Factory 3D Marine Seismic Survey Environment Plan

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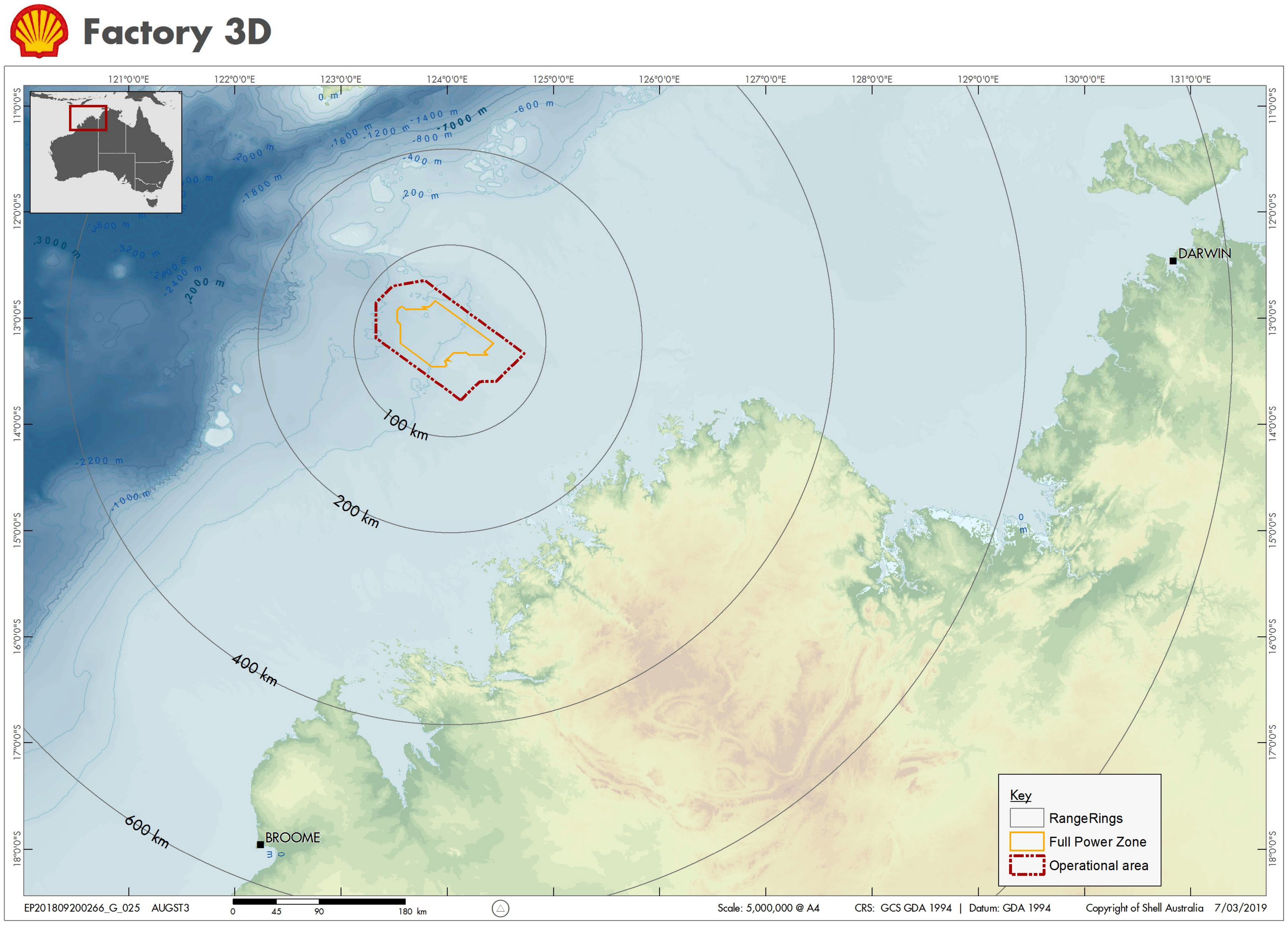

Figure 1-1 – Location of the Factory 3D MSS Operational Area (OA) and Range Rings Indicating the Distance to the Australian Mainland

1. Introduction

Shell Australia Pty Ltd (Shell Australia) is planning to undertake the Factory three-dimensional (3D) marine seismic survey (MSS) within the Browse and Bonaparte Basin offshore Western Australia (WA). The Factory 3D MSS will comprise acquisition of approximately 3,750 km^2 of 3D seismic data in Exploration Permits AC/P65, AC/P41, WA-534-P, and a very small portion of adjacent acreage for the purposes of acquiring sufficient data to fully-image the prospects on the titles. The Factory Operational Area (OA) is located approximately 103 km from the Kimberley coast of northern WA and is approximately 200 km from the Indonesian archipelago and East Timor.

Following acceptance, the Factory 3D MSS environment plan (EP) will be valid until the end of September 2020. The survey will be conducted as a single acquisition operation either between the beginning of November 2019 and the end of February 2020 or between the beginning of April 2020 and the end of September 2020; the survey will take a maximum of 73 days plus a contingent additional 17 days for unplanned down time such as bad weather etc.

1.1. Purpose

This EP has been prepared in accordance with the requirements of the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGS Act) and associated Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS (E) Regulations). It has also been prepared with reference to the Environment Plan Content Requirements Guidance Note (Rev 4, April 2019) produced by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

The EP aims to demonstrate that the Factory 3D MSS will be undertaken in a manner consistent with the principles of ecologically sustainable development and carried out such that environmental impacts and risks will be reduced to as low reasonably practicable (ALARP) and acceptable levels.

In accordance with Regulation 10A of the OPGGS (E) Regulations, this EP aims to:

- Be appropriate for the nature and scale of the Factory 3D MSS;
- Demonstrate that the environmental impacts and risks of Factory 3D MSS will be reduced to levels that are ALARP and acceptable;
- Provide for appropriate environmental performance outcomes (EPO), environmental performance standards (EPS) and measurement criteria (MC);
- Include an appropriate implementation strategy and monitoring, recording and reporting arrangements;
- Not involve activities being undertaken in any part of a World Heritage property;
- Demonstrate that appropriate consultation has been carried out by the titleholder and that the measures the titleholder intends to adopt as a result of consultation are appropriate; and
- Provide the basis for compliance with the requirements of the OPGGS Act and the OPGGS (E) Regulations.

1.2. Scope of this Environment Plan

The scope of this EP covers seismic data acquisition activities, normal vessel movements and operations (survey and support vessels) and associated vessel operations, within the OA.

This EP covers deployment and retrieval of all components of the towed seismic array (acoustic source array, streamer and associated equipment—vanes, tail buoy, birds etc.), vessel turning during line changes, line run-ins and run-outs, and all emergency response activities associated with the activity. The EP does not cover the transit of the survey or support vessel(s) to and from the survey location—i.e. from port to the survey area; and on completion of the survey from the survey area to either port or another location.

The scope does not include periods when the seismic and support / chase vessel(s) vessels are not engaged in survey or associated activities, such as during cyclone avoidance and maintenance outside of the OA.

Whilst the seismic vessel may transit WA State waters during transit to/from the OA, there will be no acquisition within WA State waters.

1.3. Titleholder

Titleholder Details	Liaison Person Details
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Should the details of the nominated liaison person or the contact details for either the titleholder or the liaison person change (as outlined on the coversheet submitted together with the EP), NOPSEMA will be notified via email from the company to submissions@nopsema.gov.au and via written correspondence.

2. Description of the Activity

2.1. Activity Overview

Shell Australia proposes to undertake the Factory 3D MSS over the AC/P65, AC/P41 and WA-534-P permits and surrounding areas in Commonwealth waters off WA.

The Factory 3D MSS is a typical 3D survey using methods and procedures similar to others conducted in Australian waters. No unique or unusual equipment or operations are proposed.

The survey acquisition area is approximately 3,750 km^2 with a larger OA (10,358 km^2) around it to allow for vessel line-turns and testing of equipment.

2.2. Location

The Factory 3D MSS will take place within Commonwealth waters off the WA coast within the Browse and Bonaparte Basins. The OA is approximately 500 km north of Broome, WA, and approximately 103 km from the Kimberley coast (i.e. Maret Islands). Water depths in the OA range from 24 m to 455 m, with most of the area deeper than 100 m water depth. Water depths within the FPZ specifically range from ~76 m to 374 m with the majority >100 m.

2.3. Survey Areas

For the Factory 3D MSS, several areas have been defined (**Figure 2-1** and **Figure 2-2**):

- <u>AC/P65 and WA-534-P permit areas</u> - acquisition over Shell Australia acreage totalling approximately 3,240 km^2 (2,910 km^2 and 330 km^2 respectively) which is the work programme commitment for seismic acquisition within these two permits.
- <u>Survey area</u> – the area in which the survey vessel will travel along pre-determined acquisition lines, towing the streamers and discharging the acoustic source. This area is approximately 3,750 km^2, including AC/P64, WA-534-P, and small portions of the adjacent areas to achieve sufficient coverage (AC/P41, AC/P59, AC/P36, and open acreage).
- <u>Full power zone (FPZ)</u> – this is the area where the seismic source will be at full power (3,480 in^3), to obtain full coverage within the survey area, as well as line run-outs beyond the survey area. This area is approximately 3,930km^2 but may be adjusted slightly due to adjustments in the acquisition line plan due to prevailing conditions. The FPZ includes the survey area with ~2.5 km extension where the seismic source leaves the survey area (run outs) after each line.
- <u>Soft Start Zone (SSZ)</u> – The area within which planned soft starts will occur prior to commencing each line of acquisition. Soft starts will follow the EPBC policy statement 2.1 (Part A.3) which mean the acoustic source will only gradually be 'ramped up' over the course of half an hour. This means the lowest source level would be used at the outer edges of the SSZ. The area covers a 6km buffer around the survey area outlined in **Figure 2-2**.
- <u>Operational Area (OA)</u> – this encompasses the survey area, FPZ and SSZ, and incorporates the necessary additional space for vessel manoeuvring and ancillary activities (i.e. additional area for line turns and maintenance). Maintenance will involve scheduled (notionally weekly) and unplanned maintenance of the airguns. This requires a brief test in order to verify correct operation of the acoustic source (several airgun discharges only). Test discharges of the acoustic array as part of maintenance will be undertaken using the lowest adequate power required, and by minimising the active array volume for the tests (less than 50% total array volume). No continuous line acquisition (i.e. continuous operation of the acoustic source during vessel turns) will occur in this survey. The OA is approximately 10,358 km^2.
- <u>Acoustic Source Exclusion Zones</u> – No air gun will be discharged within Acoustic Source Exclusion Zones for any purpose including maintenance. This zone comprises areas less than 70m water depth (i.e. area in the surrounding vicinity of Heywood Shoal) and a 7.32km buffer around the edge of the green turtle internesting BIA which occurs within the OA. Based on the acoustic modelling, received levels are not exceeded beyond 7.32 km of the airgun array discharge at full power (Refer to section 6.5.8).

Coordinates for the survey area and OA are provided in **Table 2-1**.

2.4. Timing

The Factory 3D MSS will be acquired as a single acquisition operation either between the beginning of November 2019 and the end of February 2020 or between the beginning of April 2020 and the end of September 2020. The survey will take a maximum of 73 days plus a contingent additional 17 days for unplanned down time, bad weather etc. This includes approximately 44 days of acquisition time.

Exact start and end dates will be communicated by Shell Australia to NOPSEMA and relevant stakeholders once confirmed.

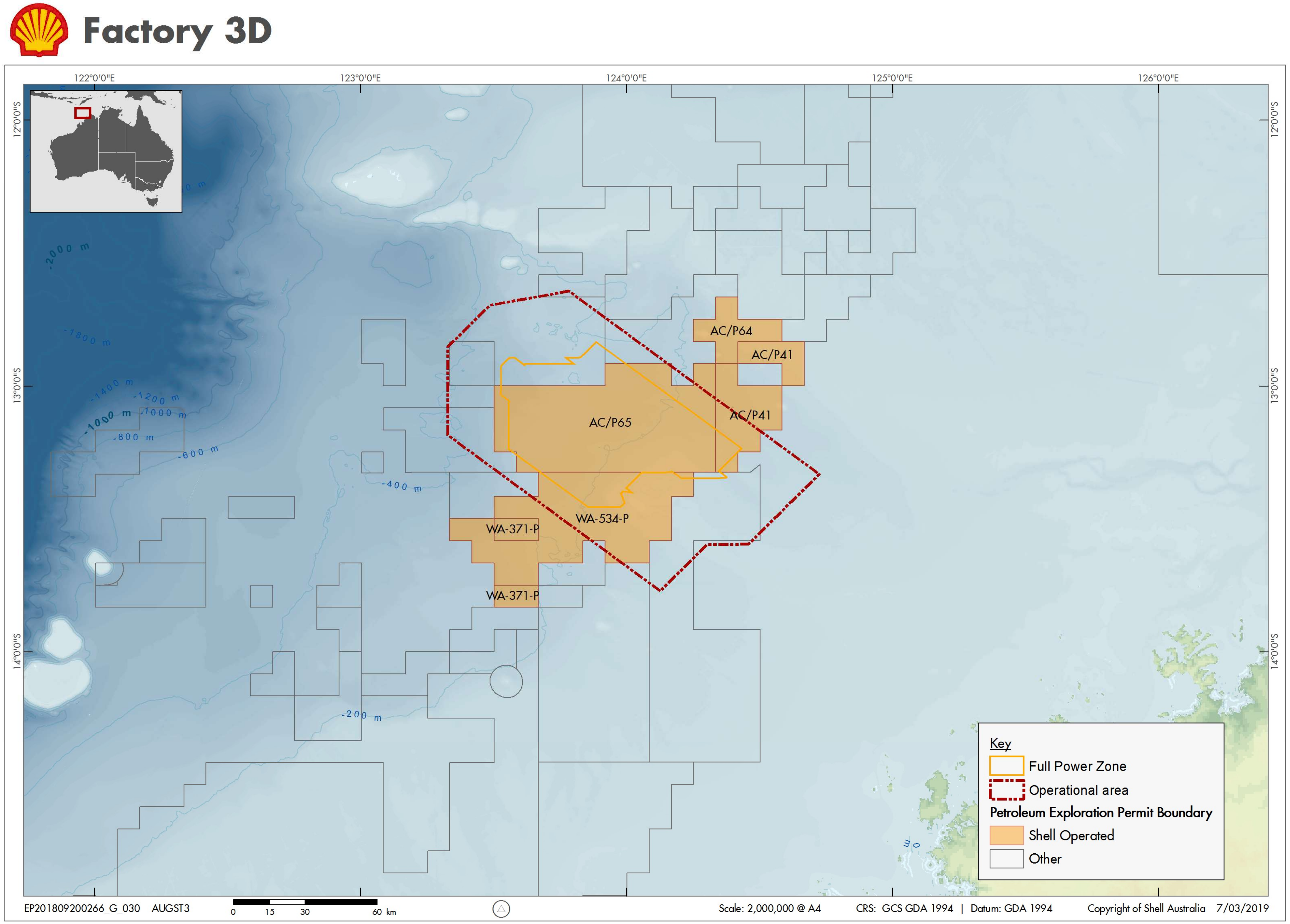


Figure 2-1 – Location of the Factory 3D MSS OA, Showing Petroleum Exploration Permit Boundaries

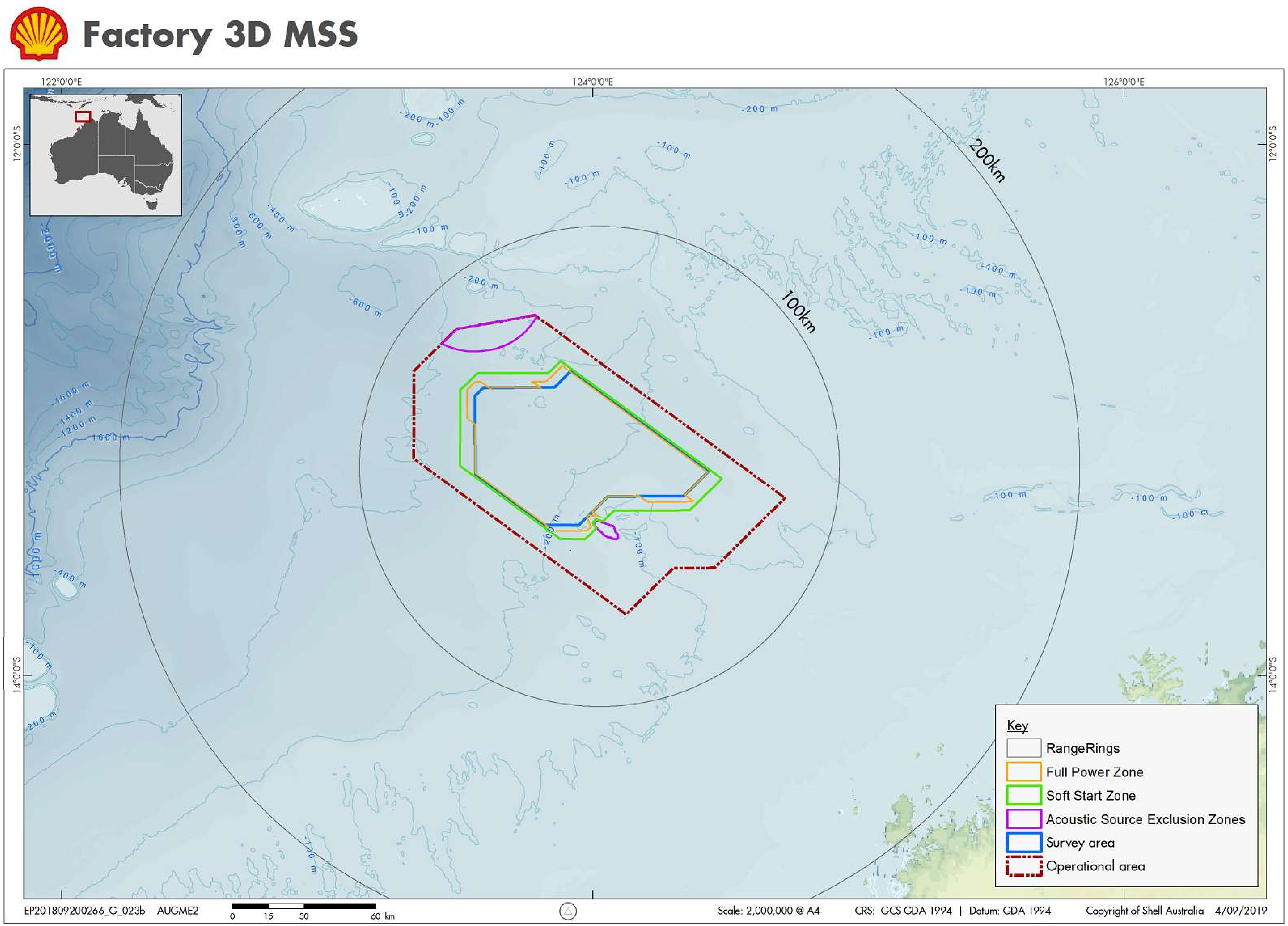


Figure 2-2 – Location of the Factory 3D MSS showing the OA, Survey Area, FPZ, Soft Start Zone and Acoustic Source Exclusion Zones.

Table 2-1 - Factory 3D MSS and OA Coordinates

No.	Latitude	Longitude
Survey Area		
1	-13.323850	124.341920
2	-13.325200	124.056058
3	-13.433239	123.946597
4	-13.433684	123.819612
5	-13.240921	123.556870
6	-12.946227	123.556208
7	-12.915817	123.587073
8	-12.915077	123.854999
9	-12.854309	123.916513
10	-13.232827	124.433821
OA		
1	-13.770243	124.125630
2	-13.184194	123.326037
3	-12.852977	123.325604
4	-12.695296	123.485755
5	-12.642742	123.782265
6	-13.331289	124.723648
7	-13.594401	124.458268
8	-13.595262	124.302798
9	-13.770243	124.125630

Datum: GDA 94 EPSG: 4283

2.5. Seismic Activity

The Factory 3D MSS is a typical 3D survey using methods and procedures similar to others conducted in Australian waters. No unique or unusual equipment or operations are proposed. A summary of the survey and equipment parameters is provided in **Table 2-2**. The survey will be conducted 24 hours a day.

The survey will comprise approximately 3,750 km^2 of data acquisition. Simultaneously to the seismic survey will be the acquisition of passive magnetic and gravity field measurements.

The planned seismic source array has a total capacity of 3,480 in^3 to be towed behind the survey vessel at 6-7 m below the sea surface. Two or three independent source arrays will be employed alternately ('flip-flop' or 'flip-flop-flap') at 6-7 second intervals along each survey line. The seismic vessel will tow an array of seismic streamers (hydrophones), each streamer will be approximately 8 km long with a tail buoy at the end, the array will be comprised of up to 12 individual streamers spaced 100 m apart and towed at a depth of 7-30 m below the sea surface. The vessel will acquire the seismic data along pre-planned lines along a north-west – south-east and south-east – north-west orientation.

Tail buoys will be used to indicate the streamer ends. Depth monitoring and control devices positioned along the streamers will be used to maintain the position of the streamers at the required depth. The survey will be conducted at a speed of approximately 4.5 knots (8.3 km/h). Specific impacts and mitigation measures for the survey activities, including the source and streamers, will be described further in this EP.

