and of acceptable level. In addition, the Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves states that DPaW should '*Ensure that important seabird and shorebird breeding and feeding areas are not significantly affected by human activities*'. The potential impacts of a hydrocarbon release on seabird breeding and feeding areas are discussed in **Table 6-4**. The low shipping and fishing activity expected in the direct area of the activity and the control measures in place are considered to result in a low risk of a collision occurring. In the unlikely event that a collision did occur within the operational area, the potential impacts to the environment would be greatest several kilometres from the spill when the toxic aromatic components of the fuel will be at their highest concentration and when the hydrocarbon is at its thickest on the surface of the receiving waters. The MGO will also rapidly lose toxicity with time and spread thinner as evaporation continues. The potential sensitive receptors in the surrounding areas of the spill will include fish, marine mammals, marine reptiles and seabirds at the sea surface. Marine habitats may also be impacted as MGO does contact shorelines but at low loadings (<1 tonne). MGO that reaches shorelines will have low viscosity (<50) and so 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 mangrove and intertidal reef and seagrass areas may be impacted through exposure to the toxic components of the MGO, although exposure times will unlikely be significant given the weathering properties of MGO. Indigenous users may be impacted in the event that a land based response is required, however consultation will ensure potential impacts are reduced to acceptable levels. Given that a vessel collision hydrocarbon spill would not result in a decreased population size at a local or regional scale, it is expected that a spill of this nature would result in a **minor** consequence.		
Likelihood	A hydrocarbon release resulting from a vessel collision is unlikely to have widespread ecological effects given the nature of the hydrocarbons on-board, the finite volumes that could be released, the depth and transient nature of marine fauna in this area. Deteriorating water quality is identified as a potential threat to turtles in the marine turtle recovery plan, and some bird and shark species. Habitat modification/degradation/disruption, pollution and/or loss of habitat are also identified as threats to sharks, birds, cetaceans and turtles in Conservation Management and Recovery Plans. However, the potential hydrocarbon releases as a result of vessel collision are not expected to significantly impact the receiving environment with control measures proposed. Additionally, long-term impacts resulting in complete habitat loss or degradation are not considered likely given the control measures proposed to prevent releases and therefore the activity will be conducted in a manner that is considered acceptable. The likelihood of a hydrocarbon release occurring due to a vessel collision is limited given the set of control measures in place for the plug and abandonment activity. Subsequently the likelihood of a vessel collision releasing hydrocarbons to the environment which results in a minor consequence is considered to be **rare**.		
Likelihood Ranking	1- Rare	**Consequence ranking**	B - Minor
Residual risk	Low		
Management Control	**Effectiveness of Control**		
MODU move procedure	MODU move procedure contains a passage plan to reduce risk of collision.		

Bulk liquid transfer procedure	Bulk liquid (hydrocarbon) transferred in accordance with bulk transfer procedure to reduce the risk of an unintentional release to the marine environment.
Maritime notices	Ensure other marine users are aware of the presence of the MODU/support vessels and are provided with information on timings of the activity, including MODU arrival and departure, so that the maritime industry is aware of the petroleum activities and to reduce risk of vessel collision.
Standby vessel	Monitor the MODU 500 m exclusion zone 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.
MODU identification system	MODU has a RACON (radar transponder) or AIS to aid in its detection at sea. Reduces risk of environmental impact from vessel collisions through ensuring safety requirements are fulfilled.
Oil pollution emergency plan (OPEP)	Implements response plan for the effective management of an accidental hydrocarbon spill (discharge to sea) in order to reduce impacts to the marine environment.
MODU and support vessel spill response plans	

Table 6-4: Impacts of water column and surface MGO on sensitive receptors found within the EMBA

Receptor	Impacts of MGO	
	Total WAF and dissolved WAF in the water column	**Surface hydrocarbons**
Marine fauna		
Plankton (including zooplankton; fish and coral larvae)	There is potential for localised mortality of plankton due to reduced water quality and toxicity. Effects will be greatest in the upper 10 m of the water column and areas close to the spill source where hydrocarbon concentrations are likely to be highest.	Surface MGO will have no impact on plankton.
	The operational area has the potential to overlap with spawning of some fish species given the year round spawning of some species. In the unlikely event of a spill occurring, fish larvae may be impacted by MGO entrained in the water column. However, following release, the MGO will rapidly evaporate and disperse in the offshore environment, reducing the concentration and toxicity of the spill. Given duration of fish spawning periods, lack of suitable habitat for aggregating fish populations near the surface, combined with the quick evaporation and dispersion of MGO, impacts to overall fish populations are not expected to be significant.	
Marine mammals	Lethal or sub-lethal physical and toxic effects such as irritation of eyes/mouth and potential illness.	At risk of direct contact with MGO due to chance of surfacing within slick. Effects include irritation of eyes/mouth and potential illness. Surface respiration could lead to accidental ingestion of hydrocarbons or result in the coating of sensitive epidermal surfaces.
	Eleven migratory cetacean species were identified by the EPBC Protected Matters search (**Section 4.3.2**). Of these, two are listed as endangered and three as vulnerable: Humpback whale; blue whale, southern right whale, fin whale and sei whale. Potential impacts to marine mammals from exposure/contact with MGO will be similar to exposure/contact with condensate. As such, for further detailed environmental impacts through hydrocarbon exposure and increased toxicity to marine mammals, refer to previous **Table 6-3**. Other migratory cetaceans may encounter either surface or water column MGO, however, the absence of any known feeding, resting or breeding areas means significant numbers are unlikely to be impacted.	
Marine reptiles	Lethal or sub-lethal physical and toxic effects such as irritation of eyes/mouth and potential illness.	At risk of direct contact with MGO due to chance of surfacing within slick. Effects include irritation of eyes/mouth and potential illness. Surface respiration could lead to accidental ingestion of hydrocarbons or result in the coating of sensitive epidermal surfaces.
	Six species of threatened marine reptile were identified as possibly being impacted by a spill. Short-nosed seasnake, flatback, hawksbill, leatherback, green and loggerhead turtles are widely dispersed at low densities across the NWS and in the unlikely event of a MGO spill occurring, individuals traversing open water may come into contact with water column or surface MGO. The operational area overlaps with the flatback turtles internesting area. The activities will not overlap with peak flatback turtle hatching periods. The results of the spill modelling indicating shorelines are contacted by at a very low loading (<1 tonne), as such there is risk of transient adults encountering MGO.	