Table 2-2 – Factory Seismic Survey Parameters

Parameter	3D MSS Equipment
No. of streamers	12
Streamer length	Max 8,100 m
Streamer spacing	100 m
Streamer depth	7-30 m (max)
Maximum Size of acoustic array	3,480 in^3
Operating pressure	2,000 psi
Source interval per array (in distance)	37.5 m
Source interval per array (in time)	~ 6-7 s
Source depth	6-7 m
Line spacing	Between 560 and 750m

2.5.1. Seismic Source Justification

The seismic source array is comprised of approximately 30 acoustic sources of varying volumes, with the distribution of acoustic sources within an array designed such that the primary energy is directed downwards into the subsurface, and not horizontally away from the source. The total volume size of the acoustic array has been chosen to be as low as reasonably practicable, based on analysis of legacy surveys in the area, the range of water depths within the survey area and depth of the target within the subsurface (3-4 km below sea level) to ensure adequate seismic imaging.

Usually a larger volume equates to a stronger signal (peak amplitude), better signal to noise ratio, deeper penetration and hence improved data quality. The acoustic source array volume has been designed / selected to provide sufficient seismic energy to characterise the geological objective of the survey, whilst minimising environmental disturbance. The amount of seismic energy required is a factor of the depth of the geological target, the geology itself as well as the water depth.

A source array volume of 3,480 in^3 was nominated for impact analysis as the maximum volume based on previous surveys by others within the Browse and Bonaparte Basins.

2.5.2. Passive magnetic and gravity field measurements

The SeaSPY Marine Magnetometer system (or equivalent) will be used for the survey purpose of collecting passive magnetic measurements. Magnetometers are used to measure the direction, strength and relative change in the ambient magnetic field at a particular location. The SeaSPY Marine Magnetometer system is a high sensitivity total field magnetometer that is towed behind a vessel for use in magnetic exploration.

The system consists of a tow fish containing an Overhauser magnetometer sensor with driving electronics, a high strength marine tow cable, a water proof deck lead, a communication interface unit and a computer that runs Sealink software system. The magnetic field measurements are taken from inside the towed fish. The tow cable supplies power to the sensor and provides a bi-directional digital communication link.

The ZLS Fluid Damped Marine Gravity Meter (or equivalent) will be used for the survey purpose of collecting passive gravity measurements. Gravity meters are used to measure the strength and relative change in the ambient gravity field at a particular location. The Marine Magnetometer system is a high sensitivity passive total field magnetometer that is towed behind a vessel for use in exploration.

The gravity measurement system consists of an integrated sensor and recording system which is wholly contained within the survey vessel. The sensor produces an analogue electrical signal that is proportional to the magnetic or gravity field being sensed. The measurement device converts the analogue signal produced by the sensor to digital data recorded during the survey.

As passive measurement systems, the magnetic and gravity sensors do not emit any energy to the environment.

2.6. Seismic Vessel

Seismic data acquisition will be undertaken by a purpose-built, modern seismic vessel similar to the below (**Figure 2-3**).

The survey vessel will have all necessary certification/registration and be fully compliant with all relevant international conventions such as the International Convention for the Prevention of Pollution from Ships (MARPOL), and the International Convention for the Safety of Life at Sea 1974 (SOLAS) specific for the vessel's size and purpose. The survey vessel will have an implemented and tested Shipboard Oil Pollution Emergency Plan (SOPEP) in accordance with Regulation 37 of Annex I of MARPOL 73/78.

The vessel will travel within the OA at an average speed of 4.5 knots (~8.3 km/h). The use of helicopters may be required for the transfer of personnel to and from the survey vessel.

Figure 2-3 - Shearwater GeoServices Seismic Survey Vessel

2.6.1.1. Refueling

The survey vessel may be refuelled at sea by a support vessel.

Depending on the availability of contracted vessels, should the survey vessel have sufficient tank capacity to have endurance for the entire survey period, then no offshore refuelling/bunkering will be required.

2.7. Support Vessels

For the Factory 3D MSS there will be two (2) support vessels that will accompany the seismic survey vessel. These comprise:

- One supply vessel for resupply, refuelling and other support functions; and
- One chase vessel accompanying the seismic vessel to assist with maintaining a safe distance between the survey array and other vessels and to manage interactions with shipping and fishing activities.

The supply vessel will have sufficient size and power to tow the seismic vessel in the unlikely event of an emergency (e.g. if the seismic vessel loses power). The support and chase vessels will have an implemented and tested SOPEP.

Crew changes for the seismic vessel are expected to occur every 35 days by helicopter and/or by vessel transfer. The support and chase vessel will return to port for crew changes.

The relevant requirements of Shell's HSSE & SP Control Framework and Shell Australia HSSE & SP Management System are included in the Shell Australia Business Management System and are included in the contractual requirements for all contractors.

3. Description of Existing Environment

This section describes the key physical, biological, cultural and socio-economic characteristics of the existing environment that may be affected (EMBA) by the Factory 3D MSS, both from planned and unplanned events. The EMBA defines the maximum spatial extent for potential impacts from the Factory 3D MSS and has been developed by combining two different aspect exposures, adopting the greater extent of the two where they differ, for conservatism;

- Impacts from planned noise emissions from the seismic array (**Section 6.5**); and
- Impacts from an unplanned diesel spill resulting from a vessel to vessel collision (**Section 7.5**).

As defined in **Section 2.3**; the OA encompasses the survey area and incorporates the necessary space for vessel manoeuvring and ancillary activities, the survey area is the proposed area to be surveyed by the seismic vessel, and the FPZ defines the area where the seismic source will be at full power (i.e. 3,480 in^3; **Figure 2-1**)

The description of the existing environment provided in this section has informed a detailed evaluation of all impacts and risks associated with the project, as presented in **Sections 6** and **7**. It is important to note that impacts are not expected to occur within the entire EMBA, or the entire OA. For more information on the aspect exposures for noise and oil spills, see **Section 6.5** and **Section 7** respectively.

3.1. Regional Environment

The OA is located off the north-west coast of WA in the Browse Basin, approximately 500 km north of Broome and 103 km from the Kimberley coastline (Maret Islands). The OA lies in the North-west Marine Region (NWMR) defined by the Australian Government's Commonwealth Marine Reserves Network (Director of National Parks 2018).

The NWMR covers approximately 1.07 million km^2 of tropical and subtropical waters extending from the WA-NT border to Kalbarri, south of Shark Bay (Department of the Environment, Water, Heritage and the Arts (DEWHA) 2008; Director of National Parks 2018).

3.1.1. IMCRA Provincial Bioregions

The NWMR comprises eight provincial bioregions as identified in the Integrated Marine and Coastal Regionalisation of Australia (Department of the Environment and Heritage (DEH) 2006; DEWHA 2008; Director of National Parks 2018). Two of these overlap the survey area; the Timor Province and the North West Shelf Transition. A third provincial bioregion overlaps the south-western extent of the EMBA, the North West Shelf Province (**Figure 3-1**). These provincial bioregions are described below.

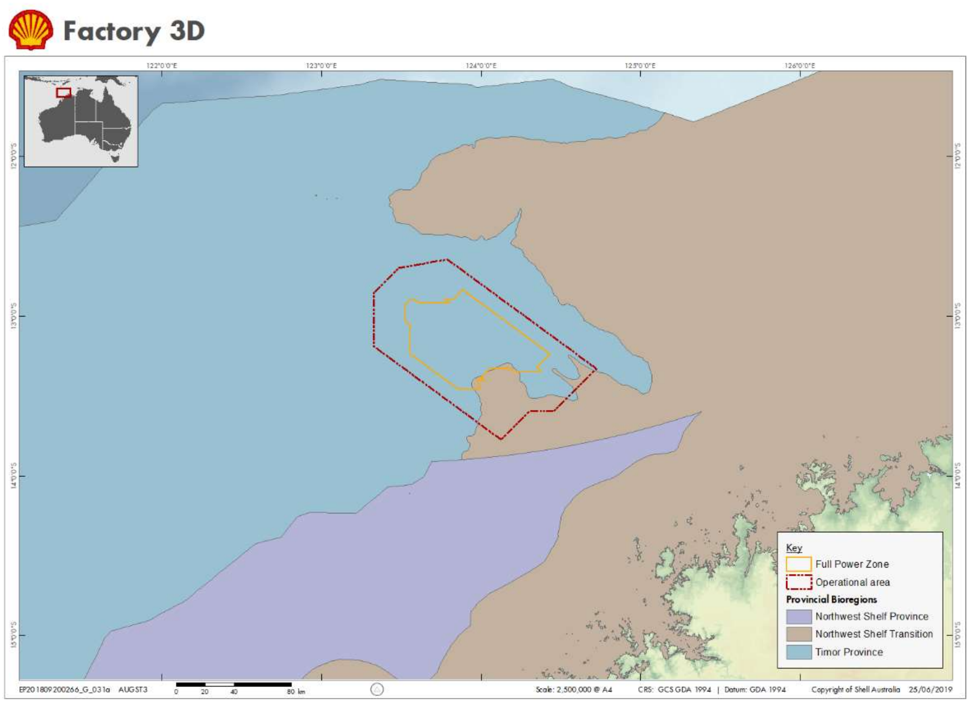
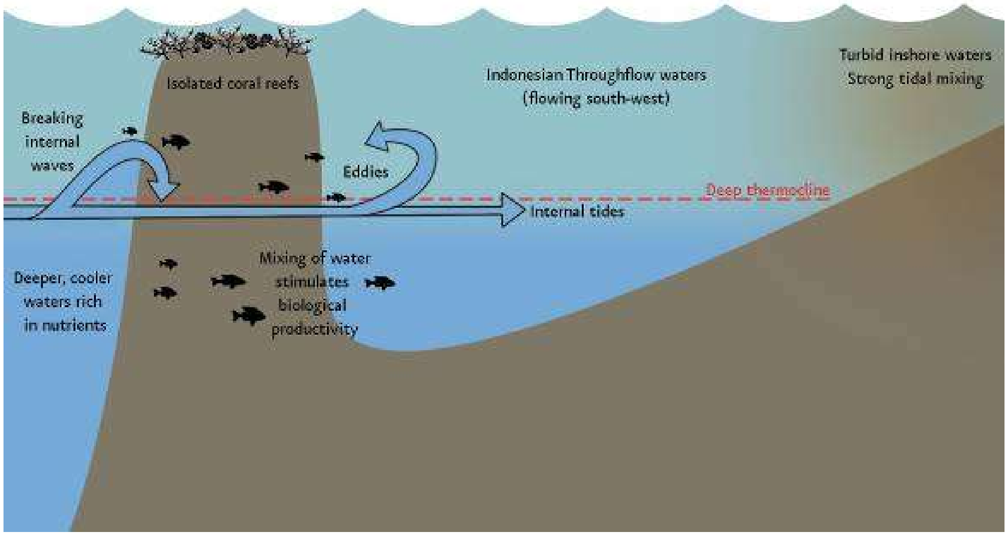


Figure 3-1 – IMCRA Provincial and Meso-scale Bioregions and the OA and FPZ (IMCRA v 4.0)

3.1.1.1. Timor Province

The Timor Province predominantly covers the continental slope and abyss between Broome and Cape Bougainville with water depths ranging from 200 m near the shelf break to 5,920 m over the Argo Abyssal Plain (DEWHA 2008). The bioregion comprises a number of geomorphic features including the Scott Plateau, the Ashmore Terrace, and a section of the Rowley Terrace. Many of these features are associated with significant reefs within the NWMR, including Scott Reef, Seringapatam Reef, Ashmore Reef and Cartier Island. Of these features Cartier Island and Ashmore Reef overlap the EMBA, and none overlap the OA.

Oceanographic processes influenced by bathymetry and geological features within the Timor Province are considered important for stimulating seasonal biological productivity in the region (**Figure 3-2**; DEWHA 2008). Wave movement over the shelf break and around features such as islands and shoals is thought to enhance mixing of surface waters with deeper nutrient rich waters resulting in increased productivity (DEWHA 2008). The diverse geomorphic features within the bioregion also provide for distinct habitat types and communities. Species and biological communities within the OA and EMBA are described below in **Section 3.4**.



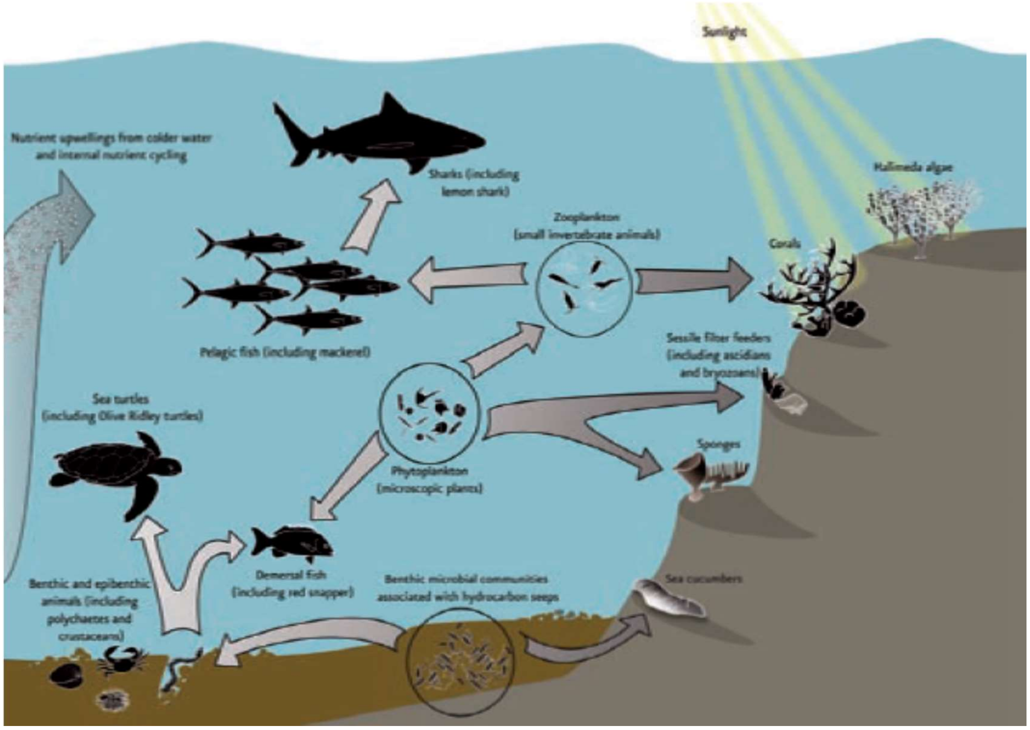
Source: modified from DEWHA (2008)

Figure 3-2 - Simplified diagram of trophic relationships of the Timor Province

3.1.1.2. North West Shelf Transition

The North West Shelf Transition provincial bioregion is located between the NWMR and North Marine Region (NMR) and extends from the Cape Leveque to the Tiwi Islands. The bioregion is located on the continental shelf with the majority of the region having water depths ranging from 10-100 m (DEWHA 2008). The bioregion comprises a number of unique geomorphic features, including extensive carbonate banks and shoals, submerged terraces, plateaus, pinnacles, sand banks, canyons, and reefs (DEWHA 2008). A number of these features have been defined as Key Ecological Features (KEFs). KEFs overlapping the OA and EMBA are described further in **Section 3.4.2**.

Biological communities range from soft-sediment associated filter-feeders and mobile invertebrates including echinoderms and crustaceans, to hard-substrate associated hard and soft corals, gorgonians, sponges and macro algae (DEWHA 2008). Areas of hard substrate generally support higher diversity benthic communities, while soft-sediment benthic communities are more sparsely distributed (DEWHA 2008). The North West Shelf Transition also supports a number of protected marine species, including marine turtles, dugongs and cetaceans, seabirds, and sharks and rays. Relevant species are described below in **Section 3.4**. An example of the trophic relationships between the communities in this provincial bioregion is shown in **Figure 3-3**.



Source: modified from DEWHA (2008)

Figure 3-3 - Simplified Diagram of Trophic Relationships at Van Diemen Rise, a bank within the North West Shelf Transition

3.1.1.3. North West Shelf Province

The North West Shelf Province is located predominately on the continental shelf (i.e. the North West Shelf), between the North West Cape and Cape Bougainville (DEWHA 2008). Across the bioregion the continental shelf slopes gradually from the coastline aside from a few notable unique features including banks/shoals, holes/valleys and several terraces (DEWHA 2008). The Ancient Coastline at 125 m Depth Contour is an important terrace which extends north-east from the North West Shelf Province into the North West Shelf Transition. The area has been defined as a KEF and is considered to be an important migratory pathway for cetaceans and other pelagic species including the whale shark (DEWHA 2008) (**Section 3.4.2**). The North West Shelf Province bioregion overlaps the EMBA, however, it does not extend into the OA.

3.2. Physical Environment

3.2.1. Climate

The Browse Basin and Timor Sea region experience a tropical climate with two distinct monsoonal seasons, a winter or "dry" season from April to September and a summer or "wet" season from October to March (RPS 2017). This is a result of the two major atmospheric pressure systems of the region; a subtropical ridge of high-pressure cells (highs or anticyclones) and a broad tropical low pressure (LP) region (the monsoon trough or inter-tropical convergence zone; RPS 2017). The south-east trade winds originating over the mainland provide a steady easterly air flow to the region in the dry season. The monsoon trough is characterised by the reversal of these winds and brings high rainfall when it is near or over the mainland (RPS 2017). The region experiences monsoonal climate patterns with tropical cyclones producing heavy rains, winds, swells and storm surges (BOM 2019).

Observations from the RPS (2017) metocean study, which comprised collection of 12 months of data in the offshore OA, noted that air temperatures remained relatively stable, with mean monthly temperatures ranging between 27°C in August and 30°C in December (RPS 2017).

3.2.1.1. Wind

South-east trade winds are prevalent from April to September. From May to August the winds average 11 to 30 km/h; however, winds stronger than 31 km/h are not uncommon. The trade winds are usually associated with fine dry weather. The trade winds produce a large swell that influences the southern side of most reefs in the area, resulting in consolidated crustose coralline algae and limestone substrates on the reef slopes (Skewes et al. 1999).

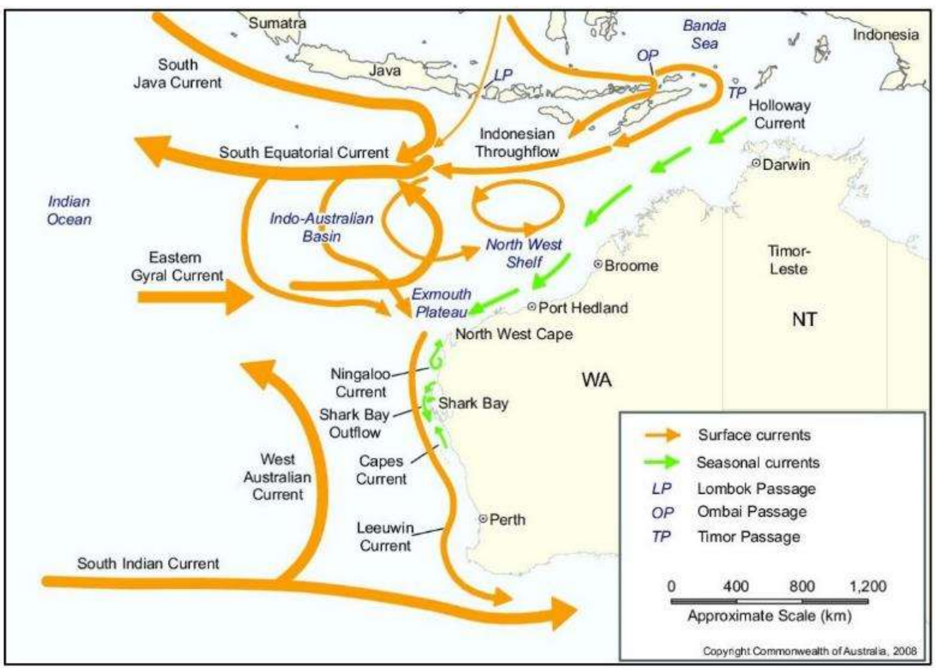
3.2.2. Oceanography

3.2.2.1. Currents

During the south-east trade winds (April to September), the predominant direction of the ocean current is south-west. In the monsoon season (December to March) winds come from the north-west or west, and the direction of the ocean current reverses becoming east-north-east. The mean rate of ocean currents throughout the year is usually less than 0.5 knots (Skewes *et al*. 1999).

Overall, a key characteristic of the regional oceanography of the NWMR is the poleward flow of the main surface currents. The significant difference in steric height between the Pacific and Indian Oceans drives Pacific waters through the Indonesian archipelago via the Indonesian Throughflow into the Indian Ocean. A portion of these waters eventually travel poleward via a strong alongshore pressure gradient. This pressure gradient is not present along the eastern edge of other major oceans and makes the WA system unique globally (DEWHA 2007).

The NWMR large scale surface currents are subject to strong seasonal variations, largely due to annual variation in the alongshore pressure gradient that is the main driver of the region's surface currents. The South Equatorial Current and Eastern Gyral Current intensify during July-September (**Figure 3-4**; DEWHA 2007). This complex system of ocean currents changes between seasons and between years, generally resulting in the surface waters being warm, nutrient poor and of low salinity (DEWHA 2008a).



Source: modified from DEWHA (2007).

Figure 3-4 - Regional oceanography and surface currents

3.2.2.2. Cyclones

The North-west or West Monsoons prevail from December to March and are associated with prominent cloud, rain and thunderstorm activity. Cyclones may occur between December and April. Typically, cyclones move south-west across the Arafura and Timor Seas. Gale to hurricane force winds can be encountered over an area between ~32 and 240 km wide during a cyclonic event. Approximately five cyclones occur in the region annually (BOM 2018a).

3.2.2.3. Sea Temperature and Salinity

Two separate surveys have been recently conducted by Shell Australia to assess water quality within the Browse Basin as part of the Crux project. The surveys sampled 24 sites within the Crux retention lease (AC/RL9) in April/May 2016 and October/November 2016 to reflect seasonality (AECOM 2016, 2017). The Crux retention lease is located within the EMBA, approximately 10 km north-east of the OA. Given this, and that the water depth and general environmental conditions are similar within the OA as in the Crux retention lease area, data collected as part of this survey is considered broadly applicable to the Factory 3D MSS.

Overall, surveys reported that water quality was of high quality (AECOM 2016, 2017). Temperature, salinity, pH and dissolved oxygen (DO) showed minor seasonal variation, however, overall measurements were relatively consistent across all sites and well within expected ranges when compared to previous studies in the region, such as Prelude (Shell 2009), Ichthys (INPEX 2010) and Barossa (ConocoPhillips 2018). Surface temperatures (in the shallow profile up to 10 m depth) ranged between approximately 30°C to 31 °C for both surveys (AECOM 2016, 2017).

Average surface salinities (0 m – 10 m) were recorded between 34 – 35 Practical Salinity Unit (PSU). Salinity was generally slightly lower near the seabed when compared to the surface waters. Turbidity was consistently low throughout the water column (< 1 NTU), which can be expected for offshore marine environments. Nutrient concentrations, including nitrite and nitrate, total nitrogen and total phosphorus, were consistently low across sites for both surveys, as were levels of photosynthetic pigments indicating little seasonal variation in these properties and no obvious nutrient loads.

3.2.3. Tides

The tides of the region are mixed and predominantly semi-diurnal (two high tides and two low tides per day), with well-developed spring to neap tidal variation (DEWHA 2008b). The region has some of the largest tides in Australia, with an increase in amplitude from south to north, which corresponds with the increasing width of the shelf. The mean spring and neap tidal ranges to the north-west of the OA at Ashmore Reef are approximately 4.7 m and 2.8 m respectively (Berry 1993).

Tides up to 5 m have been shown to strongly influence regional currents in the coastal zone and, over the inner to mid-shelf, large tidal ranges influence the dispersal of bottom sediments in the NWMR (Brewer *et al*. 2007; Ivey *et al*. 2016; RPS 2017).

The dominant tidal current flows in the NWMR in summer are east-north-east and west-south-west, with speeds generally ranging from 0.1 to 0.3 m/s (Pearce *et al*. 2003). Notably, tidal amplitudes seem to be retained at large distances offshore and travel initially in a north-east direction in the deeper waters of the region (RPS 2017).

3.2.4. Waves

The NWMR typically receives a persistent swell of around 2 m, generated by low-pressure systems in southern latitudes during winter; strong easterly winds can also generate 2 m seas. Both swell and seas tend to be smaller during summer (Pearce *et al.* 2003). Tropical cyclones generate waves propagating out in a radial direction from the storm centre, and generate swells from any direction, with wave heights between 0.5 and 9.0 m.

3.2.5. Bathymetry

The bathymetry of the OA, and the FPZ, (shown in **Figure 3-5**) is reflective of the geomorphic features of the operational area (described in **Section 3.3**) and is representative of the geomorphic features of the wider region. Water depths of the OA range from ~24 m to 455 m with the majority >100 m. Water depths within the FPZ specifically range from ~76 m to 374 m with the majority >100 m (**Table 3-1**).

Table 3-1 – Water Depths within the OA and FPZ

Depth Range (m)	FPZ		OA	
	km²	%	km²	%
0 to -20	0	0	0	0
-20 to -25	0	0	0.26	< 0.0
-25 to -30	0	0	2.58	0
-30 to -35	0	0	6.56	0.1
-35 to -40	0	0	3.99	0
-40 to -60	0	0	12.03	0.1
-60 to -100	5.11	0.1	631.39	6.1
-100 to −200	1188.14	31.7	4129.43	39.9
-200 to -650	2557.11	68.2	5572.54	53.8

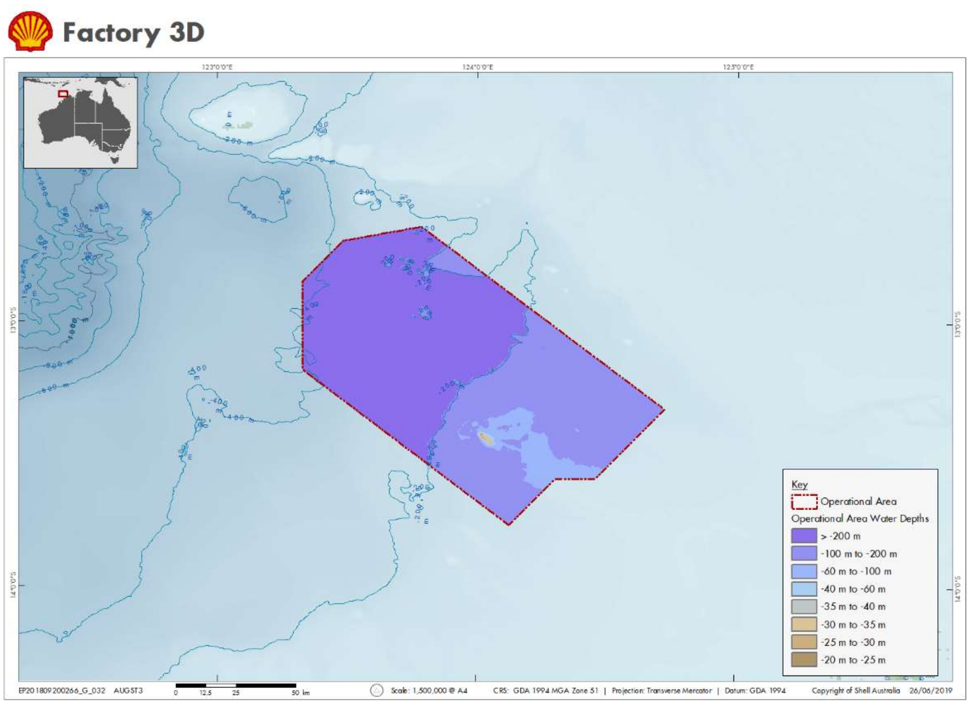


Figure 3-5 - Bathymetry of the OA and FPZ

3.3. Geomorphic Features

An important element of the diversity and dynamics of marine biological communities is an understanding of seabed bathymetry and seabed forms (i.e. geomorphic features). This is particularly important in areas where limited biological studies have been undertaken. Geoscience Australia have used bathymetric data and published geological studies to identify and classify geomorphic features of the seabed within the continental margin of Australia (Harris *et al*. 2005).

Based on Harris *et al*. (2005) the following geomorphic features are identified to be present within the EMBA:

- Bank – elevation over which the depth of water is relatively shallow but normally sufficient for safe surface navigation.
- Shoal - offshore hazard to surface navigation that is composed of unconsolidated material.
- Hole/Valley – Deep: restricted to depths greater than 6,000 m.
  - Hole: local depression, often steep sided, of the sea floor.
  - Valley: relatively shallow, wide depression, the bottom of which usually has a continuous gradient.
- Pinnacles - High tower or spire-shaped pillar of rock or coral, alone or cresting a summit. It may extend above the surface of the water and may or may not be a hazard to surface navigation.
- Shelf - Zone adjacent to a continent (or around an island) and extending from the low water line to a depth at which there is usually a marked increase of slope towards oceanic depths.
- Slope - Slope seaward from the shelf edge to the upper edge of a continental rise or the point where there is a general reduction in slope.
- Terrace - relatively flat horizontal or gently inclined surface, sometimes long and narrow, which is bounded by a steeper ascending slope on one side and by a steeper descending slope on the opposite side.
- Reef - Rock lying at or near the sea surface that may constitute a hazard to surface navigation.
- Plateau - Flat or nearly flat area of considerable extent, dropping off abruptly on one or more sides.
- Apron/Fan –
  - Apron: Gently dipping featureless surface, underlain primarily by sediment, at the base of any steeper slope.
  - Fan: Relatively smooth, fan-like, depositional feature normally sloping away from the outer termination of a canyon or canyon system.
- Canyon - A relatively narrow, deep depression with steep sides, the bottom of which generally has a continuous slope, developed characteristically on some continental slopes.

A summary of the occurrence of these geomorphic features within the EMBA and FPZ is provided in **Table 3-2**. The geomorphic features located within the vicinity of the OA as identified by Harris *et al*. (2005) are also shown in **Figure 3-6**. Most of the OA is classified as a hole/valley, with areas of terrace and slope. The area shown as a bank/shoal within the OA is Heywood Shoal. There are five other shoals which overlap the EMBA. These shoals, as well as the banks, reefs and islands within the OA and EMBA, are described in **Section 3.4.1.**

Table 3-2 –Summary of the Geomorphic Features Occurring Within the Factory EMBA and FPZ

Geomorphic Feature	Occurrence			
	EMBA	% intersecting EMBA within the Geomorphic Feature [1]	FPZ	% intersecting FPZ within the Geomorphic Feature
Apron/fan	✓	0.11	n/a	n/a
Bank/shoal	✓	0.60	n/a	n/a
Canyon	✓	0.69	n/a	n/a
Deep hole/Valley	✓	85.28	✓	3.68
Pinnacle	✓	7.51	n/a	n/a
Plateau	✓	2.20	n/a	n/a
Reef	✓	9.09	n/a	n/a
Shelf	✓	0.20	n/a	n/a
Slope	✓	1.84	✓	0.19
Terrace	✓	4.9	✓	0.03

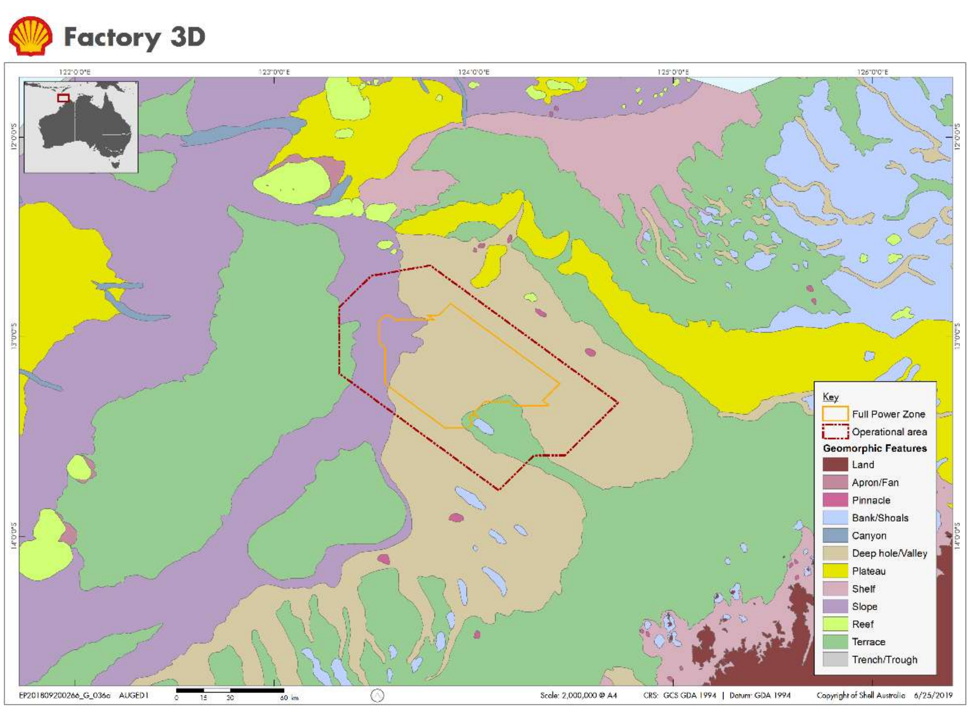


Figure 3-6 – Geomorphic Features of the OA and FPZ (source: Harris et al. 2005)

[1] Percentage is based on % cover of geomorphic features within the Timor Province, North West Shelf Transition and North West Shelf Province.

In addition to the geomorphic features described above, a survey by Fugro (2017a; located approximately 10 km north-east of the OA) recorded gravelly sand with hard substrate and a large outcropping reef area in the shallower north-eastern zone of the survey area (within the Factory EMBA). This outcropping reef structure is thought to be similar in origin to the many other shoals in the wider region of the Browse Basin (Fugro 2017a).

The survey found the seabed throughout the surveyed area to be relatively flat with a gentle gradient falling from the north-east toward the deeper south-west (Fugro 2017a). Seabed morphology was typically smooth and absent of hard substrates (excluding the north-eastern zone described above), with predominantly sandy sediments observed (Fugro 2017a). Other seabed features observed across the surveyed area included clusters of pockmarks, sand waves, megaripples and some anchor drag scars (Fugro 2017a).

3.4. Ecological Environment

3.4.1. Benthic Communities

Seafloor communities in offshore deeper waters, such as those found within the OA, are generally expected to be less abundant and diverse than shallower coastal areas. Notably, the absence of hard substrate at depth in areas of soft sediment is also considered a limiting factor for the recruitment of epifaunal benthic communities (Shell 2009; **Table 3-2**).

Camera observation and benthic grab surveys for benthic fauna and community characterisation were undertaken within the Crux retention lease by Fugro (2017a) and AECOM (2017). As described in **Section 3.2.5**, the Crux retention lease is located approximately 10 km from the OA, within the EMBA. The towed video and camera survey were conducted in April/May, recording benthic communities along 10 transects. Grab sampling sites for the sediment benthic fauna analysis by AECOM (2017) were the same sites as for the sediment quality assessment. Given the proximity of the survey to the OA, and the similar depth profile within these two areas, benthic communities within the OA are expected to be broadly the same as observed during these surveys.

Benthic surveys observed a very low fauna abundance (AECOM 2017). The dominant phyla were Annelida, Mollusca, Porifera and Arthropoda, as expected for the region. The amount of hard substrate present at each site appeared to have the greatest effect on the composition of the benthic community present (Fugro 2017a). Overall epifaunal abundance was low with some habitats having little to no visible fauna. Most habitats had low faunal abundance with a few characterising taxa. There were no evident spatial trends in benthic infauna based on sediment physicochemical attributes.

3.4.1.1. Shoals, Banks and Reef Communities

A large number of shoals and banks exist within the Browse Basin and open offshore waters off northern Australia, many of which have recognised biodiversity habitat value.

Shoals and banks are known to support highly diverse tropical communities and are generally similar in terms of seabed habitats, sediments, and biota; as are the drivers behind the species composition, diversity and abundance at these features. Shoals and banks support many of the same species found on emergent reef systems of the Indo West Pacific region, such as Ashmore Reef, Cartier Island, Seringapatam Reef and Scott Reef (Heyward *et al*. 2017b). This indicates a high level of ecological connectivity among the reef systems and between the shoals/banks.

While the benthic communities on each shoal/bank reveal a degree of connectivity, it is acknowledged that they may vary in the abundance and diversity of dominant benthic species, with subsets of species featuring more prominently on some than others (Heyward *et al*. 2017b). This variability may reflect different disturbance events (e.g. cyclones, storm damage and coral bleaching) and recruitment histories, as well as potentially different ecosystem trajectories (Heyward *et al*. 2017b).

The shoals, banks, reefs and islands which occur within the EMBA and OA are summarised in **Table 3-3** and shown in **Figure 3-7**. These features are described in **Sections 3.4.1.1.1** through **Sections 3.4.1.1.4**.

Table 3-3 Summary of the shoals, banks, reefs and islands within the EMBA, OA and FPZ

Feature	FPZ	OA	EMBA	
	Present	Present	Present	Distance from OA
Shoal				
Heywood Shoal	×	✓	✓	0 km (within the OA)
Eugene McDermott Shoal	×	×	✓	~ 13 km north-east
Goeree Shoal	×	×	✓	~ 14 km north-east
Vulcan Shoal	×	×	✓	~ 17 km north-east
Barracouta Shoal	×	×	✓	~ 23 km north-east
Echuca Shoal	×	×	✓	~ 25 km south-west
Bank				
Sahul Bank	×	×	✓	~ 130 km north-east
Woodbine Bank	×	×	✓	~ 30 km north
Holothuria Bank	×	×	✓	~ 142 km east
Reefs / Islands				
Cartier Island	×	×	✓	~ 9 km north
Ashmore Reef	×	×	✓	~ 52 km north-west
Browse Island	×	×	✓	~ 67 km south-west
Scott Reef[1]	×	×	×	~ 170 km south-west

[1]Scott Reef is not located within the EMBA, however; oil spill modelling indicate that shoreline accumulation may occur at South Scott Reef (Sandy Islet). This receptor is included here and discussed **Section 3.4.1.1** for completeness.

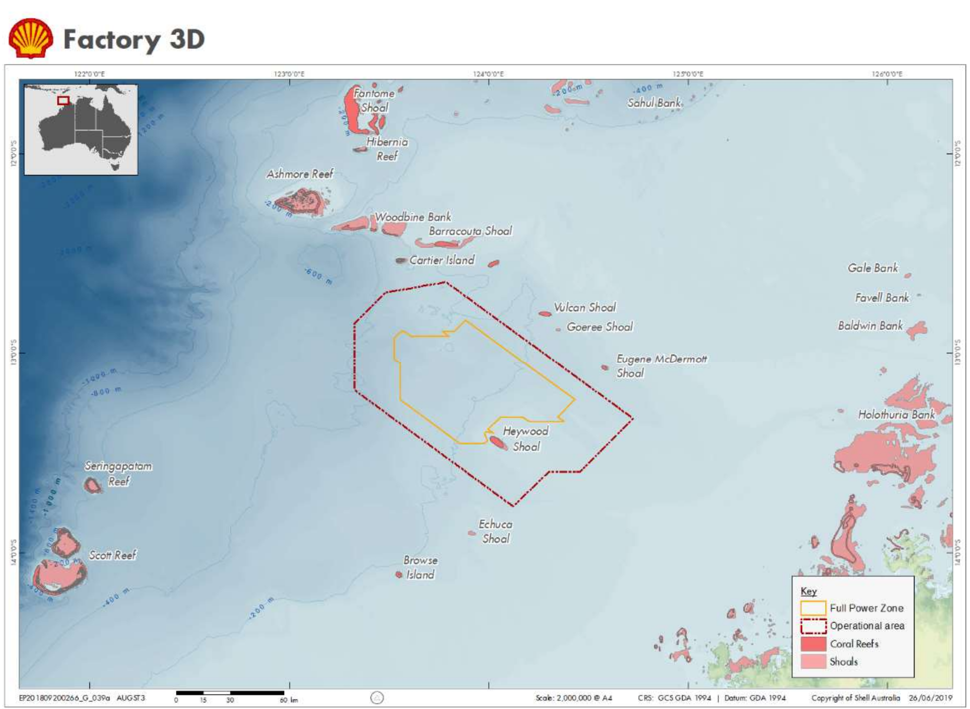
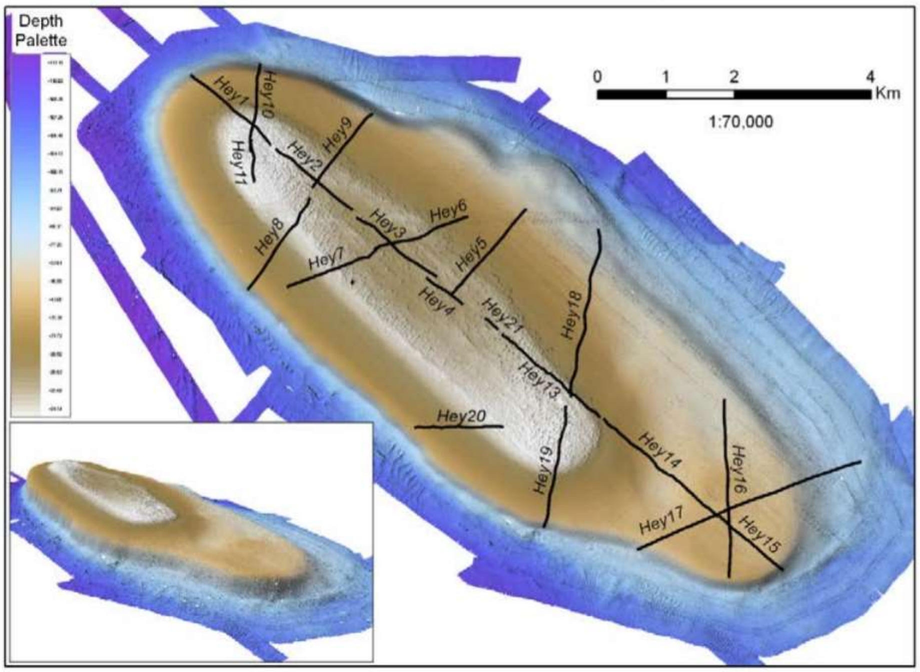


Figure 3-7 – Shoals, banks, reefs and islands within and adjacent to the OA and FPZ

3.4.1.1.1. Shoals within the Operational Area

Heywood Shoal

Heywood Shoal lies within the OA and just outside of the full power zone (**Figure 3-7**). As described above, the shoal rises abruptly from ~100 m water depth to form a plateau. Heywood shoal is characterised by two plateaus; a main plateau in shallow water depths of 15 to 20 m and a secondary plateau on the south-eastern side of the shoal in deeper waters (**Figure 3-8**).



modified from Heyward et al.et al. (2011).

Figure 3-8 - Heywood Shoal morphology and depth

The Australian Institute of Marine Science (AIMS) has undertaken annual field surveys (2014 – 2016) at Heywood Shoal which have included survey of the benthic habitats and associated fish communities (Heywood *et al*. 2017). The seabed is a mix of sand, rubble and generally low-relief consolidated reef supporting corals (hard and soft), invertebrates, fish and algae (Halimeda and Rhodoliths; **Figure 3-9**).