	For further detailed environmental impacts through hydrocarbon exposure and increased toxicity to marine mammals, refer to previous **Table 6-3**.	
Seabirds and shorebirds	Lethal or sub-lethal physical and toxic effects such as irritation of eyes/mouth and potential illness. May encounter entrained MGO while diving and foraging.	Particularly vulnerable to surface MGO. As most fish survive beneath floating slicks, they will continue to attract foraging seabirds, which typically do not exhibit avoidance behaviour. Smothering can lead to reduced water proofing of feathers and ingestion while preening. In addition, MGO can erode feathers causing chemical damage to the feather structure that subsequently affects ability to thermoregulate and maintain buoyancy on water.
	Seven threatened species, as identified by the EPBC Protected Matters database search, may be encountered during the plug and abandonment activities and may have foraging or feeding habitat in the vicinity of the EMBA. Potential impacts to seabirds/shorebirds from exposure/contact with MGO will be similar to exposure/contact with condensate. As such, for further detailed environmental impacts through hydrocarbon exposure and toxicity effects, refer to previous **Table 6-3**.	
Fish and sharks	Potential impacts to fish/sharks from exposure/contact with MGO will be similar to exposure/contact with condensate. As such, for further detailed environmental impacts through hydrocarbon exposure and toxicity effects, refer to previous **Table 6-3**.	While fish and sharks do not generally break the sea surface, individuals may feed at the surface. However, since the MGO is expected to quickly dispersed and evaporated (modelling results indicate approximately 55% of hydrocarbons evaporate after 3 days at moderate wind speeds), the probability of prolonged exposure to a surface slick by fish and shark species is low.
	For further detailed environmental impacts through hydrocarbon exposure and toxicity effects, refer to previous **Table 6-3**.	
Socio-economic		
Fisheries	MGO in the water column can have toxic effects on fish (as outlined above) reducing catch rates and rendering fish unsafe for consumption.	In addition to the effects of total WAF and dissolved WAF, exclusion zones surrounding a spill can directly impact fisheries by restricting access for fishermen.
	Both water column and surface MGO have the potential to lead to temporary financial losses.	
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 around the Montebello Islands but are concentrated in the vicinity of the population centres such as Exmouth, Dampier and Onslow. In the waters immediately surrounding the operational area, tourism activities are expected to be low, however exclusion zones surrounding a spill will reduce access for vessels for the duration of the response undertaken for spill clean-up (if applicable).	
Shipping	Hydrocarbons in the water column will have no effect on shipping.	Exclusion zones surrounding a spill will reduce access for shipping vessels for the duration of the response undertaken for spill clean-up (if applicable); vessel may

		have to take large detours leading to potential delays and increased costs.
Defence	The level of defence activities carried out in the vicinity of operational area is low , if any, and therefore interference of defence activities due to a MGO spill are likely to be minimal.	
Shipwrecks	Surface hydrocarbons will have no impact on shipwrecks. Hydrocarbons in the water column from a vessel collision will remain in the surface waters and is therefore unlikely to have an impact on shipwrecks.	
Indigenous	The level of activities undertaken by indigenous users is expected to be low, if any, therefore interference due to an MGO spill are likely to be minimal, however in event there is a requirement for land based response activities/ disturbance relevant representatives (identified in **Section 5**) will be contacted.	
Existing oil and gas activity	Exclusion zones surrounding spills will reduce access potentially leading to delays to work schedules with subsequent financial implications. Chevron undertake a number of activities on Barrow Island and therefore may be impacted in the event of an unplanned spill event through exclusion from undertaking activities.	
Protected areas	Protected areas are described in **Section 4.3** but are summarised below. *Montebello Marine Park* Includes habitat for foraging and breeding for seabirds and marine turtles. *Barrow Island Marine Park, Barrow Island Marine Management Area and Montebello Islands Marine Park* Includes foraging and nesting areas for marine turtles, and feeding/resting/breeding areas for seabirds and migratory shorebirds.	
	As discussed above, marine mammals, seabirds, sharks and reptiles are at risk of direct contact with MGO due to chance of surfacing within slick. Effects include irritation of eyes/mouth and potential illness.	
KEFs	KEFs are described in Section 4.3.1 but are summarised below: *Ancient Coastline at 125m Contour* Contributes to higher diversity and enhanced species richness relative to soft sediment habitat; Attracts opportunistic feeding by larger marine life including humpback whales, whale sharks and large pelagic fish. *Canyons linking the Cuvier Abyssal Plain and the Cape range Peninsula* Supports the productivity and species richness of Ningaloo Reef. *Continental Slope Demersal Fish Communities* Provides important habitat for demersal fish communities, characterised by high endemism and species diversity.	
	A loss of MGO to the marine environment would result in a localised reduction in water quality in the upper surface waters of the water column.	