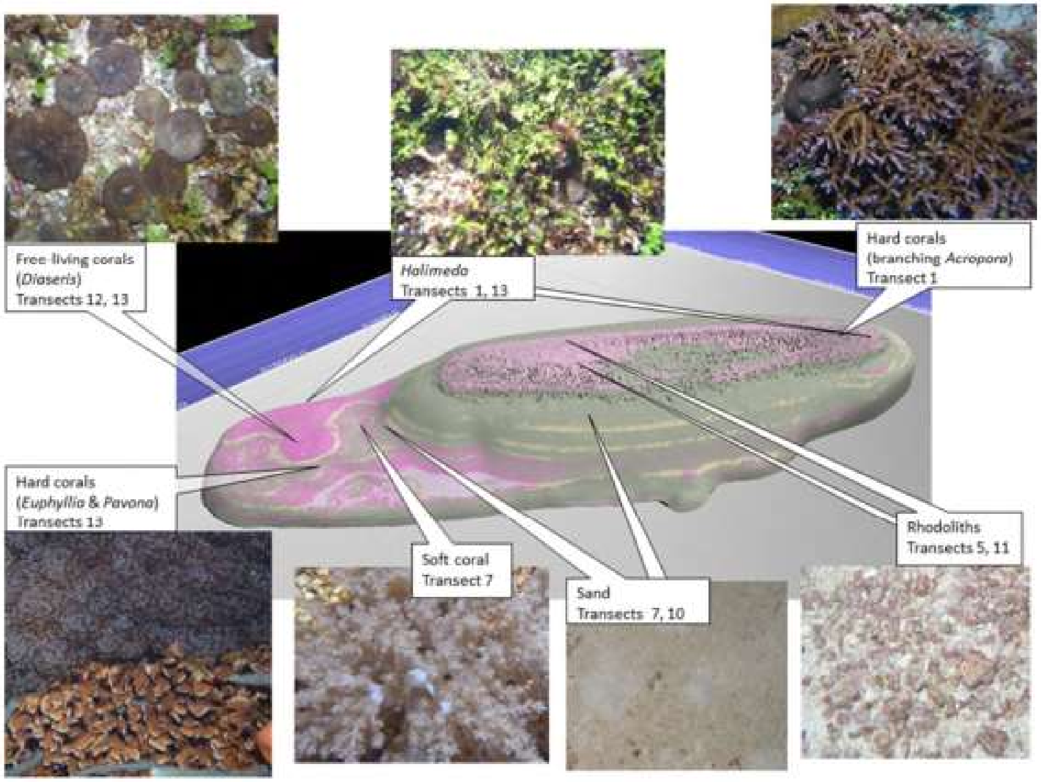
The coral cover component of the benthic communities was variable across the shoal. Hard coral is typically found in waters < 30 m. However, the shallow communities at Heywood shoal are characterised by halimeda, sand and rhodoliths and low cover of most other groups. Hard coral cover in these shallow areas are typically low (average of 2.6%). In deeper waters (>40 m) the secondary shoal supports a thriving epibenthic community with coral cover (hard and free-living corals) of 31.9%. The abundance (percent cover) of coral has been variable over time (**Figure 3-10**).

The most common biota across surveys at Heywood Shoal was the various algal species. Macroalgae was the most abundant benthic biota at the shoal with a mean coverage of 39% between 2014 and 2016, dominated by red algae and turf. Notably, there was distinct variation in macroalgae composition between seasons. This was particularly evident when comparing the 2014 survey (which took place in spring) with the 2015 and 2016 surveys (which were undertaken in autumn). Generally, the macroalgae community included fewer taxonomic groups in 2015 and 2016.

Biota at Heywood Shoal comprises a diverse and abundant assemblage of fauna, including reef-associated fishes, sharks, rays and sea snakes. Surveys undertaken using Baited Remote

Underwater Video Systems (BRUVs) indicated that the shoal has four distinct fish assemblages, largely dependent on water depth, reef cover and size of the shoal (Heywood *et al*. 2017).

On the primary plateau of Heywood Shoal there were two different fish assemblages based on reef cover; in areas of high reef cover the fish assemblage was characterised by species associated with coral habitat, including species of butterfly fish (Chaetodonidae), angel fish (Pomacanthidae) and snapper (Lutjanidae). In areas of low coral cover, fish assemblages were characterised with species of trevally (Carangidae), wrasse (Labridae) and surgeon fish (Acanthuridae). The secondary plateau, deeper plateau with high coral cover hosted such species as angelfish (Pomacanthidae), groupers (Serranide) and wrasse (Labridae). While around the periphery of the shoal in deeper water, the fish assemblages were characterised with species of trigger fish (Balistdae), toadfish (Tetraodontidae) and jacks (Carangidae).



Source: modified from Heywood *et al*. (2017).

Figure 3-9 – Examples of the biota found at sampling locations on Heywood Shoal

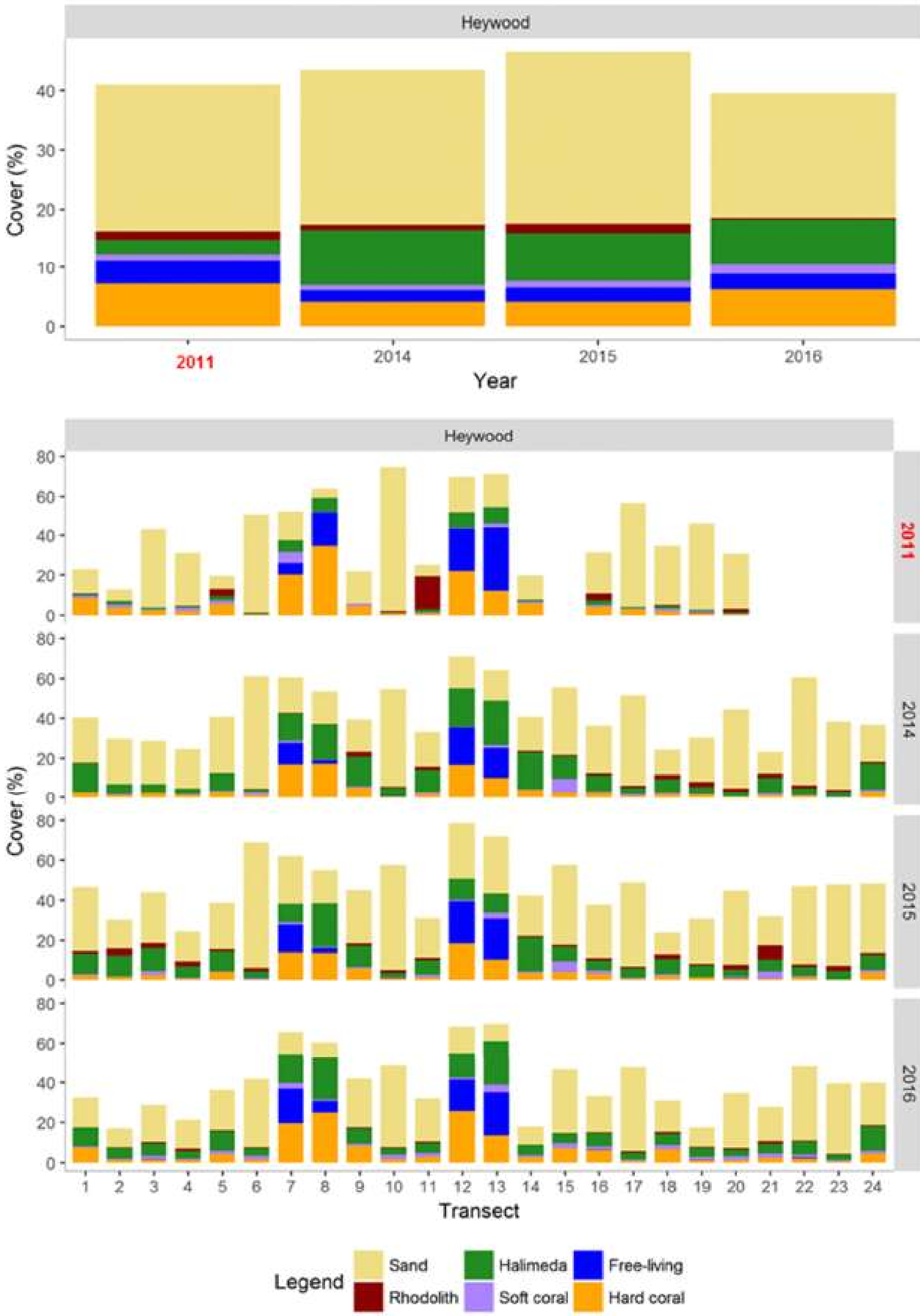


Figure 3-10 - Abundance of six broad-scale categories of biota and substrate type at Heywood Shoal. The upper histogram shows shoal-scale overall percentages across time and the cumulative bar plots show percent cover by individual transect.

3.4.1.1.2. Shoals in the region

In addition to Heywood Shoal, there are five other shoals that occur within the EMBA (**Figure 3-7**); Eugene McDermott, Goeree, Vulcan, Barracouta and Echuca Shoals. These shoals rise steeply from 100-200 m water depths on the outer continental shelf and begin to flatten out into plateau-like tops typically ranging in depth from approximately 16–50 m below sea level (Heyward et al. 2012; Heyward et al. 2017b). The plateau areas of each shoal occasionally rise to within approximately 10 m of the sea surface.

Vulcan shoal is slightly larger than Echuca Shoal, with plateau areas for both shoals approximately 11-13 km^2 (Heyward et al. 2012). Eugene McDermott Shoal is smaller, approximately 6 km^2 in area, and the minimum depth below sea level is 38 m. Goeree Shoal is the smallest of the five, with a plateau area of 3 km^2. Barracouta shoal comprises two shoals, Barracouta East and Barracouta West, separated by a deep channel (>200 m; Heyward et al. 2012). The total plateau area for these shoals is 9 km^2 with Barracouta East the larger of the two at 6km^2.

On the shoal plateaus, there is adequate light to support many photosynthetic organisms. All shoals support diverse biological communities across their shallow plateau areas (Heyward et al. 2012). The benthic communities across shoals in proximity to the OA have been found to be typical of shallow tropical reef systems in the region, with many coral and algae species shared between the shoals and the emergent coral reefs (Heyward et al. 2012; Heyward et al. 2017). Habitats in < 30 m of water are characterised by consolidated reef (and associated turfing algae), hard coral, sand and algae (Heyward et al. 2017). The abundance of hard coral habitat decreases with increasing water depth (Heyward et al. 2017).

Habitat cover has been variable over time at all of the shoals, with the exception of Eugene McDermott which has not been monitored since 2011 (e.g. decreased in biotic cover after 2011). Physical disturbance associated with storms may be an important driver of shoal communities (Heyward et al 2017). Though all shoals have seen an increase in biotic cover in 2016 (Heyward et al 2017a and 2017b). Notably, seagrass meadows were observed at Vulcan Shoal in 2010 but had significantly declined by 2011 and had not recovered by 2016 (Heyward et al. 2017).

Fish assemblages at these shoals, as at Heywood Shoal (**Section 3.4.1.1**), were variable with water depth, reef cover and size of the shoal. Similar fish assemblage diversity was identified by Heyward et al. (2012) at Eugene McDermott, Barracouta East and Barracouta West Shoals, all shoals of similar size. The coral habitat in the shallower part of the shoal hosted species such as grouper (Serranidae), damselfish (Pomacentridae) and wrasses (Labridae), which was similar to the assemblage in this habitat at Goeree Shoal (Heyward et al. 2012). Deeper parts of the shoal plateau with relatively high reef cover hosted angelfish (Pomacanthidae), groupers (Serranidae) and wrasses (Labridae; Heyward et al. 2012). The relatively deep peripheral shoal hosted a less diverse assemblage hosting wrasses (Labridae), houndsharks (Triakidae) and dartfish (Ptereleotrinae; Heyward et al. 2012). While Goeree Shoal had similar fish assemblages to Eugene McDermott, Barracouta East and Barracouta West Shoals there were fewer fish assemblages, likely due to the smaller shoal and less variation in benthic habitat.

Vulcan and Echuca shoal had a similar fish assemblage diversity to the other shoals, however the fish assemblages differed largely due to the difference in shoal size. The fish assemblage associated with the relatively shallow areas with high coral cover include angelfish (Chaetodontidae), butterfly fish (Pomacanthidae) and snapper (Lutjanidae; Heyward et al. 2012). Shallower areas with less reef cover supported species that were less likely to be site-attached and included trevally (Carangidae), wrasses (Labridae) and scad (Carangidae; Heyward et al. 2012). Deeper areas with low reef cover supported wrasses (Labridae), houndsharks (Triakidae) and dartfish (Ptereleotrinae; Heyward et al. 2012).

3.4.1.1.3. Banks in the region

There are three banks within the EMBA (**Table 3-3**); Sahul, Woodbine and Holothuria Banks. An overview of these features is provided here:

- The Sahul Banks are located along the north-facing margin of the continental shelf, north-west of Ashmore Reef. The banks comprise three main clusters located between the 200 and 300 m isobaths, and a smaller cluster along the 200 m isobath. The Sahul banks seem to be primarily formed by skeletal accumulations of calcareous alga Halimeda. The top of the banks are situated within approximately 20

to 25 m water depth (with some points as shallow as 7 m), with hard coral habitats noted. The banks are thought to have once been a chain of islands, however; subsidence of the shelf margin and rising sea levels have covered these features. The Sahul Banks form part of the Carbonate bank and terrace system of the Sahul Shelf KEF (**Section 3.4.2**).
The Sahul Banks are thought to support a high diversity of species, including reef fish, sponges, corals (soft and hard) and sessile filter feeding organisms. The banks are known to provide foraging habitat for loggerhead, olive ridley and flatback turtles. Humpback whales, and green and freshwater sawfish are also thought to occur within the system of banks.
- Woodbine Bank is located along the 200 m isobath and to the west of Ashmore Reef.
- Holothuria Bank is located in the northern most part of the Commonwealth Kimberley Marine Park (**Section 3.5.3**). This area is considered to be the most diverse marine area in the Kimberley region, primarily as a result of the Indonesian Throughflow current which brings eggs, larvae and fish to this area from the Coral Triangle located to the north. East Holothuria Reef, part of Holothuria Bank, is known to support breeding flatback turtles, green turtles and lesser frigatebirds.

3.4.1.1.4. Offshore Reefs and Islands in the region

There are no known reefs and islands within the OA. However, Cartier Island, Ashmore Reef and Browse Island occur within the EMBA (**Figure 3-7**). The following list provides a brief description of the features of these reefs and islands:

- Cartier Island lies approximately 9 km north of the OA, within the EMBA. Cartier Island is an un-vegetated sand cay surrounded by a wide platform, that rises steeply from the seabed, and fringing coral reef flats (ConocoPhillips 2018). The coarse sandy beaches of the island support large populations of nesting green turtles. The island and surrounding reefs are protected by the Cartier Island Marine Park, an Australian Marine Park (AMP; **Section 3.5.3**).
- Ashmore Reef is located approximately 52 km north-west of the OA, within the EMBA. Ashmore Reef is a large platform reef complex containing an atoll-like structure with two lagoons, large areas of drying flats that become exposed at low tide, shifting sand banks and three vegetated sandy cays: West Island (281,000 km^2), East Island (134,200 km^2), and Middle Island (129,800 km^2; ConocoPhillips 2018). The area is protected by the Ashmore Reef Marine Park (an AMP; **Section 3.5.3**) and is also a designated Ramsar wetland of international significance (**Section 3.5.3**).
- Browse Island lies approximately 67 km south of the OA, within the EMBA. Browse Island is a sand and limestone cay situated on a limestone and coral reef, covering an area of 13 ha (0.13 km^2; Shell 2009). The island is a known turtle nesting site for green turtles.

One other reef within the vicinity of the EMBA is Scott Reef which is located approximately 60 km south-west of the EMBA. Scott Reef is comprised of two coral atolls, South Scott Reef and North Scott Reef, with a deep channel between them, and is known to support nesting populations of green turtle, and low numbers of seabirds and migratory shorebirds. Pygmy blue whales (*Baleanoptera musculus brevicauda*) may also forage and migrate within and in the vicinity of this feature. Scott Reef may be contacted by shoreline accumulation (**Table 7-12**) and has, therefore, been included here for completeness.

The surrounding waters within three nautical miles (nm) of Scott Reef and Browse Island are WA State Territorial Waters and have been defined as WA State managed nature reserves (**Section 3.5.1**).

3.4.2. Key Ecological Features

KEFs are elements of the Commonwealth marine environment that are considered to be of regional importance for either the marine region's biodiversity or its ecosystem function and integrity. KEFs are features protected under the Commonwealth *Environment Protection and*

Biodiversity Conservation Act 1999 (EPBC Act). Two KEFs occur within the OA (and, therefore, the EMBA):

- Ancient Coastline at 125 m Depth Contour KEF; and
- Continental Slope Demersal Fish Communities KEF.

Two additional KEFs located only within the EMBA (and not the OA) are (**Figure 3-11**):

- Ashmore Reef and Cartier Islands and Surrounding Commonwealth Waters KEF;
- Carbonate bank and terrace system of the Sahul Shelf.

A summary of these KEFs is provided in **Table 3-4** (DSEWPaC 2012a; 2012b).

The Seringapatam Reef and Commonwealth waters in the Scott Reef complex KEF has also been included in **Table 3-4** for completeness**,** as oil spill modelling has identified potential shoreline accumulation may occur during transitional months (1% probability) reefs (**Table 7-12**).

Table 3-4 – Description of the KEFs overlapping the Factory EMBA, OA and FPZ

KEF	Occurrence			Summary of Key Values	% of KEF intersects the FPZ
	FPZ	OA	EMBA		
Ancient Coastline at 125 m Depth Contour	✓	✓	✓	*Unique seafloor feature with ecological properties of regional significance* The areas of hard substrate along this ancient coastline, which follows the 125 m depth contour, are thought to provide biologically important habitats in areas otherwise dominated by soft sediments; thereby providing for higher species diversity and richness relative to the wider region. The topographic complexity of these escarpments may also facilitate vertical mixing of the water column providing a relatively nutrient-rich environment for species present on the escarpment. The KEF encompasses an area of approximately 16,190 km^2.	*0.8*
Continental Slope Demersal Fish Communities	✓	✓	✓	*Communities with high species biodiversity and endemism* There is a high diversity of demersal fish assemblages on the Australian continental slope from the North West Cape to the edge of the NMR. Specifically, the continental slope between North West Cape and the Montebello Trough has more than 500 fish species, 76 of which are endemic, which makes it the most diverse slope bioregion in the whole of Australia (DEHWA 2008). The Timor Province and North West Transition bioregions, in which the OA and EMBA is located, are the second-richest areas for demersal fish across the entire continental slope. The KEF encompasses an area of approximately 33,182 km^2.	*1.5*
Ashmore Reef and Cartier Islands and Surrounding Commonwealth Waters	-	-	✓	*High productivity and aggregations of marine life* Ashmore Reef is the largest of only three emergent oceanic reefs present within the north-eastern Indian Ocean and is the only oceanic reef in the region with vegetated islands. The emergent reefs are known to provide areas of enhanced primary productivity in otherwise oligotrophic environments. Ashmore Reef and Cartier Islands and the surrounding Commonwealth waters are regionally important for feeding and breeding aggregations of seabirds and shorebirds, and other marine life. Ashmore Reef regularly supports more than 40,000 waterbirds (those ecologically dependant on wetlands) and is estimated to support as many as 100,000 seabirds in a twelve-month period (Hale 2013). The marine habitats supported by the reefs are nationally and internationally significant, providing habitat for diverse and abundant marine reptile (including feeding, nesting and internesting areas for green, hawksbill and loggerhead turtles) and marine mammal populations, including dugongs. Species at Ashmore and Cartier include more than 225 reef-building corals, 433 molluscs, 286 crustaceans, 192 echinoderms, and 709 species of fish. Thirteen species of sea snakes occur in high numbers at Ashmore and Cartier reefs but are in decline. Additionally, Ashmore Reef supports the highest number of coral species of any reef off the WA coast and plays a primary role in the maintenance of the biodiversity of reef systems in the region. The KEF encompasses an area of approximately 2,259 km^2.	*n/a*

Carbonate bank and terrace system of the Sahul Shelf	-	-	✓	*Unique seafloor feature with ecological properties of regional significance* While little is known about this KEF, the carbonate banks and terrace system of the Sahul Shelf is considered regionally important because of their role in enhancing biodiversity and local productivity relative to their surrounds, largely due to the presence of elevated hard substrates. The seabed features are thought to create enhanced productivity and biodiversity because of upwellings of cold nutrient-rich water at the heads of the channels. The KEF covers an area of approximately 41,158 km2. The banks rise to depths of 150-300 m and are separated from each other by narrow meandering channels which are up to 150 m deep. The hard substrates of the banks are thought to support a high diversity of organisms including reef-fish, sponges, soft and hard corals, gorgonians, bryozoans, ascidians and other sessile filter feeders.	*n/a*
Seringapatam Reef and Commonwealth waters in the Scott Reef complex	-	-	✓	*High productivity and aggregations of marine life* The coral communities at Seringapatam and Scott Reefs play a key role in maintaining species richness and aggregations of marine life. Scott Reef is a particularly biologically diverse system and includes more than 300 species of reef-building corals, approximately 400 mollusc species, 118 crustacean species, 117 echinoderm species, around 720 fish species and several species of sea snakes.	*n/a*

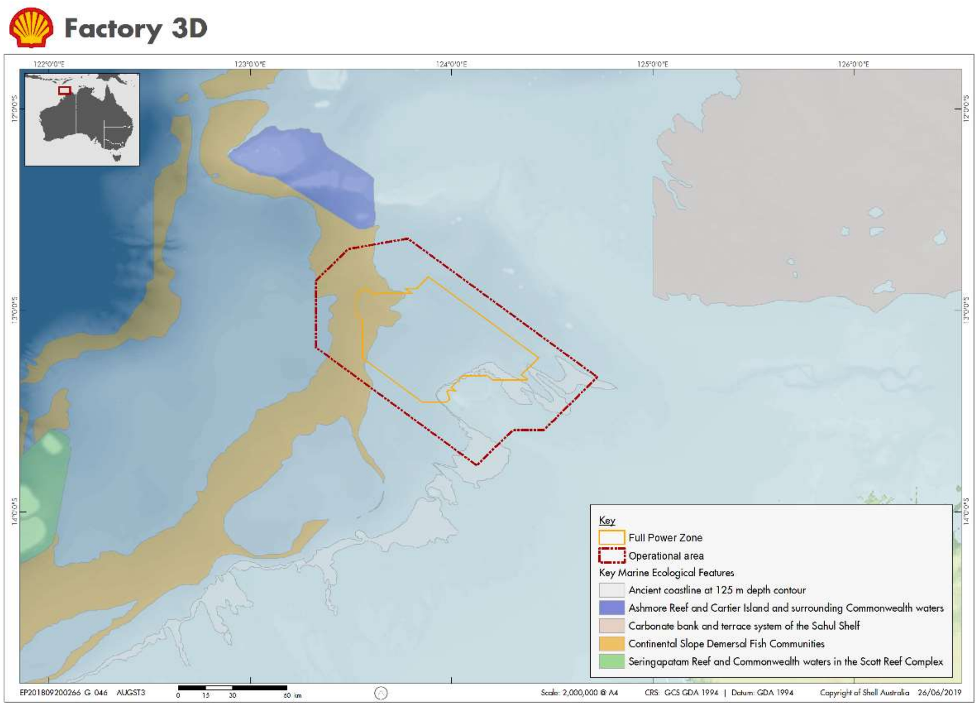


Figure 3-11 - Key Ecological Features within the OA and FPZ

3.4.2.1. Anthropogenic Pressures

The DoEE Commonwealth Marine Report Cards for the NWMR and NMR provide a high-level analysis of the anthropogenic pressures on KEFs (DSEWPaC 2012a; 2012b). The analysis defines five categories in which each pressure impacts on the designated KEF including 'of concern', 'of potential concern', 'of less concern', 'not of concern' and 'data deficient or not assessed'.

Table 3-5 outlines identified pressures to the KEFs within the FPZ, OA and EMBA. From this, five credible pressures were identified as relevant; the highest pressure was listed as 'Potential concern' for invasive species and marine debris within the Ashmore Reef and Cartier Islands and Surrounding Commonwealth Waters KEF (outside the OA and FPZ). A detailed assessment of the potential impact to these KEFs from oil pollution is provided in Section 7.5.

Table 3-5 – Relevant Pressures to KEFs from the Factory 3D MSS (DSEWPaC 2012)

KEF	Pressure				
	Marine debris – vessels	Noise pollution – vessels and seismic exploration	Physical habitat modification – Vessels anchorage	Oil pollution – shipping	Invasive species – vessels
Ancient Coastline at 125 m Depth Contour	Not assessed	Less concern	Not assessed	Not of concern	Not of concern
Continental Slope Demersal Fish Communities	Not assessed	Not of concern	Not assessed	Not assessed	Less concern

KEF	Pressure				
	Marine debris – vessels	Noise pollution – vessels and seismic exploration	Physical habitat modification – Vessels anchorage	Oil pollution – shipping	Invasive species – vessels
Ashmore Reef and Cartier Islands and Surrounding Commonwealth Waters	Potential concern	Not of concern	Less concern	Less concern	Potential concern
Carbonate bank and terrace system of the Sahul Shelf	Less concern	Not of concern	Not of concern	Not of concern	Not of concern
Seringapatam Reef and Commonwealth waters in the Scott Reef complex	Potential concern	Less concern	Less concern	Less concern	Potential concern

3.4.3. Ecological Environment

3.4.3.1. EPBC Act Listed Threatened and Migratory Species and Threatened Communities

A search of the DoEE EPBC Act Protected Matters Search Tool (PMST) Database was undertaken for both the OA and EMBA (including a 1 km buffer; **Appendix B** and **Appendix C**) to identify the likelihood of occurrence of Matters of National Environmental Significance (MNES); including threatened and Migratory species and Threatened Ecological Communities (TECs). No Listed TECs were identified in the PMST reports. The following is a summary of the PMST reports for the EMBA and OA:

- OA – the PMST report identified 21 listed threatened fauna species and 35 listed migratory species (17 of which are also listed as threatened) that may occur or have habitat in the area (**Table 3-6**); and
- EMBA – the PMST report identified 24 listed threatened fauna species and 54 listed migratory species (17 of which are also listed as threatened) that may occur or have habitat in the area (**Table 3-6**).

Four marine bird species not listed in the PMST reports are known to breed at Ashmore Reef (within the EMBA); the eastern great egret (*Ardea modesta*), little egret (*Egretta garzetta*), eastern reef egret (*Egretta sacra*) and nankeen night-heron (*Nycticorax caledonicus*; Clarke *et al*. 2011). These species are listed marine species under the EPBC Act and may occur within the EMBA. The Indo-Pacific humpback dolphin (also known as the Australian humpback dolphin) was not identified in the PMST report, however, it has BIAs in the same coastal area as the spotted bottlenose dolphin and Australian snubfin dolphin (which were both identified in the PMST reports) and so this species has been included in Sections **3.4.3.5.1** and **3.4.3.2** for completeness.

Table 3-6 – EPBC Act Listed Threatened and Migratory Species that May Occur within the OA and/or EMBA

Species	EPBC Act Status	Migratory	Occurrence	
			OA	EMBA
Marine Mammals				
Sei whale (*Balaenoptera borealis*)	Vulnerable	✓	✓	✓
Blue whale (*Balaenoptera musculus*)	Endangered	✓	✓	✓
Fin whale (*Balaenoptera physalus*)	Vulnerable	✓	✓	✓
Humpback whale (*Megaptera novaeangliae*)	Vulnerable	✓	✓	✓
Bryde’s whale (*Balaenoptera edeni*)		✓	✓	✓
Killer whale (*Orcinus orca*)		✓	✓	✓
Sperm whale (*Physeter macrocephalus*)		✓	✓	✓
Spotted bottlenose dolphin (*Tursiops aduncus*)		✓	✓	✓
Dugong (*Dugong dugon*)		✓		✓
Australian snubfin dolphin (*Orcaella heinsohni*) (Formerly known as the Irrawaddy dolphin, *O. brevirostris*)		✓		✓
Marine Reptiles				
Loggerhead turtle (*Caretta caretta*)	Endangered	✓	✓	✓
Green turtle (*Chelonia mydas*)	Vulnerable	✓	✓	✓
Leatherback turtle (*Dermochelys coriacea*)	Endangered	✓	✓	✓
Hawksbill turtle (*Eretmochelys imbricata*)	Vulnerable	✓	✓	✓
Olive ridley turtle (*Lepidochelys olivacea*)	Endangered	✓	✓	✓
Flatback turtle (*Natator depressus*)	Vulnerable	✓	✓	✓
Short-nosed sea snake (*Aipysurus apraefrontalis*)	Critically Endangered		✓	✓
Leaf-scaled sea snake (*Aipysurus foliosquama*)	Critically Endangered			✓
Salt-water Crocodile, Estuarine Crocodile (*Crocodylus porosus*)		✓		✓
Birds				

Species	EPBC Act Status	Migratory	Occurrence	
			OA	EMBA
Australian lesser noddy (*Anous tenuirostris melanops*)	Vulnerable		✓	✓
Red knot (*Calidris canutus*)	Endangered	✓	✓	✓
Curlew sandpiper (*Caladris ferruginea*)	Critically Endangered	✓	✓	✓
Eastern curlew (*Numenius madagascariensis*)	Critically Endangered	✓	✓	✓
Abbott's booby (*Papasula abbotti*)	Endangered		✓	✓
Bar-tailed godwit (baueri) *(Limosa lapponica baueri)*	Vulnerable			✓
Northern Siberian bar-tailed godwit (*Limosa lapponica menzbieri*)	Critically Endangered			✓
Common noddy (*Anous stolidus*)		✓	✓	✓
Streaked shearwater (*Calonectris leucomelas*)		✓	✓	✓
Lesser frigatebird (*Fregata ariel*)		✓	✓	✓
Great frigatebird (*Fregata minor*)		✓	✓	✓
White-tailed tropicbird (*Phaethon lepturus*)		✓	✓	✓
Red-footed booby (*Sula sula*)		✓	✓	✓
Common sandpiper (*Actitis hypoleucos*)		✓	✓	✓
Sharp-tailed sandpiper (*Calidris acuminata*)		✓	✓	✓
Pectoral sandpiper (*Calidris melanotos*)		✓	✓	✓
Oriental reed-warbler (*Acrocephalus orientalis)*		✓		✓
Wedge-tailed shearwater (*Ardenna pacifica*) (Formerly known by species name *Puffinus pacificus*)		✓		✓
Caspian tern (*Hydroprogne caspia)*		✓		✓
Bar-tailed godwit (*Limosa lapponica)*		✓		✓
Bridled tern (*Onychoprion anaethetus)*		✓		✓

Species	EPBC Act Status	Migratory	Occurrence	
			OA	EMBA
(Formerly known by species name *Sterna aneathetus*)				
Osprey (*Pandion haliaetus*)		✓		✓
Red-tailed tropicbird (*Phaethon rubricauda*)		✓		✓
Roseate tern (*Sterna dougalli*)		✓		✓
Little tern (*Sterna albifrons*)		✓		✓
Masked booby (*Sula dactylatra*)		✓		✓
Brown booby (*Sula leucogaster*)		✓		✓
Sharks and Rays				
White shark, great white shark (*Carcharodon carcharias*)	Vulnerable	✓	✓	✓
Northern river shark (*Glyphis garricki*)	Endangered		✓	✓
Largetooth, freshwater sawfish (*Pristis pristis*)	Vulnerable	✓	✓	✓
Green sawfish (*Pristis zijsron*)	Vulnerable	✓	✓	✓
Whale shark (*Rhincodon typus*)	Vulnerable	✓	✓	✓
Shortfin mako (*Isurus oxyrinchus*)		✓	✓	✓
Longfin mako (*Isurus paucus*)		✓	✓	✓
Reef manta ray (*Manta alfredi*)		✓	✓	✓
Giant manta ray (*Manta birostris*)		✓	✓	✓
Narrow sawfish (*Anoxypristis cuspidata*)		✓	✓	✓

3.4.3.2. Biologically Important Areas

Biologically important areas (BIAs) are defined by DoEE as “spatially defined areas where aggregations of individuals of a regionally significant species are known to display biologically important behaviours such as breeding, foraging, resting or migration” (DoEE 2018e). BIAs provide a tool for defining areas of importance for marine fauna species.

A review of BIAs defined for marine species within and in proximity to the OA and EMBA (DoEE 2018f) determined that BIAs for eight species overlap the OA, with an additional six species with BIAs overlapping the EMBA. These BIAs are discussed under the relevant species-specific sections below and summarised in **Table 3-7**.

Table 3-7 - BIAs Located Within and Adjacent to the EMBA and OA

Common Name	Behaviour	Location	Occurrence	
			OA	EMBA
Marine Mammals				
Pygmy blue whale	Distribution	NWMR, SWMR, SEMR and outside.	**Overlapping the OA**	**Overlapping the EMBA**
	Migration	Augusta to Derby (500 – 1,000 m depth contours)	**Overlapping the OA** (BIA extends into the OA by <1 km)	**Overlapping the EMBA**
	Foraging	Scott Reef	145 km south-west of the OA	30 km south-west of the EMBA
Humpback whale	Migration – north and south, calving, nursing, resting	Kimberley/coastal North Lacepede Island, Camden Sound	14 km south of the OA	50 km south of the EMBA
Dugong	Foraging	Ashmore Reef	60 km north-west of the OA	**Overlapping the EMBA**
	Breeding		76 km north-west of the OA	**Overlapping the EMBA**
	Calving		76 km north-west of the OA	**Overlapping the EMBA**
	Nursing		76 km north-west of the OA	**Overlapping the EMBA**
Indo-Pacific humpback dolphin, spotted bottlenose dolphin, Australian snubfin dolphin	Foraging, breeding, calving	Multiple locations across the Kimberley coastline	Closest is 100 km south-east of the OA	Closest occurs 40 km south-east from the EMBA
Marine Reptiles				
Green turtle	Internesting buffer	Ashmore Reef	43 km north-west of the OA	**Overlapping the EMBA**
	Nesting		64 km north-west of the OA	**Overlapping the EMBA**
	Foraging		61 km north-west of the OA	**Overlapping the EMBA**
	Mating		73 km north-west of the OA	**Overlapping the EMBA**
	Internesting buffer	Cartier Island	**Overlapping the OA** (BIA extends into the OA by 3 km)	**Overlapping the EMBA**
	Nesting		17 km north of the OA	**Overlapping the EMBA**
	Foraging		n/a	n/a
	Internesting buffer	Browse Island	n/a	n/a
	Nesting		n/a	n/a
	Foraging		67 km south-west of the OA	**Overlapping the EMBA**

Common Name	Behaviour	Location	Occurrence	
			OA	EMBA
	Internesting buffer	Scott Reef (and Sandy Islet)	170 km south-west of the OA	62 km south-west of EMBA
	Nesting		>190 km south-west of OA	80 km south-west of EMBA
	Foraging		n/a	n/a
	Internesting buffer	Cassini Island	97 km south-east of the OA	45 km south-east of the EMBA
	Nesting		121 km south-east of the OA	65 km south-east of the EMBA
	Foraging		n/a	n/a
Hawksbill turtle	Internesting buffer	Ashmore Reef	44 km north-west of the OA	**Overlapping the EMBA**
	Nesting		64 km north-west of the OA	**Overlapping the EMBA**
	Foraging		70 km north-west of the OA	**Overlapping the EMBA**
	Internesting buffer	Cartier Island	n/a	n/a
	Nesting		n/a	n/a
	Foraging		16 km north of the OA	**Overlapping the EMBA**
	Internesting buffer	Scott Reef	171 km south of the OA	65 km South of EMBA
	Nesting		>190 km from OA	80 km south of EMBA
	Foraging		n/a	n/a
Flatback Turtle	Internesting buffer	Western Joseph Bonaparte Depression	n/a	n/a
	Nesting		n/a	n/a
	Foraging		193 km north-east of the OA	140 km east of the EMBA
Loggerhead Turtle	Internesting buffer	Western Joseph Bonaparte Depression	n/a	n/a
	Nesting		n/a	n/a
	Foraging		192 km north-east of the OA	145 km east of the EMBA
Birds				
Greater frigatebird	Breeding (foraging)	Kimberley and Ashmore Reef	**Overlapping the OA**	**Overlapping the EMBA**
Red-footed booby	Breeding (foraging)	North West Kimberley and Ashmore Reef	**Overlapping the OA**	**Overlapping the EMBA**
Wedge-tailed shearwater	Breeding (foraging)	Kimberley, Pilbara and Gascoyne coasts and islands (including Ashmore Reef)	**Overlapping the OA**	**Overlapping the EMBA**
White-tailed tropicbird	Breeding (foraging)	Kimberley, Pilbara and Gascoyne coasts and islands	**Overlapping the OA**	**Overlapping the EMBA**

Common Name	Behaviour	Location	Occurrence	
			OA	EMBA
		(including Ashmore Reef)		
Lesser frigatebird	Breeding (foraging)	Ashmore Reef	**Overlapping the OA**	**Overlapping the EMBA**
		Kimberley and Pilbara coast and islands	18 km south of the OA	**Overlapping the EMBA**
Brown booby	Breeding (foraging)	Ashmore Reef	15 km north of the OA	**Overlapping the EMBA**
		Kimberley and northern Pilbara coasts and islands	15 km north-west of the OA	**Overlapping the EMBA**
Lesser crested tern	Breeding (foraging)	Kimberley, Pilbara and Gascoyne coasts and islands (including Ashmore Reef)	37 km north of the OA	**Overlapping the EMBA**
Roseate tern	Breeding (foraging)	Kimberley, Pilbara and Gascoyne coasts and islands (including Ashmore Reef)	37 km north of the OA	**Overlapping the EMBA**
Little tern	Resting	Kimberley, Pilbara and Gascoyne coasts and islands (including Ashmore Reef)	53 km north-west of the OA	**Overlapping the EMBA**
Sharks and Rays				
Whale shark	Foraging	Northward from Ningaloo Reef along the 200 m isobath	**Overlapping the OA**	**Overlapping the EMBA**

Source: modified from NCVA (2018)

3.4.3.3. Habitat Critical to the Survival of a Species

The EPBC Act Significant Impact Guidelines 1.1 – MNES (DoE 2013a) define 'habitat critical to the survival of a species' as areas necessary:

- *"for activities such as foraging, breeding or dispersal;*
- *for the long-term maintenance of the species (including the maintenance of species essential to the survival of the species);*
- *to maintain genetic diversity and long-term evolutionary development; or*
- *for the reintroduction of populations or recovery of the species."*

Such habitat may be, but is not limited to, habitat identified in a recovery plan and/or habitat listed on the Register of Critical Habitat.

The OA and EMBA overlaps three defined areas of nesting habitat critical to the survival of one species, the green turtle, including around Ashmore Reef, Cartier Island and Browse Island (**Figure 3-21**). The OA overlaps only one of these areas, around Cartier Island. This area, which is an internesting BIA, intersects the OA by approximately 5 km at the furthest point. Scott Reef and other mainland and island coastlines outside the EMBA also provide habitat critical to the flatback turtle, green turtle, leatherback turtle, loggerhead turtle, and olive ridley turtle. Further discussion of habitat critical to the survival of marine turtles, specifically for the green turtle, is provided in **Section 3.4.3.6**.

3.4.3.4. Plankton

The offshore waters of the NWMR are oligotrophic and planktonic abundances are low. The region is characterised by high species diversity but relatively low endemicity. Seasonal changes in the region's oceanography are the primary drivers of biological productivity and, subsequently, abundance of plankton in the NWMR. These include the weakening of the ITF; the seasonal reversal in wind direction, which supports the development of currents such as the Ningaloo Current; and episodic events such as cyclones. Because of the periodic nature of these changes, biological productivity follows boom and bust cycles, is sporadic and significantly geographically dispersed (DEWHA 2007).

Bentho-pelagic fish (those that occur in water depths of ~200-1,000 m) are a vital link in the trophic systems of the region (Brewer *et al.* 2007). As they migrate vertically between the pelagic and benthic (seafloor) systems they consume nutrients and aid the transfer of the nutrients between the two systems. Other processes also transfer nutrients from pelagic systems to benthic systems. For example, many deep-water benthic communities are either attached to the seafloor or have limited ranges and are heavily reliant upon nutrients in the form of detritus falling through the water column into the benthic environment (DEWHA 2008a).

3.4.3.5. Marine Mammals

Marine mammals are typically widely distributed and highly mobile within the NWMR. In general, distribution patterns reflect seasonal feeding areas, characterised by high productivity, and migration routes associated with reproductive patterns.

Eight migratory marine mammal species listed under the EPBC Act, including baleen whales, toothed whales and dolphins, were identified as potentially occurring or having habitat within the OA and wider EMBA (**Table 3-6**). This includes four threatened species; the blue whale, humpback whale, sei whale and fin whale. An additional two listed migratory species were identified as potentially occurring or having habitat within the EMBA; the dugong and Australian snubfin dolphin.

Of those species identified in the PMST reports, the pygmy blue whale and humpback whale are most likely to occur in the OA based on historical distribution and habitat preference; albeit in low numbers. These species of primary relevance, as well as other threatened and/or migratory marine mammal species that may traverse through the OA and EMBA, are discussed in detail below.

3.4.3.5.1. Cetaceans

Blue Whale

Blue whales are widely distributed throughout the world's oceans and may be present in the proposed OA as indicated from the PMST reports (**Table 3-6**). There are four recognised subspecies of blue whales worldwide and two of these are known to occur in the southern hemisphere; the Antarctic blue whale (*Balaenoptera musculus intermedia*) and the pygmy blue whale (*B. musculus brevicaudia*). Both sub-species are listed as Endangered under the World Conservation Union (IUCN) Red List of Threatened Species. The Antarctic blue whale is recognised as a 'true' blue whale and has been recorded offshore in all states excluding the Northern Territory (NT; DoE 2015a). Blue whales have an international distribution, their migration paths are widespread and do not distinctly follow coastlines. The blue whale is rarely present in large numbers outside recognised aggregation areas, of which none are present within the OA.

Antarctic blue whale

Antarctic blue whales are usually found in waters south of 60° S and will generally migrate between (low-latitude) breeding grounds where both mating and calving take place during the winter, and (high-latitude) feeding grounds during the summer (DoE 2015a). Future research undertaken by the Australian Marine Mammal Centre (AMMC) and Australian Antarctic Division (AAD) aims to further define the Antarctic blue whale BIA, population structure, and the spatial and temporal distributions of animals (DoE 2015a). There are currently no known BIAs for this species.