6.4.3 Minor hydrocarbon release (surface)

Event: Minor Hydrocarbon Release (Surface)	Causes for accident hydrocarbon releases (other than diesel and loss of well control) include: • Hydraulic fluids, lubricant oils and (stored) waste oils from: o ROV failure (including oil seal, hydraulic system hose and quick disconnect system failures); o Loss of primary containment (drums, tanks, IBCs, etc.) due to handling, storage and dropped objects (e.g. swinging load during lifting activities); o Vessel or MODU pipework failure or rupture, hydraulic hose failure, inadequate bunding; • Formation fluids from flaring drop-out; • Hydrocarbon contaminated returns (e.g. oily water, completion fluid). The MODU/support vessel main engines and equipment such as pumps, cranes, winches, power packs and generators require MGO for fuel and a variety of hydraulic fluids and lubricating oils for efficient operation and maintenance of moving parts. These products are present within the equipment and also held in storage containers and tanks on the MODU and support vessels. Small hydrocarbon leaks could occur from loss of primary containment due to handling, storage and dropped objects (during lifting activities). Volumes are likely to be small and limited to the volume of individual containers (e.g. intermediate bulk container (IBC), 44-gallon drums, etc.) stored on the deck of support vessels or the MODU. The credible spill for this scenario is considered to be the loss of an IBC (1 m^3) during transfer from a support vessel to the MODU. ROV operations can result in unplanned discharges (of hydraulic fluids) directly to the marine environment due to equipment failure, ROV interactions with the vessel thrusters and/or accidental contact with sub-sea infrastructure. The largest credible hydrocarbon spill from ROV operations would be an accidental release of approximately 0.05 m^3 (50 L) of hydraulic fluid from the deployed ROV. Hydrocarbon flaring may be interrupted by pressure drops, inadequate combustion, or higher than anticipated fluid content in the flaring system during bleed-off operations. As a result of flaring drop out, formation fluids (~1 m^3 condensate) may subsequently be discharged into the marine environment. Minor accidental loss of other hydrocarbon-based liquids (e.g. used lubricating oils, cooking oil, and hydraulic oil) to the marine environment could also occur via tank pipework failure or rupture, hydraulic hose failure, inadequate bunding and/or storage, insufficient fastening or inadequate handling which could result in impacts to water quality and hence sensitive environmental receptors.
Potential Receptors	Marine fauna – Fish, cetaceans, marine mammals, marine reptiles and seabirds
Potential Impacts	Hydraulic fluids and lubricating fluids behave similarly to MGO when spilt in the marine environment (for information on MGO behaviour in the marine environment refer to **Section 6.4.2**). Hydraulic fluids are medium oils of light to moderate viscosity and have a relatively rapid spreading rate and, like diesel, will dissipate quickly, particularly in high sea states, although lubricating oils are more viscous and so the spreading rate of a spill of these oils would be slightly slower. For environmental effects of formation fluids and hydrocarbon contaminated returns (e.g. oily water, completion fluid), refer to **Section 6.4.1**.
Impact Assessment	
Receptors	**Consequence**

Marine Fauna – Fish, cetaceans, marine mammals, marine reptiles, and seabirds	In the event of a minor hydrocarbon spill, the quantities would be limited to approximately 1 m^3 for the loss of the contents of an IBC, 50 L for ROV hydraulic fluid, or 1 m^3 for formation fluids from flaring drop-out/hydrocarbon contaminated returns. The small volumes and dilution and dispersion from natural weathering processes such as ocean currents are such that spills will be limited in area and duration. The number of receptors present at the activity location are expected to be limited to a small number of transient individuals. The susceptibility of marine fauna to hydrocarbons is dependent on hydrocarbon type and exposure duration however given that exposures would be limited in extent and duration, exposure to marine fauna from this hazard is considered to be low. The small volumes of worst-case discharges are such that, the impacts to receptors will decline rapidly with time and distance at the sea surface. Rapid dilution at depth would also result in the impacts to receptors declining rapidly with time and distance. Deteriorating water quality and marine pollution are identified as potential threats to a number of marine fauna species in relevant Recovery Plans and Conservation Advice. With control measures in place, the activity will be conducted in a manner that reduces potential impacts to ALARP and of acceptable level. For marine mammals that may be exposed to the more toxic aromatic components of the minor hydrocarbon spills, toxic effects are considered unlikely since these species are mobile and therefore not be constantly exposed for extended durations that would be required to cause any major toxic effects. Although humpback and blue whales may be exposed, this event is not expected to interfere with their migration activity. Toxic impacts are not expected to the benthic community due to the water depths. Near the sea surface, fish are able to detect and avoid contact with surface slicks and as a result, fish mortalities rarely occur in open waters from surface spills (Kennish, 1997; Scholz *et al*., 1992). Pelagic fish species are therefore generally not highly susceptible to impacts from hydrocarbon spills. In offshore waters near to the release point, pelagic fish are at risk of exposure to the more toxic aromatic components of the marine diesel. Pelagic fish in offshore waters are highly mobile and comprise species such as tunas, sharks and mackerel. Due to their mobility, it is unlikely that pelagic fish would be exposed to toxic components for long periods in this spill scenario. The more toxic components would also rapidly evaporate and concentrations would significantly diminish with distance from the spill site, limiting the potential area of impact. Deteriorating water quality is identified as a potential threat to turtles in the marine turtle recovery plan, and some bird and shark species. However, the potential minor hydrocarbon releases are not expected to significantly impact the receiving environment with control measures proposed to prevent releases and therefore the activity will be conducted in a manner that is considered acceptable. Given that a small hydrocarbon spill would not result in a decreased population size at a local or regional scale, it is expected that a spill of this nature would result in a **minor** consequence.		
Likelihood	The likelihood of a small hydrocarbon release occurring is limited given the set of management controls in place for this activity.		
Likelihood Ranking	3- Unlikely	**Consequence ranking**	B –Minor
Residual risk	Low		
Management Control	**Effectiveness of Control**		
Dropped object prevention procedures	Impacts to environment are reduced by preventing dropped objects and by retrieving dropped objects where possible. Minimises drop risk during MODU lifting operations. Ensures lifting equipment certified and inspected.		