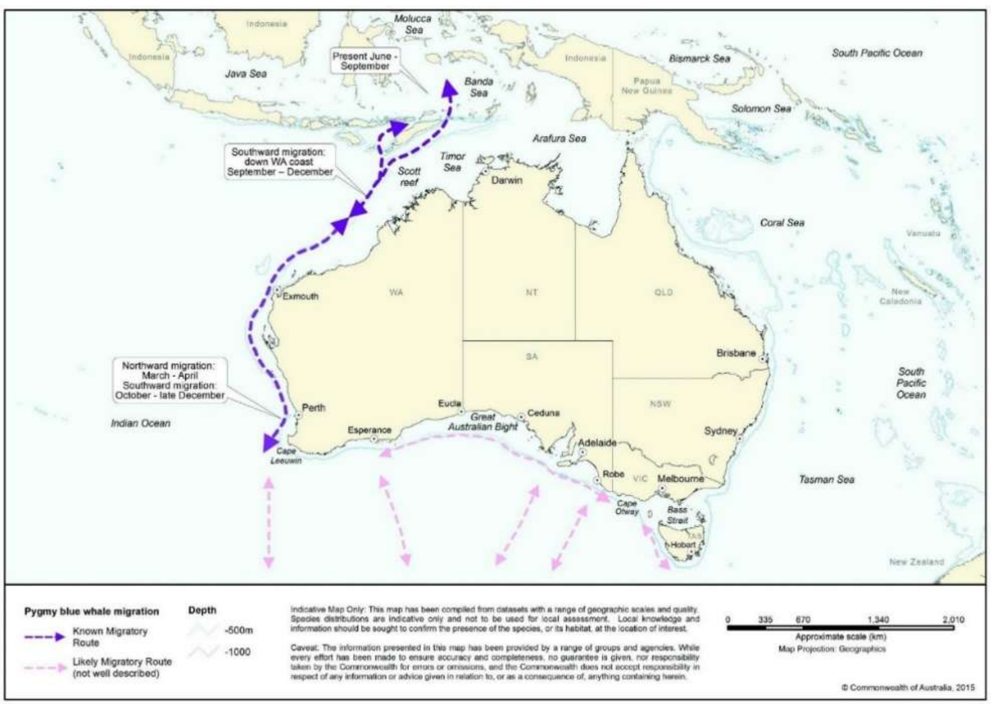
Pygmy blue whale

The pygmy blue whale is known to migrate along the WA shelf edge at depths between the 500 m and 1,000 m depth contours (DoE 2015a). The location of the pygmy blue whale breeding grounds is, however, still unknown (Bannister *et al*. 1996).

A migration BIA has been identified in deep offshore waters off WA (DoEE 2018f); approximately 0.02% of this BIA overlaps the OA. The northerly migration toward the calving grounds near the equator occurs in March/April to August (DoE 2015a). Noise monitoring for the Barossa project, which is located in the Timor Sea approximately 700 km north-east of the OA, detected the presence of blue whales in the months of May to August during their north-bound seasonal migration (McPherson *et al*. 2016). The southerly migration to the feeding grounds in the high-latitudes of the southern hemisphere occurs from October to December (DoE 2015a). Pygmy blue whales mostly migrate as individuals or occasionally have been sighted in small groups, based on acoustic data from noise loggers deployed around Scott Reef for the Woodside Browse project (Woodside 2014).

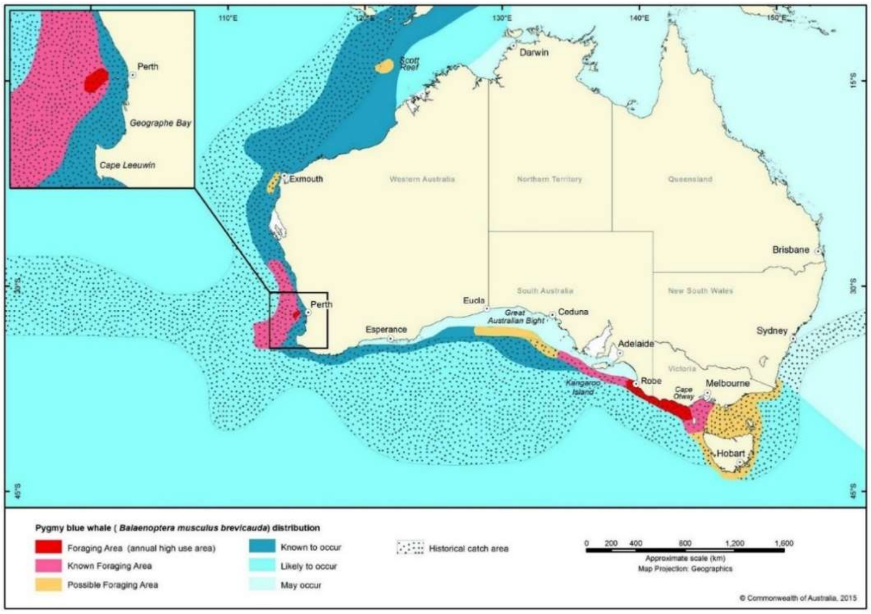
A foraging BIA surrounding Seringapatam Reef, Scott Reef and the open waters to the west of these features is located ~30 km west of the EMBA, as shown in **Figure 3-12** to **Figure 3-14**. These steep gradient reef-features tend to stimulate upwelling and, in turn, increased productivity (seasonally variable) which provides a favourable foraging area (ConocoPhillips 2018).

Based on the known distribution, preferred feeding habitats and migration pathways of pygmy blue whales, individuals of the species may be encountered in low numbers within the OA and EMBA during their seasonal migrations.



Source: modified from DoE (2015a).

Figure 3-12 - Pygmy Blue Whale Migration Routes



Foraging Area (Annual high use area)	Blue whales are regularly observed feeding on a seasonal basis	Known to occur	Blue whales are known to occur based on direct observations, satellite tagged whales or based on acoustic detections
Known Foraging Area	Known foraging occurs in these areas but is highly variable both between and within seasons	Likely to occur	Blue whales are likely to occur based on occasional observations in the area and nearby areas
Possible Foraging Area	Evidence for feeding is based on limited direct observations or through indirect evidence, such as occurrence of krill in close proximity of whales, or satellite tagged whales showing circling tracks. Blue whales travel through on a seasonal basis, possibly as part of their migratory route	May occur	Evidence for the presence of blue whales through strandings or rare observations
		Historical catch area	Blue whales were caught during the whaling period based on whaling data

Source: modified from DoE (2015a).

Figure 3-13 - Pygmy Blue Whale Distribution

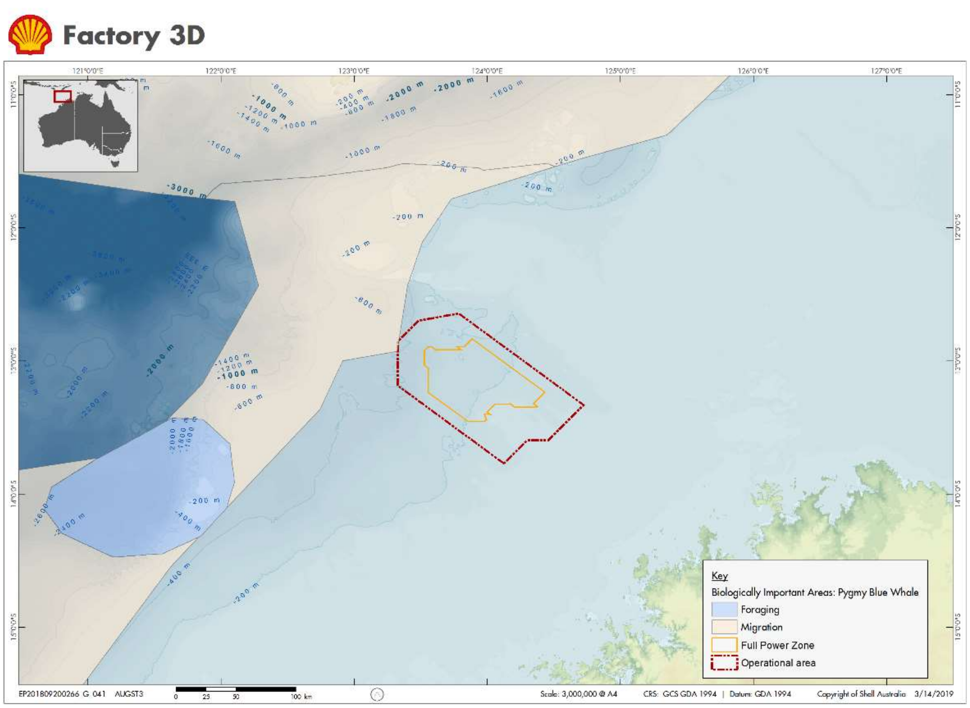


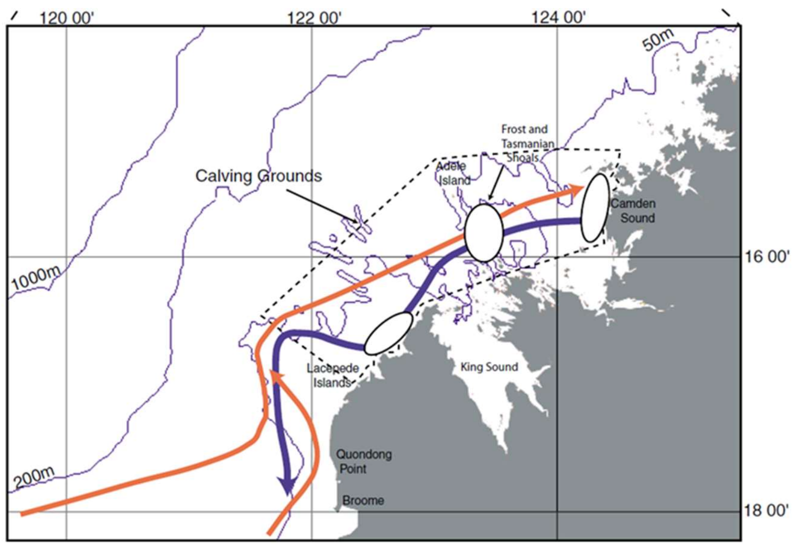
Figure 3-14 - Pygmy Blue Whale BIA and the OA

Humpback Whale

The humpback whale has a wide distribution with records of sightings throughout Australian Antarctic waters and offshore from all Australian states (Bannister *et al*. 1996). The species migrates between summer feeding grounds in Antarctica and winter breeding and calving grounds in the sub-tropical and tropical inshore waters of north-west Australia (Jenner *et al*. 2001; **Figure 3-15**). The northbound migration peaks between late July and early August, and the southbound migration peaks between late August and early September (Jenner *et al*. 2001). Humpback whales breed and calve in the NWMR between Broome and the northern end of Camden Sound in the months of June to September each year (DoE 2015b; DoEE 2018g; **Figure 3-15, Figure 3-16**).

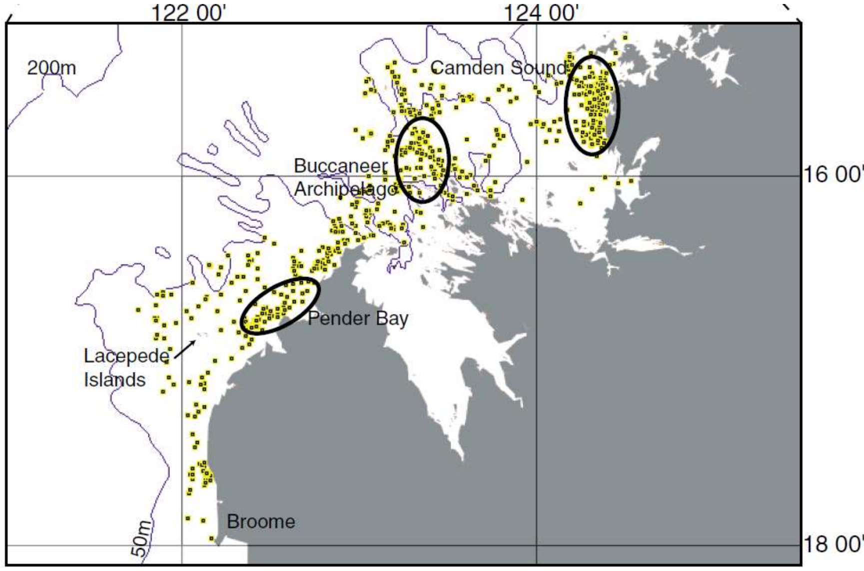
A migration BIA for humpback whales is recognised in nearshore waters (<100 km offshore) along the WA coast from west of Esperance to 100 km north of Broome (DoEE 2018f). The furthest north section of this BIA, within nearshore waters of the Dampier Peninsula and encompassing Camden Sound, is also recognised as a calving BIA. The BIA is located approximately 50 km south-west of the EMBA at its closest point (**Figure 3-17**). Relatively few humpback whales have been known to travel north of Camden Sound (Jenner *et al*. 2001; **Figure 3-18**, **Figure 3-19**). Noise monitoring undertaken for the Barossa project, which is located within the NMR, did not detect any humpback whale calls in the Timor Sea (McPherson *et al*. 2016).

Based on their known distribution and movements, humpback whales may be encountered in low numbers within the OA and EMBA during their seasonal migrations (**Figure 3-19**).



Source: modified from Jenner *et al.* (2001).

Figure 3-15 - Estimated Humpback Whale Migratory Routes (Northward and Southward) and Calving Grounds



Source: modified from Jenner *et al.* (2001).

Figure 3-16 - Humpback Whale Observations at Calving Grounds

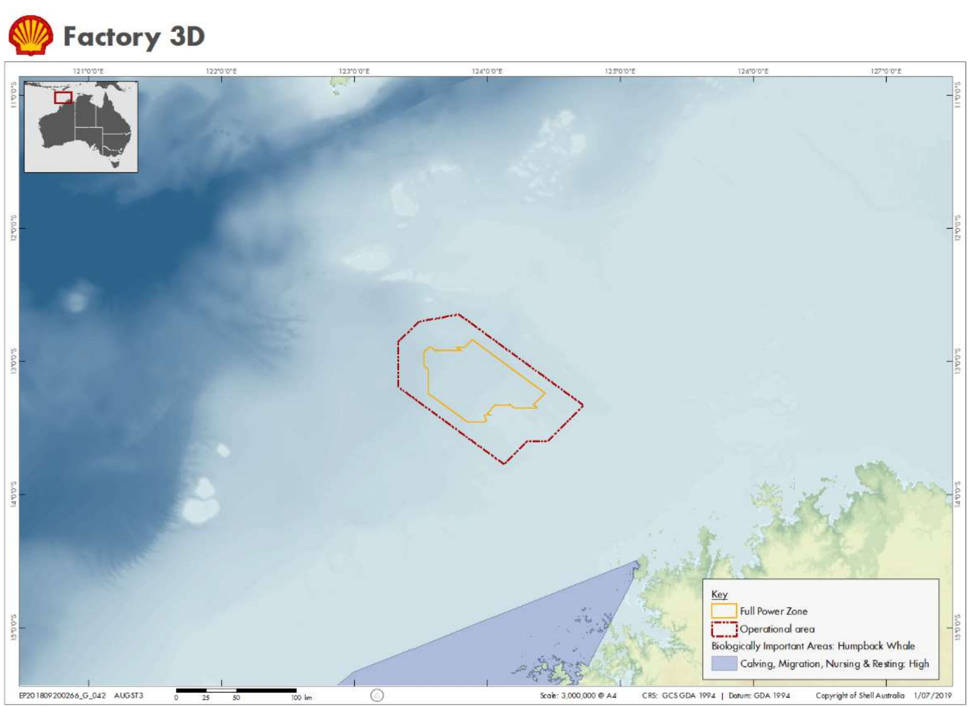
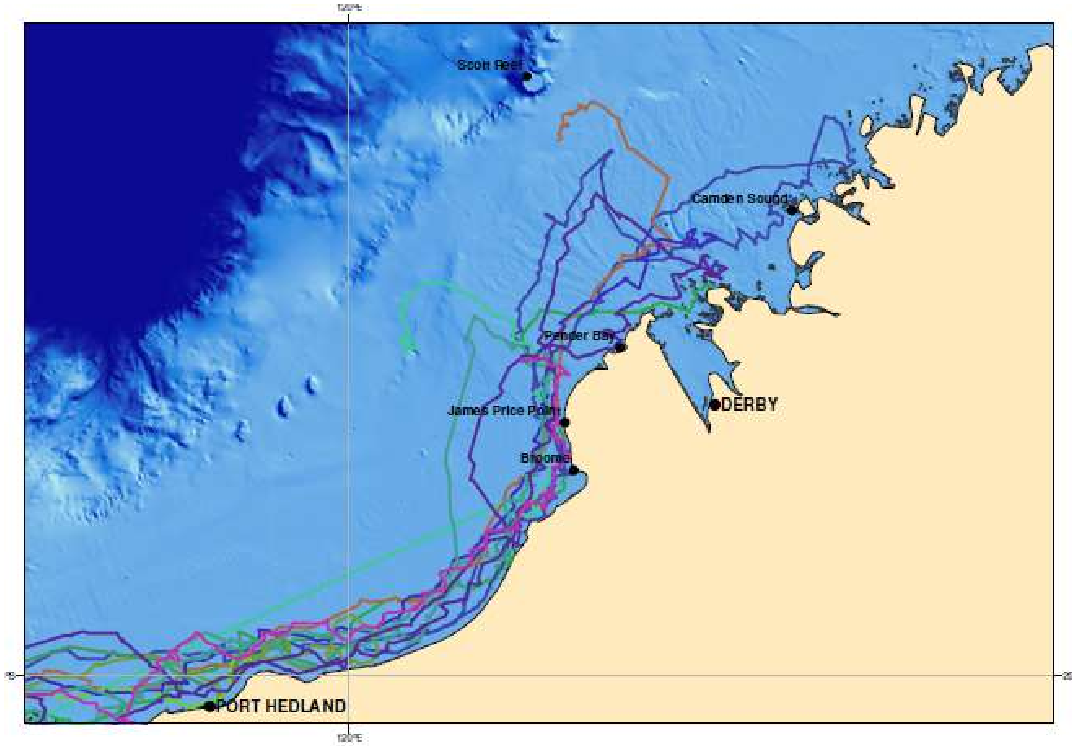
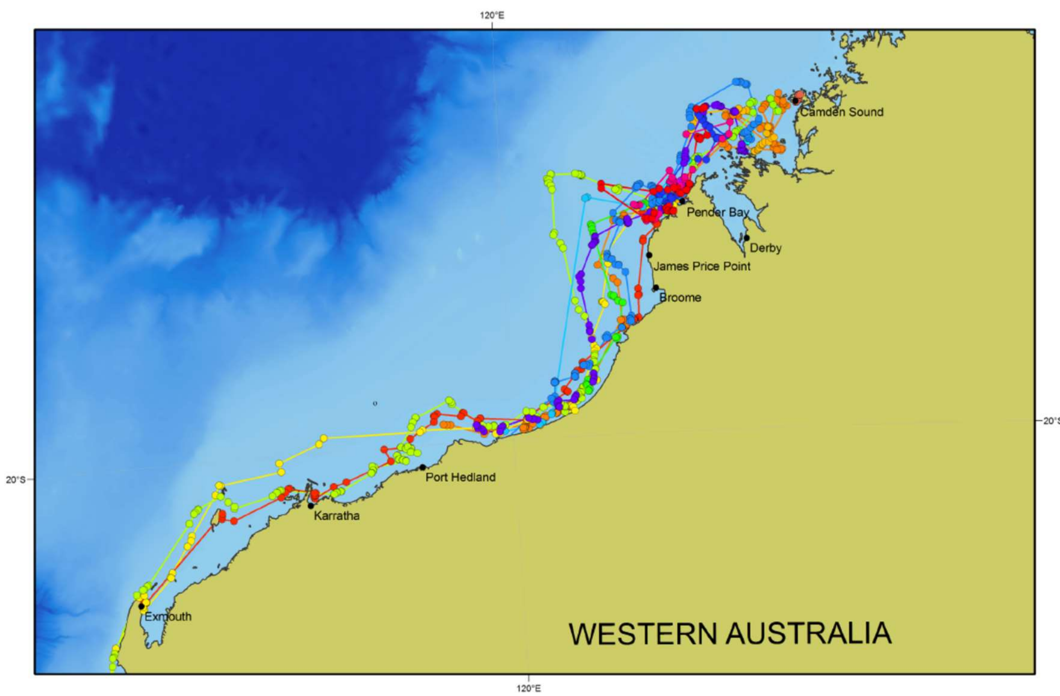


Figure 3-17 – The Humpback Whale BIA Located to the South of the OA and FPZ



Source: modified Double *et al.* (2012).

Figure 3-18 – Satellite Tracking of Tagged Humpback Whales Undertaking Their Northern Migration



Source: modified from Double *et al.* (2010).

Figure 3-19 - Tracks Obtained in 2009 from 17 Satellite-Tagged Humpback Whales Undertaking Their Southern Migration

Sei Whale

Sei whales have a wide distribution. Although sightings are rare, the species has been identified as occurring in coastal and offshore waters throughout Australia, as well as the waters surrounding Christmas and Cocos Keeling Islands (DoEE 2018h; Bannister *et al*. 1996). The species is able to utilise a diverse range of marine habitats, which has been attributed to a combination of dynamic physical and prey processes (DoEE 2018h).

Sei whale migratory movements are well defined (distinctly north-south) with the species moving between polar, temperate and tropical waters for foraging and breeding. The species feeds intensively between the Antarctic and sub-Antarctic boundary on planktonic crustacea (Bannister *et al*. 1996; DoEE 2018h). The species does not dive, rather it sinks, and tends to swim at shallower depths comparative to other species (DoEE 2018h). There have been no mating or calving areas for sei whales identified in Australian waters.

Based on their known distribution and movements, sei whales are unlikely to be encountered within the OA and EMBA.