Hazardous chemical management procedures	Reduces the risk of spills and leaks (discharges) to sea by controlling the storage, handling and clean-up.
General chemical management procedures	Potential impacts to the environment are reduced through following correct procedures for the safe handling and storage of chemicals.
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.
Remotely operated vehicle (ROV) inspection and maintenance procedures	Maintenance and pre-deployment inspection on ROV completed as scheduled to reduce the risk of hydraulic fluid releases to the marine environment.
Chemical selection procedure for drilling and cementing chemicals	Reduces toxicity to marine environment through ensuring only environmentally acceptable chemicals discharged to sea.
Bleed-off procedure	Includes control measures that reduce the risk of hydrocarbons from entering the marine environment.
Oil pollution emergency plan (OPEP)	Implements response plans to deal with an unplanned hydrocarbon release quickly and efficiently in order to reduce impacts to the marine environment.
MODU and support vessel spill response plans	

6.4.4 Non-hydrocarbon and chemicals release (surface) - liquids

Event: Non-hydrocarbon and chemicals release (surface) - liquid	Non-hydrocarbon liquids including miscellaneous chemicals and waste streams (brine, mixed cement, cleaning and cooling agents, stored or spent chemicals and leftover paint materials) are used or stored on-board the MODU/support vessels during the activity. The main engines and equipment such as pumps, cranes, winches, power packs and generators require MGO for fuel and a variety of hydraulic fluids and lubricating oils for efficient operation and maintenance of moving parts. These products are present within the equipment and also held in storage containers and tanks on the MODU/support vessels Another credible spill is due to a hose that parts when loading/offloading brine. In this case, the discharge would be approximately 2.5 m^3. The presence of non-hydrocarbons liquids and chemicals represents a potential spill risk during chemical storage and handling e.g. due to tank damage, or human error. Rupture of the pumping hose used to transfer these chemicals may occur due to dropped object, vessel motion, or hose failure.

	An accidental release of chemicals and other non-hydrocarbon liquids into the marine environment has the potential to occur from the following activities: • MODU or support vessel operations; • Transferring, storing or using bulk products (e.g. mixed cement); • Mechanical failure of equipment; • Handling and storage spills and leaks; • Hose or hose connection failure or leak; and • Lifting – dropped objects damaging liquid vessels (containers). Accidental loss of non-hydrocarbon liquids or chemicals to the marine environment could occur via tank pipework failure or rupture, inadequate bunding and/or storage, insufficient fastening or inadequate handling may result in impacts to water quality and hence sensitive environmental receptors. The maximum volume of non-hydrocarbon liquids or chemicals that could be released during routine operations is likely to be small and realistically limited to the volume of individual containers (e.g. drums etc.) stored on-deck of vessels or the MODU. The worst-case spill scenario on-board is considered to be loss of 100 m^3 of brine. In the event that the spill is not contained on deck, there would be a release to the marine environment, which would be likely to rapidly disperse and evaporate.
Potential Receptors	Fish, sharks, marine mammals, marine reptiles and seabirds
Potential Impacts	Environmentally non-hydrocarbon liquids or chemicals released to the marine environment may lead to contamination of the water column in the vicinity of the MODU and support vessels. The potential impacts would most likely be highly localised and restricted to the immediate area surrounding the spill, with rapid dispersal to concentrations below impact thresholds likely to occur in the open area of ocean. The changes to water quality that may result could potentially lead to short-term impacts on marine fauna (e.g. pelagic fish, epifauna, cetaceans, marine reptiles and seabirds), with chronic impacts not expected owing to the short exposure times. Chemical spills are unlikely to have widespread ecological effects given the nature of the chemicals on-board, the small volumes that could be released, and the depth and exposure of the location. There is no emergent or intertidal habitat that could be impacted by a surface spill. Owing to the water depth (~100 m), any spilled material is unlikely to reach land or effect any of the demersal species or benthic habitats at the seabed. Physical coating of marine fauna or lethal/sub-lethal toxicity effects from any accidentally released non-hydrocarbon liquids or chemicals, is considered unlikely given the expected low concentrations and short exposure times.
Impact Assessment	
Receptors	**Consequence**
Marine fauna – Fish, sharks, marine mammals, marine reptiles, and seabirds	In the event of a non-hydrocarbon liquid or chemical spill, the quantities would be limited to small volumes (worst-case approximately 100m^3 brine in tanks on MODU). The small volumes, dilution and dispersion from natural weathering processes such as ocean currents indicate that the extent of exposure will be limited in area and duration. The susceptibility of marine fauna to non-hydrocarbon liquids and chemicals is dependent on the type and exposure duration however given that

	exposures would be limited in extent and duration, exposure to marine fauna from this hazard is not expected to result in a fauna fatality. Impacts from discharges to the marine environment to water quality would be short-term and localised, due to the nature and behaviour of the chemicals identified as being at risk of spilling; only pelagic fauna present in the immediate vicinity of the spill would likely be at risk of impact. Habitat degradation, deteriorating water quality and marine pollution are identified as potential threats to a number of marine fauna species in relevant Recovery Plans and Conservation Advice. The above information demonstrates that the activity will be conducted in a manner that reduces potential impacts to ALARP and of acceptable level. The lack of significant habitat within the operational area indicates that only a small number of marine fauna has the potential to be exposed to a small non-hydrocarbon or chemical spill given the transient nature of fauna in this area. Deteriorating water quality is identified as a potential threat to turtles in the marine turtle recovery plan, and some bird and shark species. However, the potential non-hydrocarbon releases of liquids or chemicals are not expected to significantly impact the receiving environment with control measures proposed to prevent releases and therefore the activity will be conducted in a manner that is considered acceptable. Given that a non-hydrocarbon or chemical spill would not result in a decreased population size at a local or regional scale, it is expected that a spill of this nature would result in a **negligible** consequence.		
Likelihood	A small non-hydrocarbon liquid release is unlikely to have widespread ecological effects given the nature of the chemicals on-board, the small volumes that could be released, the depth and transient nature of marine fauna in this area, the control measures in place to prevent spills and the procedures in place to clean up a spill. Quadrant reviewed non-hydrocarbon spills and leaks from equipment and machinery in recent history (due to split hoses, small leaks, or handling errors). Most of the spills and leaks reported occurred within bunded areas, were less than 100 L, did not reach the marine environment and were cleaned up immediately. The likelihood of a small non-hydrocarbon liquid or chemical release occurring is limited given the control measures in place for this activity. Consequently, the likelihood of non-hydrocarbon liquids or chemical spills entering the marine environment is considered to be **very unlikely**.		
Likelihood Ranking	2- Very unlikely	**Consequence ranking**	A – Negligible
Residual Risk	Low		
Management Control	**Effectiveness of Control**		
Dropped object prevention procedures	Minimises dropped object risk during MODU lifting operations that may cause secondary spill resulting in reduction in water quality. Ensures lifting equipment certified and inspected.		
Hazardous chemical management procedures	Reduces the risk of spills and leaks to the sea by controlling the storage, handling and clean-up of hazardous chemicals.		
Deck cleaning product selection procedure	Improve water quality discharge (reduced toxicity) to the marine environment through selection of acceptable chemicals.		
General chemical management procedures	Potential impacts to the environment are reduced through following correct procedures for the safe handling and storage of chemicals.		

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.
Bulk liquid transfer procedure	Bulk liquid transferred in accordance with bulk transfer procedures to reduce the risk of an unintentional release to the 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 for drilling and cementing chemicals	Reduced toxicity to marine environment. Only environmentally acceptable chemicals would be released in the event of an accidental discharge to sea.

6.4.5 Non-Hydrocarbon surface release – solids

Event: Non-Hydrocarbon Surface Release – Solids	Non-hydrocarbon surface releases of non-hazardous solid materials and wastes including paper, plastics and packaging, and hazardous solid wastes such as batteries, fluorescent tubes, medical wastes, and aerosol cans may be dropped unintentionally to the marine environment, potentially impacting on sensitive receptors. Release of these waste streams may occur as a result of overfull and/or uncovered bins, incorrectly disposed items or spills during transfers of waste. Dropped objects/lost equipment such as the riser could also result in seabed disturbance. Accidental discharge of non-hydrocarbon solid materials also has the potential to occur during product transfers or storage of dry bulk product (e.g. cement) and solid additives (e.g. barite and bentonite).
Potential Receptors	Benthic habitats; Marine fauna – Fish, sharks, marine mammals, marine turtles and seabird.
Potential Impacts	Non-hydrocarbon solids 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 potentially result in fauna fatality. Floating non-biodegradable marine debris has been highlighted as threat to marine turtles, humpback whales, whale sharks and albatrosses/ giant petrels in the Marine Turtle Recovery Plan (Commonwealth of Australia, 2013), Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015a), Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015b) and Background Paper for albatrosses/giant petrels (DSEWPaC, 2011). The Recovery Plan, Approved Conservation Advice and Background Paper have specified a number of recovery actions to help combat this threat. Of relevance to this activity is the legislation for the prevention of garbage disposal from vessels. Release of hazardous solids (e.g. wastes such as batteries) may result in the pollution of the immediate receiving environment, leading to detrimental health impacts to marine flora and fauna. Physiological damage can be through ingestion or absorption may occur to individual fish, cetaceans, marine reptiles or seabirds. The area of potential disturbance due to non-hydrocarbon solids would be restricted to the operational area. The seabed within the operational area is primarily soft sediments with little epifauna; this habitat type is widely distributed and well represented in the NWS region. While soft sediment benthic habits will not be destroyed, disturbance of the communities on and within them (i.e. the epifauna and infauna) will occur in the event of a dropped object and depressions may remain on the seabed for some time after removal of the dropped object as it gradually infills over time.

	Dropped objects could also impact water quality and lead to potential injury to fauna depending on the contents of the object e.g. a drum containing chemicals. Impacts from lost liquid materials / wastes are discussed in **Section 6.4.4**.		
Impact Assessment			
Receptors	**Consequence**		
Marine fauna- cetaceans, marine turtles, seabirds and fish	In the event of a non-hydrocarbon solid release or dropped object, the quantities would be limited. This release could cause localised impacts to water quality and the benthic environment if the solid can degrade, leading to impacts on localised flora and fauna species. Ingestion of solid wastes by marine fauna could occur in small quantities. Only small volumes of non-hydrocarbon solids would be generated during the activity, as a result, any accidental loss to the environment would be small in size. Any impacts would be restricted to a small number of individuals, if any. As such there is the potential for short-term behavioural impacts only to a small proportion of a local population and not during critical lifecycle activity for cetaceans, marine turtles or fish. Marine debris is identified as a potential threat to a number of marine fauna species in relevant Recovery Plans and Conservation Advice. The above information demonstrates that the activity will be conducted in a manner that reduces potential impacts to ALARP and of acceptable level. In addition, the Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves states that DPAW should '*Ensure that important seabird and shorebird breeding and feeding areas are not significantly affected by human activities*'. The limited quantities associated with this event indicate that even in a worst-case release of solid waste, the number of fauna fatalities would be limited to individuals and is not expected to result in a decrease of the local population size and the consequence level is therefore **negligible**.		
Physical Environment – Seabed disturbance	In the event of a dropped object or a non-hydrocarbon solid sinking to the seabed, there will be localised and short-term damaged the seabed. The extent of the impact is limited to the size of the dropped object or non-hydrocarbon solid released and given the size of standard materials transferred, any impact is expected to be very small. Previous surveys undertaken in the area show the seabed to comprise soft sediments with little epifauna. Subsequently any impacts are predicted to be short-term in nature. Any impact to seabed through dropped objects would result in a negligible reduction in habitat area/function impacted.		
Likelihood	Control measures proposed ensure that the risk of dropped objects, lost equipment or release of non-hydrocarbon solid waste to the environment has been minimised. The likelihood of transient marine fauna occurring in the operational area is limited and given the control measures in place, the likelihood of releasing non-hydrocarbon solids to the environment resulting in a **negligible** consequence is considered **unlikely** (assumes potential for a single loss of solid waste incident during the activity).		
Likelihood Ranking	3 - Unlikely	**Consequence Ranking**	A – Negligible
Residual Risk	Low		
Management Control	**Effectiveness of Control**		
Dropped object prevention procedures	Impacts to environment are reduced by preventing dropped objects and by retrieving dropped objects where possible. Minimises drop risk during MODU lifting operations. Ensures lifting equipment certified and inspected.		