Fin Whale

Fin whales are widely distributed from polar to tropical waters and have been recorded in all Australian states, aside from New South Wales (NSW) and the NT (Bannister *et al*. 1996). The species rarely occupies inshore waters and displays well defined migratory movements between polar, temperate and tropical waters (Bannister *et al*. 1996; DoEE 2018i). Migration within Australian waters does not appear to follow a clear route and is thought to occur in summer and autumn. Breeding in the Southern hemisphere occurs in tropical and sub-tropical latitudes between May and July (DoEE 2018i).

Fin whales feed on planktonic crustacea, such as Antarctic krill, and primarily forage in high latitudes (Bannister *et al*. 1996; DoEE 2018i). Within Australian waters, Antarctic waters and the Bonney Upwelling are thought to be important foraging grounds for this species. Based on their known distribution and movements, fin whales may occur in low numbers within the OA and EMBA during their seasonal migrations.

Bryde's Whale

Bryde's whale distribution encompasses tropical and warm temperate waters with individuals being recorded in all Australian states, excluding the NT. The species typically moves between 40 °N and 40 °S, with these movements seeming to be primarily linked to prey availability (DoEE 2018j). Bryde's whale are thought to be divided into offshore and onshore forms with the distinction between the two based on prey preference (DoEE 2018j). The offshore form is found in deeper waters (500 m to 1,000 m) and is thought to migrate seasonally in favour of warmer waters in winter months. The onshore form generally inhabits waters <200 m and displays no distinct migratory movements (DoEE 2018j). The noise monitoring study undertaken for the Barossa project detected Bryde's whales almost year-round (January to October; McPherson *et al*. 2016).

Based on their known distribution and movements, individual Bryde's whales may occasionally transit through the OA and EMBA in low numbers.

Killer Whale

Killer whales have a vast global distribution and utilise a wide range of habitats. However, they appear to be primarily concentrated in coastal waters and cooler regions of high productivity (Bannister *et al*. 1996; DoEE 2018n).

The species is distributed throughout Australian waters, in particular near Tasmania and the waters surrounding Macquarie Island (1,500 km south – south-east of Tasmania; Bannister *et al*. 1996; DoEE 2018n). Off Australia, the species is typically observed moving along the continental slope and shelf, and near seal colonies (Bannister *et al*. 1996). There are no key localities identified within continental Australian waters for this species. Killer whales are carnivores and their diet vary seasonally and regionally (Bannister *et al*. 1996; DoEE 2018n).

Globally killer whales are known to migrate; however, specific routes and seasonal movement patterns are not known in detail and are thought to relate to prey availability (Bannister *et al*. 1996). Migration movements within Australian waters include a summer migration from sub Antarctic islands to Macquarie Island (DoEE 2018n). Mating occurs year-round and there are no known calving areas in Australian waters (Bannister *et al*. 1996).

Based on their known distribution and movements, killer whales are unlikely to be encountered in within the OA and EMBA.

Sperm Whale

Sperm whales occur in deep waters in all oceans, typically remaining at depths of 200 m or greater, and are known to occur throughout Australian waters (Bannister *et al*. 1996). Sperm whales are known to occur in WA waters between Cape Leeuwin and Esperance (WA) and along the continental shelf approximately 20 – 30 nm offshore (Bannister *et al*. 1996). Migration patterns vary between male and female sperm whales. Mature females and juveniles are thought to be resident in tropical and subtropical waters throughout the year, whereas mature males are thought to migrate between the tropics and Antarctic (Bannister *et al*. 1996; DoEE 2018k).

Based on their known distribution and movements, low numbers of sperm whales may occasionally transit through the OA and EMBA.

Spotted Bottlenose Dolphin

The spotted bottlenose dolphin (Arafura/Timor Sea populations) occurs primarily in continental shelf waters (<200 m deep), and in nearshore areas with rocky or coral reefs, sandy or soft sediments, or seagrass beds (DSEWPaC 2012c). Small populations also occur in the inshore waters of some oceanic islands. The species inhabits slightly the deeper and more open water estuarine habitats, when compared to those favoured by the Australian snubfin and humpback dolphins (Reeves and Brownell 2009, cited in DSEWPaC 2012c). Migration patterns for the species in Australia are variable, including of year-round residency in small areas, long-range movements and migration (DoEE 2018o).

Australian Snubfin Dolphin

The Australian snubfin dolphin (also known as the Irrawaddy dolphin) occurs in shallow coastal and estuarine waters (typically less than 20 m deep; DoEE 2018q); however, the species has also been recorded up to 23 km offshore. The Australian snubfin dolphin is likely to occur in higher densities in areas of complex habitat type which provide a variety of prey types (DSEWPaC 2012c). In Australia, the species distribution covers the coastal waters of Queensland, NT and north-western Australia. The population in Australian waters is thought to be continuous with the Papua New Guinea species but separate from populations in Asia.

Within the NWMR the species is likely to migrate and forage off the eastern and western sides of the Cambridge Gulf, to the north and north-west of Cape Londonderry and Cape Talbot, west of Augustus Island, west and north-west of the Buccaneer Archipelago, and from Cape Leveque to Broome (all outside the EMBA; DSEWPaC 2012c). Breeding is thought to occur throughout the year for this species.

Indo-Pacific Humpback Dolphin

Indo-Pacific humpback dolphins and are known to occur year-round in and around King Sound and Camden Sound around to Vansittart Bay (DSEWPaC 2012). Indo-Pacific humpback dolphins habitat preference is for complex tidal areas and creek systems and dense mangroves where there are high prey densities. Although there are anecdotal reports of them occurring around deep-water islands such as the Rowley Shoals, the BIA of does not overlap the proposed OA and therefore it is unlikely that these species will be encountered.

A number of BIAs exist for the three dolphin species discussed above along the Kimberley and Pilbara coastlines (outside the EMBA). The nearest BIA to the EMBA for any dolphin species lies approximately 40 km south-west of the EMBA. Due to their tendency to occupy inshore coastal shallow waters it is unlikely that these species will occur in the OA and EMBA, except possibly in proximity to Cartier Island or Browse Island or along the furthest southern extent of the EMBA as vagrants.

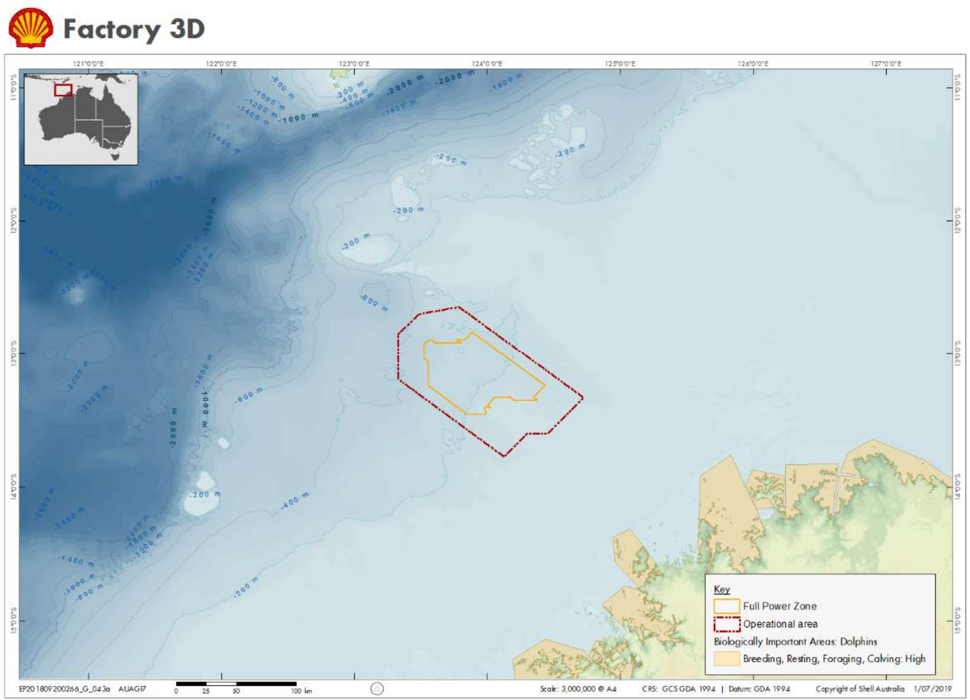


Figure 3-20 –Foraging, Breeding and Calving BIAs for Dolphin Species (spotted bottlenose dolphin and Australian snubfin dolphin) Relative to the Location of the OA and FPZ

3.4.3.5.2. Sirenian

Dugong

Dugongs occur in tropical and sub-tropical coastal and inland waters broadly coincident with the distribution of seagrasses, which typically occur in shallow intertidal zone areas to water depths of around 25 m (DoEE 2018r). Dugong feeding aggregations tend to occur in large seagrass meadows within wide shallow protected bays, shallow mangrove channels and in the lee of large inshore islands. The movements of most individuals are limited to within tens of kilometres within the vicinity of seagrass beds (National Oceans Office 2004). However, some individuals have been observed to travel large distances of up to 600 km over a few days (National Oceans Office 2004).

Dugongs and areas of potential dugong habitat exist along the majority of WA coastline north from Shark Bay. A number of designated BIAs have also been established within WA waters, however, none of these overlap the OA. A small population of approximately 50 individuals exists at Ashmore Reef, which is considered to be genetically distinct from other nearby Australian or Indonesian populations (DoE 2014a). A foraging BIA has been defined for this population of dugongs and lies within the EMBA. It is possible that the range of the Ashmore Reef population extends to Cartier Island where individuals maintain a presence (DoE 2014a). Dugongs may also frequent other shallow shoals on the Sahul Banks; however, there has only been a single sighting of this occurrence in 1996 (Whiting and Guinea 2003).

Considering the habitat preference of the species, it is unlikely that dugongs will occur within the OA, however, they are expected to occur in low numbers within the EMBA, particularly near Cartier Island and Ashmore Reef.

3.4.3.5.3. EPBC Act Management/Recovery Plans and Conservation Advices for Marine Mammals

EPBC Act Management/Recovery Plans and conservation advices have been developed for a number of marine mammal species identified by the PMST reports as potentially occurring within the OA and EMBA. Key threats identified within these plans that are relevant to the Factory 3D MSS are summarised in **Table 3-8**.

Table 3-8 - Summary of EPBC Act Management / Recovery Plans and Conservation Advices Relevant to Marine Mammals

Species	EPBC Act Management Plan / Recovery Plan/ Conservation Advice	Key Threats Identified in relevant Management Plan / Recovery Plan / Conservation Advice	Cross-reference to EP Impact and Risk Evaluation Section
Blue whale	Conservation management plan for the blue whale; A recovery plan under the *Environment Protection and Biodiversity Conservation Act 1999* 2015-2025 (October 2015; DoE 2015a)	Vessel disturbance	**Section 6.1**
		Noise interference	**Section 6.5**
		Habitat modification including marine debris infrastructure and acute/chronic chemical discharge	**Section 7.5**
Fin whale	Conservation advice on fin whale (*Balaenoptera physalus*; October 2015) (DoE 2015d)	Vessel strike	**Section 7.4**
		Anthropogenic noise and acoustic disturbance	**Section 6.5**
		Pollution (persistent toxic pollutants)	**Section 7.5**
Humpback whale	Conservation advice on humpback whale (*Megaptera novaeangliae*) (October 2015) (DoE 2015b)	Vessel disturbance and strike	**Section 6.1 & Section 7.4**
		Noise interference	**Section 6.5**
		Entanglement – marine debris	**Section 7.4**
Sei whale	Conservation advice on sei whale (*Balaenoptera borealis*; October 2015) (DoE 2015c)	Vessel strike	**Section 7.4**
		Anthropogenic noise and acoustic disturbance	**Section 6.5**
		Pollution (persistent toxic pollutants)	**Section 7.5**

3.4.3.6. Marine Reptiles

3.4.3.6.1. Marine Turtles

Turtles are oceanic species except during seasonal onshore nesting periods, which are species-dependent and vary in location along the Australian coastline (Commonwealth of Australia 2017a). While the incubation time between turtle nesting and emergence of hatchlings varies between species, it is generally about two months (Commonwealth of Australia 2017a). Female turtles also exhibit an internesting phase in which they spend 2–3 months in shallow waters in the vicinity of the nesting beach or rookery while they produce the next clutch of eggs (Guinea 2013; Commonwealth of Australia 2017a). The female turtles will rest on the seabed during the internesting period but are not known to feed (ConocoPhillips 2018).

The EMBA overlaps emergent features (i.e. Cartier Island, Ashmore Reef and Browse Island) which are known to be of importance to foraging turtles. Additionally, Heywood Shoal (a shallow feature within the OA that may support foraging and internesting turtles) and Ashmore Reef is a recognised nesting and foraging area for marine turtles (Commonwealth of Australia 2017a). The turtle population at Ashmore Reef and Cartier Island predominantly consists of green turtles, with very few numbers of hawksbill turtles recorded during recent scientific surveys (Guinea 2013). Subsequently, green turtles and hawksbill turtles may be present within the OA and EMBA during the survey, however, it is unlikely other species of marine turtle will occur.

The broad distribution and habitats of each marine turtle species is summarised below, with further detail on BIAs and habitat critical to the survival of these species (based on geographically distinct genetic stocks) provided in **Table 3-9** and shown in **Figure 3-21**.

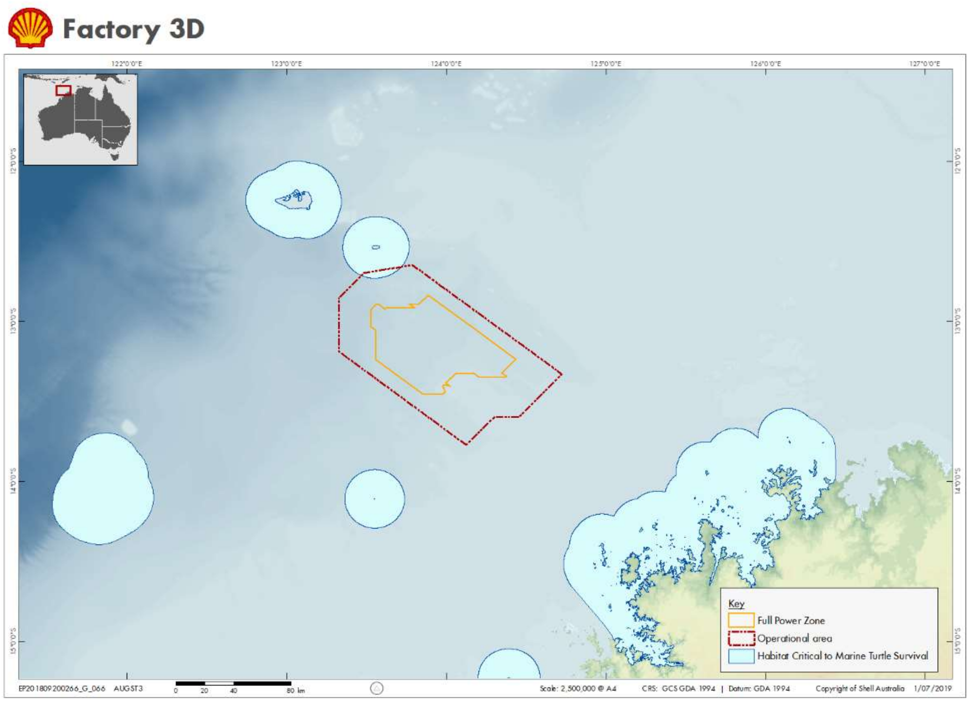


Figure 3-21 –Habitats Critical to the Marine Turtle Survival and the OA and FPZ

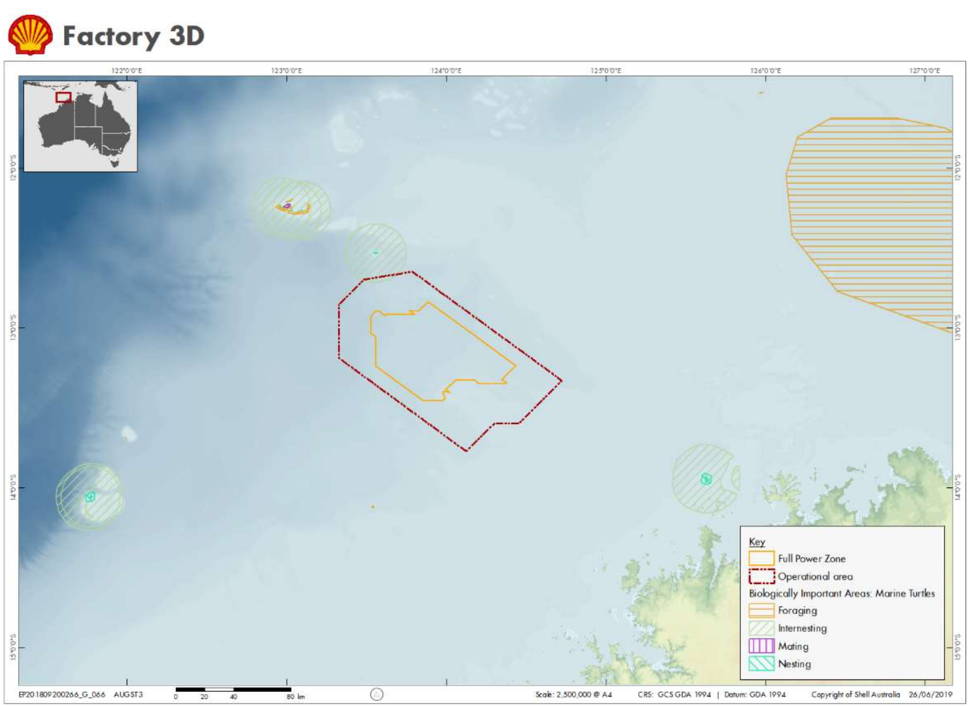


Figure 3-22 – Biologically Important Areas for Marine Turtles and the OA and FPZ

Green turtle

Within Australian waters green turtles are predominately found off the WA, NT, Queensland coastlines (Commonwealth of Australia 2017a). The green turtle is the most common marine turtle breeding in the NWMR and WA supports one of the largest remaining green turtle populations in the world (DSEWPaC 2012e). The species is primarily herbivorous and forages on algae, seagrass and mangroves, including where these habitats exist at offshore coral reef habitats (Commonwealth of Australia 2017a). Green turtles are also known to travel large distances of up to 2,600 km between nesting and feeding areas (DSEWPaC 2012e).

Ashmore Reef and Cartier Island support a genetically distinct stock of breeding green turtles. Mating occurs within this stock between September and November, with nesting on Ashmore Reef occurring year-round (peak between December and January; Commonwealth of Australia 2017a). Hatching takes place between September and May. Outside of breeding periods, green turtles of this population disperse widely across the Timor Sea from Ashmore Reef to the eastern coast of the Gulf of Carpentaria and up into some areas of south Indonesia (Commonwealth of Australia 2017a). Some green turtles of the North West Shelf genetic stock are also known to forage at Ashmore Reef (Commonwealth of Australia 2017a).

Scott Reef and Browse Island support the Scott-Browse genetic stock of green turtle (Commonwealth of Australia 2017a). Nesting is known to occur at Scott Reef from late November to February and turtles utilise the full extent of the sandy substrates of Sandy Islet, an emergent sandy cay, to nest, as well as the waters surrounding Sandy Islet and within South Scott Reef during their internesting period (Guinea 2009). Browse Island is also used from November to March by nesting Green turtles (Commonwealth of Australia 2017a).

A number of BIAs and habitat critical to the survival of green turtles overlap the EMBA, with a 20 km internesting buffer BIA around Cartier Island and one nesting habitat critical area overlapping the OA (refer **Section 3.4.3.2** and **3.4.3.3**; **Figure 3-21**).

Hawksbill turtle

Hawksbill turtles are found in tropical, subtropical and temperate waters in all the oceans of the world. Hawksbill turtles are known to inhabit the open ocean, particularly during their earlier years (DOE 2013). Nesting is mainly confined to tropical beaches (Marquez 1990), and in WA, occurs year-round with a peak between October and January (Robinson 1990; cited in Limpus 1995, Commonwealth Government of Australia 2012).

Hawksbill turtles predominately occur along the northern WA, NT and northern Queensland coastlines. Hawksbill turtles are omnivorous and feed on algae, sponges, soft corals and soft bodied-invertebrates. This species is typically associated with rocky and coral reef habitats and is expected to be found foraging within these habitats along the WA coastline, from Shark Bay to the northern extent of the NWMR (Commonwealth of Australia 2017a).

Hawksbill turtles are known to nest at Ashmore Reef year-round and are known to stay within a 20 km inter-nesting buffer from nesting beaches (DOE 2015f). They have been recorded nesting on the West, Middle and East islands at Ashmore Reef (Guinea 2013). The species is also known to forage at Cartier Island year-round (DOE 2015f). BIAs have been identified at Ashmore Reef and Cartier Island for the hawksbill turtle to highlight nesting, inter-nesting and foraging behaviours in the area (DOE 2015f; **Figure 3-21**). The internesting buffer around Ashmore Reef and foraging buffer around Cartier Island overlap the EMBA, however, no BIA or habitat critical to the survival of hawksbill turtles extends into the OA.

Loggerhead turtle

The loggerhead turtle has a global distribution throughout tropical, sub-tropical and temperate waters. Nesting is mainly concentrated on subtropical beaches (Marquez 1990). The species is known to range along most of the Australian coastline and throughout the NWMR (Commonwealth of Australia 2017a). Loggerhead turtles are carnivorous and mainly feed on benthic invertebrates in a wide range of habitats ranging from nearshore to 55 m in depth (Commonwealth of Australia 2017a).