Waste (garbage) management procedure	Reduces risk of waste being discharged to sea, reducing potential impacts to marine fauna. Ensure compliance with MARPOL requirements.
Hazardous chemical management procedures	Reduces the risk of spills and leaks (discharges) to 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 by controlling the storage, handling and clean-up.
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.
Bulk solid transfer procedure	Bulk solids transferred in accordance with bulk transfer procedure to reduce the risk of an unintentional release to sea.

6.4.6 Marine fauna collisions

Event: Marine Fauna Collisions	There is the potential for the MODU and support vessels involved in the activity to strike marine fauna including cetaceans, fish, sharks, marine reptiles and seabirds. The main collision risk associated with the activity is through support vessel collision with large, slow moving cetaceans, potentially resulting in severe injury or mortality.
Potential Receptors	Fish, sharks, cetaceans, marine reptiles and seabirds
Potential Impacts	Cetaceans are naturally inquisitive marine mammals that are often attracted to vessels underway; for example, dolphins commonly `bow ride' with vessels. Marine fauna in surface waters that would be most at risk from vessel collision include marine mammals, marine turtles and whale sharks. The operational area overlaps with flatback turtle internesting habitat buffer zone (60 km of Barrow Island), whale shark foraging BIA and humpback whale migration BIA. Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015a) indicates that humpback whales are one of the most frequently reported whale species involved in vessel strikes worldwide (Laist *et al*., 2001; Jensen & Silber, 2003). The increase in vessel numbers (Silber & Bettridge, 2012) is not only a threat to humpback whales in relation to vessel strikes but also in disturbance and displacement from key habitats. Similarly, boat strike is also recognised by the Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015b) as one of the threats to their recovery. Turtle/vessel interactions arising from increased vessel traffic is also recognised as one of a number of key impacts to marine turtles in the Recovery Plan for Marine Turtles (Commonwealth of Australia, 2017). The worst potential impact from vessel collision would be mortality or serious injury of an individual. Collisions between vessels and cetaceans are most frequent on continental shelf areas where high vessel traffic and cetacean habitat occur simultaneously (WDCS, 2006). 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. Whale and Dolphin Conservation Society (WDCS) (2006) also indicates that some cetacean species, such as humpback whales, can detect and change course in order to avoid a vessel. The most commonly sighted whale in continental shelf waters of the region is the humpback whale. The humpback whale migrates between calving grounds in the Kimberley region of WA to feeding grounds in Antarctica; with the northbound migration from early June to early August (BHPB, 2005), and the peak of the northbound migration between Exmouth Gulf and the Dampier Archipelago occurring around July, concentrated inshore of the 200 m depth contour (Jenner *et al.*, 2001). The southern migration, which peaks around early September, with pods travelling in shallower waters, typically at 30-100 m and passing to the west of Barrow Island and north of the Montebello islands. Based on the proposed timing for the activity, water depths and migration pathways there is the potential for humpback whales to be encountered in the operational area undertaking their northbound migration. High numbers may also be encountered in the operational area during the humpback whale southern migration. Nearly all blue whales sighted in the NWS region are likely to be pygmy blue whales. The pygmy blue whales may also transit through the operational area during their migrations. However, given the width of the blue whale migration corridor in the region (>200 km) and depth range (between 300 m and 850 m) it is highly unlikely that there will be significant interactions with pygmy blue whales during the activity. 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). Given the operational area overlaps with whale shark foraging BIA, individuals may be encountered during the activity. However, large numbers of whale shark encounters are not expected because the proposed schedule occurs outside the main whale shark aggregation period (May-June) at Ningaloo and the distance to the Ningaloo Marine Park where they aggregate is approximately 130 km southwest of the operational area. It is possible that individual flatback turtles may be encountered in the operational area, particularly due to overlap with the flatback internesting habitat critical buffer (60 km radius from Barrow Island nesting location). However, given the peak nesting season at Barrow Island is between late November and January, and the activity is expected to commence in June, with activities completed within approximately 45 days, large numbers of turtle encounters are not expected. Marine turtle mortality due to boat strike has been identified as an issue in Queensland waters in the Marine Turtle Recovery Plan (Commonwealth of Australia, 2017). However, turtles appear to be more vulnerable to boat strike in areas of high urban population where incidents of pleasure crafts are higher. WA turtle populations have not been highlighted as those most affected by boat strike, possibly due to the relatively low human population density of the NWS coastline. Given that the support vessels will move slowly (<5 knots) within the operational area, the risk of collision with marine fauna is extremely low.

Impact Assessment			
Receptors	**Consequence**		
Marine fauna – Fish, sharks, cetaceans, marine reptiles, seabirds	In the event of a collision with marine fauna, there is the potential for injury or death to an individual. The number of receptors present at the operational area are expected to be limited to a small number of transient individuals, no significant areas of habitat are present in the immediate vicinity of the operational area. Boat strike and vessel disturbance are identified as potential threats to a number of marine fauna species in relevant Recovery Plan and Conservation Advice. The above information demonstrates that with control measures in place the activity will be conducted in a manner that reduces potential impacts to ALARP and of acceptable level. There is the potential for death or injury of EPBC Act listed individual species, however as they would represent a small proportion of the local population it is not expected that it would result in a decreased population size over what would usually occur due to natural variation, at a local or regional scale, It is expected that the loss of an individual would be a minor consequence.		
Likelihood	The Australian National Marine Safety Committee (NMSC) reports that during 2009, there was one report of a vessel collision with a marine animal (species not defined) (NMSC, 2010). The operational area overlaps the humpback whale northern and southern migration pathway, and as such migrating individuals may traverse the operational area. No known aggregation areas (breeding, resting or calving) occur within the operational area and therefore concentrations of milling individuals are unlikely. Pygmy blue whales may be encountered in the operational area. Tagging surveys have shown pygmy blue whales migrating northward relatively near to the Australian coastline (100 km) until reaching North West Cape after which they travelled offshore (240 km) to Indonesia. Passive acoustic data documented pygmy blue whales migrating along the Western Australian shelf break (Woodside, 2012). The National Conservation Values Atlas has identified the pygmy whale migration pathway on the continental shelf edge at depth of 500 to 1,000 m (McCauley & Jenner 2010). Breeding areas have not yet been identified however it is likely that pygmy blue whales calve in tropical areas of high localised production such as deep offshore waters of the Banda and Molucca Seas in Indonesia (Double *et al*., 2014). There are no known breeding areas of significance to blue whales in waters from Busselton to the Northern Territory border. Vessels will be moving very slowly whilst inside the operational area, posing a low risk of collision with marine fauna. In addition, the noise generated from vessel operations will deter marine fauna from coming in close proximity to vessels. Subsequently the likelihood of a collision with marine fauna resulting in a **minor** consequence is considered to be **very unlikely**.		
Likelihood Ranking	2 - Very unlikely	**Consequence Ranking**	B – Minor
Residual Risk	Low		
Management Control	**Effectiveness of Control**		
Procedure for interacting with marine fauna	Reduces risk of physical and behavioural impacts to marine fauna from interactions with support vessels and helicopters.		

6.4.7 Introduction of invasive marine species (IMS)

Event: Introduction of IMS	Invasive marine species (IMS) have been introduced and translocated around Australia by a variety of natural and human means including biofouling and ballast water. IMS can be introduced into the operational area and surrounds by the MODU/support vessels carrying IMS on external biological fouling, internal systems (sea chests, seawater systems etc.), on submersible marine equipment (e.g. ROVs), or through ballast water exchange. Cross contamination between vessels can also occur.
Potential Receptors	Marine ecosystem as a whole and commercial/ recreational users of the marine environment.
Potential Impacts	IMS are marine plants, animals and algae that have been introduced into a region that is beyond their natural range but have the ability to survive, and possibly thrive (DAFF, 2011). The majority of climatically compatible IMS to the NWS are found in south-east Asian countries. Some IMS pose a significant risk to environmental values, biodiversity, ecosystem health, human health, fisheries, aquaculture, shipping, ports and tourism (DAFF, 2011; Wells *et al*., 2009). When IMS achieve pest status, they are commonly referred to as introduced marine pests and 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. Species of concern are those that are not native to the region; are likely to survive and establish in the region; and are able to spread by human mediated or natural means. Species of concern vary from one region to another depending on various environmental factors such as water temperature, salinity, nutrient levels and habitat type. These factors dictate their survival and invasive capabilities. It is recognised that artificial, disturbed and/or polluted habitats in tropical regions are susceptible to introductions, which is why ports are often areas of higher IMS risk (Neil *et al*., 2005). However, in Australia there are limited records of detrimental impact from IMS compared to other tropical regions (such as the Caribbean). Following their establishment, eradication of IMS populations is difficult, limiting management options to ongoing control or impact minimisation. Case studies in Australia indicate that from detection to eradication this can take approximately 4 weeks (Bax, 1999). However, this is dependent on the environmental conditions and species. For this reason, increased management requirements have been implemented in recent years by Commonwealth and State regulatory agencies. Biofouling on vessel hulls and other external niche areas, biofouling on internal niches and biofouling on equipment routinely immersed in water all pose a potential risk of introducing IMS into Australia. The potential biofouling risk presented by the MODU and support vessels will relate to the length of time that these vessels have already been operating in Australian waters or, if they have been operating outside Australian waters, the location/s of the operations they have been undertaking, the length of time spent at these location/s, and whether the vessels have undergone hull inspections, cleaning and application of new anti-foulant coating prior to returning to operate in Australia.
Impact Assessment	
Receptors	**Consequence**

Marine fauna – Fish and benthic habitats; Physical environment/ habitat	Ballast water is responsible for 20–30% of all marine pest incursions into Australian waters, however, research indicates that biofouling (the accumulation of aquatic micro-organisms, algae, plants and animals on vessel hulls and submerged surfaces) has been responsible for more foreign marine introductions than ballast water (DAFF, 2011). 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 and can subsequently impact on fisheries or aquaculture. If an IMS is introduced, they have been known to colonise areas outside of the areas they are introduced to. In the event that an IMS is introduced into the operational area, given the lack of diversity and extensiveness of similar benthic habitat in the region, there would only be a minor reduction in the physical environment. No threatened ecological communities are present in the area that could be affected. The overall consequence level was assessed as **moderate**.		
Likelihood	The pathways for IMS introduction are well known, and subsequently standard preventative measures are proposed. 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). Given the depth of the operational area (~100 m) creating an unfavourable habitat for colonisation (i.e. light limiting and low habitat biodiversity with sparse epibiota) and distance from shallow coastal habitats, there is a very low likelihood that IMS would be able to survive translocation and subsequently establish and colonise. With control measures in place to reduce the risk of introduction of IMS, the likelihood of introducing an IMS is considered **rare**.		
Likelihood Ranking	1 - Rare	**Consequence Ranking**	C – Moderate
Residual Risk	Low		
Management Control	**Effectiveness of Control**		
Biofouling vessel risk assessment (VRASS)	The risk of introducing IMS are reduced due to assessment procedure.		
Ballast water management plan	Reduces the risk of introducing IMS through procedures managing ballast water exchange and identifying high risk ballast water.		

7. MANAGEMENT APPROACH

The East Spar plug and abandonment 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's Management System (e.g. Environmental Management Policy).

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

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

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 outcomes, control measures and performance standards;
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 will ensure environmental performance is monitored and managed through an inspection and monitoring regime undertaken by Quadrant representatives or delegates based on the MODU/support 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. Continuous 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 and MODU/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) Regulations, as detailed within the EP. Reported HSE incidents and hazards will be communicated to personnel during daily operational meetings, and HSE incidents and hazards will be documented in the incident management systems as appropriate. Significant HSE incidents will be investigated using root cause analysis.

7.1 Management of Change

Quadrant'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) Regulations.

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 change to proceed, the associated environmental impacts and risks must be demonstrated to be acceptable and ALARP. Additional stakeholder consultation may be required depending on the nature and scale of the change. The MOC procedure also allows for the assessment of new information that may become available post EP acceptance, e.g., new Management Plans for marine reserves, Recovery Plans or Conservation Advice for species and changes to the EPBC Act Protected Matters Search results. If review identifies new information, this is treated as "Change that has an impact on Environment Plan" and the MOC process is followed accordingly.

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

8. HYDROCARBON SPILL RESPONSE ARRANGEMENTS

In the event of a hydrocarbon spill, oil spill response strategies will be implemented where possible to reduce environmental impacts to ALARP and acceptable levels. The selection of strategies will be undertaken through the Net Environmental Benefit Analysis (NEBA) process, outlined in the OPEP.

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

- Source control activities; including;
    - MODU/Vessel spill kits, secondary containment, pumping procedures, and applicable strategies contained within the MODU/Vessel's Shipboard Oil Pollution Emergency Plan (SOPEP);
    - Drilling a relief well (primary control);
    - Direct intervention using well control experts (if safe and technically feasible to do so);
    - Deployment of capping stack (if safe and technically feasible to do so);
    - Deployment of subsea first response tool kit (SFRT) – survey only (supporting control dependent on safety and technical considerations).
- Mechanical dispersion;
- Shoreline protection;
- Shoreline clean-up;
- Operational monitoring, including:
    - Vessel surveillance;
    - Aerial surveillance;
    - Tracking buoys;
    - Spill fate trajectory modelling;
    - Satellite imagery;
    - Initial oil characterisation;
    - Operational water quality monitoring; and
    - Shoreline and coastal habitat assessments.
- Scientific monitoring, could include:
    - Water and sediment quality;
    - Shoreline and coastal habitat monitoring (sandy beaches, rocky shores and intertidal mudflats);
    - Mangrove monitoring;
    - Benthic habitat monitoring (seagrass, algae, corals);
    - Marine fauna monitoring (seabirds, shorebirds, marine mammals, marine reptiles including turtles)
    - Seafood quality; and

  - Fish, fisheries and aquaculture.
- Waste management;
- Wildlife response operations including hazing and capture and rehabilitation.

8.1 Preparedness and Implementation of Response Arrangements

The MODU and support vessels are required to have and implement incident response plans, such as an emergency response plan and SMPEP/ SOPEP. Regular incident response drills and exercises (e.g. as defined in emergency response plan, SMPEP/ SOPEP, etc.) will be carried out on the MODU and support vessels to refresh the crew in using equipment and implementing incident response procedures.

Quadrant will implement the East Spar Plug and Abandonment Oil Pollution Emergency Plan (EA-66-RI-10009.02) in the event of a significant hydrocarbon spill (Tier 2 or 3). 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 will also implement its oil spill response exercise and training schedule. Further information on oil spill response is provided in the OPEP.

A communications test for the activity is completed prior to commencement of the plug and abandonment activity.

8.2 Net Environmental Analysis Benefits (NEBA)

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 Controlling Agency Incident Management Team (IMT) will use a Net Environmental Benefit Analysis (NEBA) process to inform the development and refinement of the IAPs, so the most effective response strategies with the least detrimental environmental impacts are identified, documented and executed. Within Quadrant's IMT, the Environmental Team Lead is responsible for reviewing the priority receptors identified within the EP and the OPEP, and apply NEBA to identify which response options are preferred for the situation, oil type and behaviour, environmental conditions, direction of plume and priorities for protection.

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 with support of real time metocean conditions, oil spill tracking and fate modelling.

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.

In the event of an oiled wildlife response, Quadrant will activate the West Australian Oiled Wildlife Response Plan (WAOWRP) and work with DBCA in determining resources and capability requirements. DBCA 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;
- DBCA 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. 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 East Spar Plug and Abandonment activity can be obtained from:

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