The largest loggerhead nesting in WA occurs at Dirk Hartog Island (near Exmouth Gulf >1800 km from the OA), which expects approximately 800 to 1,500 breeding females each year (Baldwin *et al*. 2003; Prince 1993, 1994b; cited in DSEWPaC 2012). Within the EMBA, the loggerhead turtle is known to forage within the Sahul Shelf area (Commonwealth of Australia 2012) and there has been one recorded nesting of a loggerhead turtle at Ashmore Reef (Department of the Environment and Energy 2019). There are no BIAs for the loggerhead turtle within the EMBA, however; this migratory species may transit the area.

Flatback turtle

Flatback turtles are known to occur along the WA, NT, Queensland coastlines, and forage widely across the Australian continental shelf and into the continental waters off Indonesia and Papua New Guinea (Commonwealth of Australia 2017a). The North West Shelf stocks of flatback turtles are two of the largest nesting stocks in the world, with annual abundance of several thousand individuals (Pendoley 2005, Whiting *et al*. 2008; cited in Commonwealth Government of Australia 2012). The southern (North West Shelf) stock nests from Exmouth to the Lacepede Islands in summer (commences in late November–December, peaks in January and finishes by February–March). Important rookeries include Thevenard Island, Barrow Island, the Montebello Islands, Varanus Island, the Lowendal Islands, islands of the Dampier Archipelago, coastal areas around Port Hedland, along much of Eighty Mile Beach and inshore islands of the Kimberley region where suitable beaches occur. The species has not been recorded at Ashmore Reef and Cartier Island during recent surveys (Guinea 2013). The nearest BIA to the OA and EMBA is a foraging BIA located within the Western Joseph Bonaparte Depression (**Figure 3-21**).

Flatback turtles are primarily carnivorous and feed predominantly on soft-bodied invertebrates (Commonwealth of Australia 2017a). Flatback turtles that nest within the Pilbara region typically migrate along the continental shelf to foraging grounds as far north as Darwin at the end of the nesting season (Commonwealth of Australia 2017a).

Olive ridley turtle

Olive ridley turtles are primarily carnivorous and feed predominantly on soft-bodied invertebrates (Commonwealth of Australia 2017a). The species is known to feed in water depths between 15 m and 200 m, and to migrate up to 1,130 km between their nesting and foraging grounds (Whiting *et al*. 2005). Nesting is known to occur in the NT and on western Cape York (QLD). Low density nesting has also been described on the Kimberley coast (Commonwealth of Australia 2017a). This species appears to remain on the Australian continental shelf into waters off Indonesia (Commonwealth of Australia 2017a). This species has not been recorded at Ashmore Reef and Cartier Island during recent surveys and is not known to nest within the OA or EMBA (Guinea 2013).

Leatherback turtle

Leatherback turtles are known to forage and migrate throughout the open offshore waters of Australia, with foraging more common along the east coast and the Bass Strait. Records of leatherback turtle nesting in Australia are sparse and limited to the Cobourg Peninsula and Queensland coast (Commonwealth of Australia 2017a). There have been no confirmed accounts of nesting on beaches along the WA coastline. Scattered isolated nesting (1-3 nests per annum) occurs in southern Queensland, which is thought to occur in summer between December and January (Limpus & McLachlan 1994). Leatherback turtles eat almost exclusively jellyfish and are pelagic throughout their life in oceanic waters around Australia (Commonwealth of Australia 2017a). There are no BIAs within the NWMR for this species.

Table 3-9 - Summary of Marine Turtle Ecology within the NWMR

Species	Flatback turtle	Green turtle	Hawksbill turtle	Loggerhead turtle	Leatherback turtle
Stock	Unknown genetic stock Kimberley, WA	**NWS Stock**	**WA Stock**	**WA Stock**	**n/a**
Area	Kimberley	North West Shelf	Centred on the Dampier Archipelago	Dirk Hartog Island Shark Bay	-
Mating	unknown	Sep–Dec	all year	unknown	unknown
Nesting	May-July	Nov–Mar (peak: Dec–Feb)	all year (peak: Oct–Jan)	Nov–Mar (peak Jan)	Dec–Jan
Hatching	unknown	Jan–May (peak: Feb–Mar)	all year (peak: Dec–Feb)	Jan–May	Jan–Feb
Internesting Buffer	**60 km**	**20 km**	**20 km**	**20 km**	**20 km**
Habitat Critical to the Survival of the Marine Turtles	Maret Islands, Montilivet Islands, Cassini Island, Coronation Islands (includes Lamarck Island), Napier-Broome Bay Islands (West Governor Island, Sir Graham Moore Island – near Kalumbaru), Champagny, Darcy and Augustus Islands (Camden Sound)	Major: Lacepede Islands, Montebello, Barrow, Muiron, Browse Islands and North West Cape. Minor: Boodie, Middle, Serrurier, Thevenard, Lowendal, Rosemary, Legendre, Delambre Islands and various mainland beaches, Shark Bay to Ningaloo and Kimberley Coast.	Major: Dampier Archipelago (Rosemary Island), Delambre Island and Montebello Islands. Minor: Ah Chong, South East and Timouille, Sholl Island, Lowendal Islands including Varanus, Beacon, Bridled, Barrow, Muiron Islands and mainland beaches from Cape Range to Ningaloo and Gnaraloo to Red Bluff.	Major: Dirk Hartog Island, South Muiron Island, North West Cape, Gnaraloo Bay. Minor: Mainland from Shark Bay to southern North-West Shelf (Northern end Ningaloo Marine Park).	Major: None. Minor: Cobourg Peninsula, Maningrida and Croker Island (NT) and unconfirmed nesting in WA. There are no confirmed leatherback turtle nesting sites in WA. Scattered nesting occurs in southern Queensland and NT.
Foraging Habitat	Post-hatchling/young juveniles: Unknown, likely to remain in waters over the Australian continental shelf. Juvenile-adult: Flatback turtles favour soft sediment habitats that support benthic invertebrates. Important foraging habitat has not been identified for this stock	Post-hatchling/young juveniles: Unknown. Likely to disperse through much of the Indian Ocean/Arafura Sea. Juvenile-adult: Tidal/sub-tidal habitats with coral reef, mangrove, sand, rocky reefs and mudflats where there are algal turfs or seagrass meadows present. A proportion of turtles may also remain resident in the open ocean.	Post-hatchling/young juveniles: Unknown. Juvenile-adult: Tidal and sub-tidal coral and rocky reef habitats where they feed on algae, sponges and soft corals. Hawksbill turtles can be found in clear or turbid water, on reefs, seagrass meadows or on soft-bottom habitats.	Post-hatchling/young juveniles: Unknown. Likely to disperse through waters of the Indian Ocean. Juvenile-adult: Tidal/sub-tidal habitats with hard and soft substrates including rocky and coral reefs, muddy bays, sand flats, estuaries and seagrass meadows. A proportion of turtles may also remain resident in the open ocean.	Post-hatchling/young juveniles: Unknown. Juvenile-adult: Leatherback turtles forage in oceanic waters on gelatinous prey (i.e. jellyfish). They occur in waters over Australia's continental shelf year-round. They are commonly observed in waters of the NT and south-western WA.

3.4.3.6.2. Sea Snakes

The PMST reports identified 14 sea snake species as potentially occurring in the OA and an additional four species as potentially occurring in the wider EMBA. This includes two species which are listed as threatened; the short-nosed sea snake and leaf-scaled sea snake. All sea snakes in Australia are listed as protected species under the EPBC Act. Twenty-five species of sea snake are known to occur in the NWMR, including eight endemic species (Guinea 2006). Specific locations within the NWMR considered significant for specific species of sea snake are Shark Bay, the Pilbara coast, the Kimberley coast (all outside the EMBA) and Ashmore Reef and Cartier Island (within the OA and EMBA; DSEWPaC 2012e).

Sea snakes generally inhabit shallow inshore regions and islands, both near the coastline and offshore, as they feed in shallow, benthic habitats. Sea snakes also inhabit waters surrounding offshore atolls and shoals/banks in the Timor Sea (Guinea 2013). Most sightings of sea snakes have been in water depths of 10 m to 50 m deep (RPS 2010), however, some species are known to dive to deeper depths. The non-pelagic sea snake species rarely, if ever, dive deeper than 100 m (Heatwole and Seymour 1975).

The distribution and movements of sea snakes vary between species. Some species, for example the pelagic yellow-bellied sea snake, traverse large distances in open offshore waters while others, such as the olive sea snake, are typically resident to a particular area. Sea snake species that reside on reefs do not actively disperse or migrate between reefs and are found to be present year-round at most reefs on the Sahul Shelf (Guinea and Whiting 2005).

A survey undertaken by AIMS (Heyward *et al*. 2012) identified 117 sea snake individuals across nine submerged shoals, which are located within an approximately 200 km radius of the EMBA. Of these individuals, 66 were identified as the olive sea snake, four as the ornate reef sea snake (also known as the spotted sea snake) and the remaining individuals were unable to be identified. The survey results included 14 olive sea snakes, one ornate reef sea snake and 13 unidentified individual sea snakes at Heywood Shoal (within the OA). A study by Guinea *et al*. (2013) identified an additional eight common reef-dwelling species of sea snake historically reported to occur on Ashmore Reef, with some of these species also occurring on Cartier Island (within the EMBA), Scott Reef, Seringapatam Reef and Hibernia Reef (outside the EMBA).

3.4.3.6.3. EPBC Act Management/Recovery Plans and Conservation Advice

A Recovery Plan has been developed for the six marine turtle species identified in **Section 3.4.3.6.1** as potentially occurring within the OA and EMBA (Commonwealth of Australia 2017a). There is also conservation advice specific to the leatherback turtle (DEWHA 2009a). The Threatened short-nosed sea snake and leaf-scaled sea snake also have species specific conservation advice (DSEWPaC 2010a and 2010b). Key threats identified within these documents that are relevant to the Factory 3D MSS are summarised in **Table 3-10**.

Table 3-10 - Summary of EPBC Act Management / Recovery Plans and Conservation Advices Relevant to Marine Turtles and Sea Snakes

Species	EPBC Act Management Plan/ Recovery Plan/ Conservation Advice	Key Threats Identified in relevant Management Plan/Recovery Plan/Conservation Advice	Cross-reference to Impact and Risk Evaluation
Loggerhead turtle Green turtle Leatherback turtle Hawksbill turtle Olive ridley turtle Flatback turtle	Recovery plan for marine turtles in Australia 2017-2027 (June 2017; Commonwealth of Australia 2017a) Conservation advice on leatherback turtle (*Dermochelys coriacea*; DEWHA 2009a)	Vessel disturbance	**Section 6.1**
		Light pollution	**Section 6.3**
		Noise interference	**Section 6.5**
		Marine debris	**Section 7.3**
		Chemical and terrestrial discharge	**Section 7.3**
Short-nosed sea snake Leaf-scaled sea snake	Conservation advice on short-nosed sea snake (*Aipysurus apraefrontalis*; DSEWPaC 2010a) Conservation advice on leaf-scaled sea snake	Habitat Loss, Disturbance and Modification	**Section 6.5**
		Incidental catch and death in commercial prawn trawling fisheries	n/a
		Unsustainable and illegal fishing practices	n/a

Species	EPBC Act Management Plan/ Recovery Plan/ Conservation Advice	Key Threats Identified in relevant Management Plan/Recovery Plan/Conservation Advice	Cross-reference to Impact and Risk Evaluation
	(*Aipysurus foliosquama*; DSEWPaC 2010b).		

3.4.3.7. Fish

The Timor Sea supports a variety of fish species of high conservation value as well as fisheries of commercial and recreational importance. The current state of knowledge of fishing activities within the OA in a socio-economic and indigenous use context is discussed further in **Section 3.5.3**. The following section provides a description of threatened and/or migratory fish species and other protected fish species listed under the EPBC Act, as well as commercially important fish species and species which are particularly vulnerable to seismic operations (i.e. site-attached fish) which have been identified as occurring within the OA and EMBA.

3.4.3.7.1. Threatened and/or Migratory Sharks, Sawfish and Rays

The NWMR has a rich fauna of sharks and rays due to the diverse marine habitats within the regions waters (DSEWPaC 2012h).

Within the OA, five species of wide-ranging whaler sharks and the great hammerhead shark (*Sphyrna mokarran*) were recorded at Heywood Shoal using BRUVs (Heyward et al 2012). Three species of shark and ray restricted to shallow waters (less than 70 m) were also recorded at Heywood Shoal, these being the tawny nurse shark (*Nebrius ferrugineus*), blue spotted stingray (*Dasyatis kuhlii*) and blotched fantail ray (*Taeniura meyeni*; Heyward et al 2012). None of the shark and ray species recorded by the BRUVs are MNES.

The PMST reports identified ten listed threatened and/or migratory shark, sawfish and ray species that may occur in or have habitat in the EMBA and OA. These species are discussed in detail below.

<u>White Shark</u>
The white shark (also referred to as great white shark) is primarily temperate and most likely to be found south of North West Cape (some 1,400 km south-south-west of the OA) with no known aggregation sites within the NWMR (DSEWPaC 2012h). Ongoing research into the seasonal movements of this species along the WA coast suggests white sharks travel northward during spring, returning to more southern waters in summer (DoEE 2018ab). Little information is available on reproductive activities of white sharks in Australian waters and no pupping grounds have been identified within the region (DSEWPaC 2012h).

Due to their relatively wide ranging and migratory behaviour along the WA coast, it is possible that white sharks may transit the EMBA and OA in low numbers.

<u>Northern River Shark</u>
Sharks of the genus *Glyphis* are considered among the most threatened elasmobranchs worldwide and appear to have limited habitat preferences (Stevens *et al*. 2005). This is applicable to the northern river shark, *Glyphis garricki*, which also exhibits habitat preference dependant on developmental stage. Habitat preferences throughout the species' life cycle include rivers, tidal sections, large tropical estuarine systems, macrotidal embayments, inshore and offshore marine habitats depending on life stage (DSEWPaC 2010d). The northern river shark has been recorded in offshore waters, however, the frequency of this occurrence is unknown.

The northern river shark has a known distribution including locations in the west and east Kimberley (DSEWPaC 2010c; 2010d). The species was listed threatened in 2001 due to their limited geographical distribution and low population estimates of mature individuals which was considered likely to continue to decline (DSEWPaC 2010c; 2010d). Given its typically limited distribution in proximity to estuarine environments, this species is not expected to transit the OA, but may occur in discrete locations within the EMBA.

<u>Whale shark</u>
The whale shark is globally distributed in tropical and warm temperate waters, and it is thought to form one single genetic population (DEWHA 2015c). Key areas of concentration within Australian waters include the Ningaloo coast (March – July), Christmas Island (December – January) and the Coral Sea (November – December), with the timing of the aggregations

thought to be linked to seasonal fluctuations in prey abundance (DEWHA 2015c). The species is an epipelagic filter feeder; therefore, their diet typically consists of planktonic and nektonic species, including small crustaceans and smaller schooling fish species (DoEE 2018aa; DEWHA 2015c). No seasonal aggregations of whale sharks are predicted within the OA.

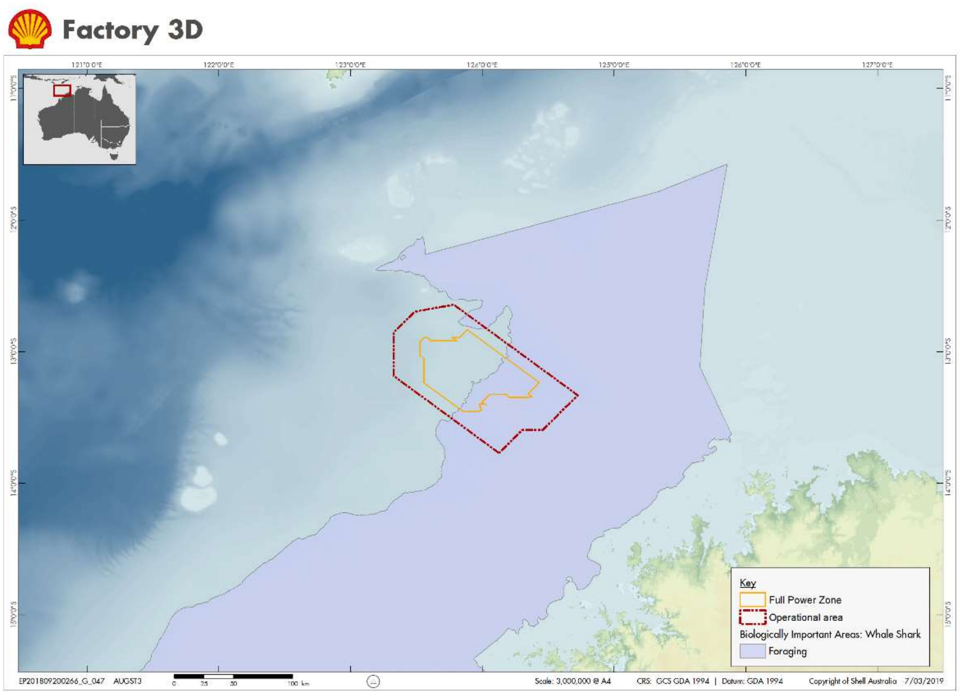


Figure 3-23 – Whale Shark Foraging BIA and the OA and FPZ

Whale sharks are known to be highly migratory with migrations of 13,000 km being recorded (Eckert and Stewart 2001). Migration along the northern WA coastline broadly follows the 200 m isobath and typically occurs between July and November (DEWHA 2015c). A foraging BIA for the whale sharks is located within northern WA, offshore of the Pilbara and Kimberley coastline (**Figure 3-23**; DoEE 2018aa, DEWHA 2015c). The OA overlaps 1.5% of this vast foraging BIA (FPZ overlaps 0.4%) (DoEE 2018aa, DEWHA 2015c).

Shortfin and longfin Mako

The shortfin mako and longfin mako were identified by the PMST reports search as potentially occurring in the OA and EMBA. The shortfin mako is a highly migratory epipelagic species widely distributed in tropical and temperate waters of temperatures above 16 °C (Groeneveld *et al*. 2014). The distribution and biology of the longfin mako is less documented, however, it is also an epipelagic shark inhabiting tropical and warm-temperature waters (Reardon *et al*. 2006). Makos exhibit sexual segregation and segregation throughout developmental stages; juveniles spend 90% of their time near the surface whereas adults dive much deeper (Groeneveld *et al*. 2014).

There are no known BIAs for the shortfin or longfin mako within the EMBA. Due to their migratory nature and known species distribution it is possible that these species may transit the OA and are expected to occur within the EMBA.

Sawfish species

Listed threatened green sawfish, largetooth sawfish and narrow sawfish occur mainly in inshore coastal waters and riverine environments in northern Australia. Considering declining global populations of these sawfishes, northern and north-west Australia may contain the last significant populations of these species (DSEWPaC 2012h).

Juvenile largetooth sawfish occur primarily in the freshwater areas of rivers and in estuaries, while adults mostly occupy marine and estuarine environments (DSEWPaC 2012h). The green sawfish and narrow sawfish do not occupy freshwater habitats and have been recorded in water depths of up to 70 and 100 m, respectively. However, the green sawfish is predominately recorded as occurring in inshore coastal areas (including estuaries and river mouths) and narrow sawfish most commonly found in sheltered bays with sandy bottoms (DSEWPaC 2012h).

BIAs for all three identified sawfish species occur along the WA coastline outside EMBA. Given these species' habitat preferences and known distributions it is unlikely that they will transit the OA or EMBA.

Giant and Reef Manta Rays

The giant manta ray and reef manta ray are globally distributed in both tropical and temperate waters. Whilst considered the more solitary of the two species, the giant manta ray is often sighted in high numbers whilst engaging in foraging, mating or cleaning activities (Marshall *et al*. 2011a). The giant manta ray also exhibits seasonality in habitat preference and is known to frequent offshore seamounts and islands, including the Cocos Islands (outside the EMBA; Marshall *et al*. 2011a).

The reef manta ray is sighted more frequently than the giant manta ray (Marshall *et al*. 2011a). The reef manta ray typically utilises productive nearshore habitats, including island groups, atolls and continental coastlines (Marshall *et al*. 2011b). However, the species has been known to undertake coastal migrations of significant distances and traverse international waters. As with the giant manta ray, this species is often sighted in high numbers, predominately when undertaking foraging activities as a group or migrating.

There is no known foraging or breeding aggregation areas for these species within the OA or EMBA. Based on the nearshore habitat preference of both the giant manta ray and reef manta ray, it is considered unlikely that they will occur in significant numbers within the OA or EMBA; however, these species may occur in low numbers as transiting vagrants.

3.4.3.7.2. EPBC Act Management / Recovery Plans and Conservation Advices

EPBC Act Management/Recovery Plans and conservation advices have been developed for a number of shark and ray species the PMST report identified as occurring within the OA and EMBA. Key threats identified within these plans that are relevant to the Factory 3D MSS are summarised in **Table 3-11**.

Table 3-11 - Summary of EPBC Management / Recovery Plans and Conservation Advices Relevant to Sharks and Rays

Species	EPBC Act Management Plan / Recovery Plan / Conservation Advice	Key Threats Identified in relevant Management Plan / Recovery Plan / Conservation Advice	Cross-reference to Impact and Risk Evaluation
Whale shark	Whale shark (*Rhincodon typus*) Recovery Plan 2005-2010 (Department of Environment and Heritage (DEH) 2005a) Conservation advice on whale shark (*Rhincodon typus*; October 2015) (DoE 2015l)	Habitat disruption from mineral exploration, production and transportation	**Section 6.5**
		Vessel strike	**Section 7.4**
		Pollution and marine debris	**Section 6.2** and **Section 7.3**
Great white shark	Recovery Plan for the White Shark (*Carcharodon carcharias*; August 2013) (DSEWPaC 2013b)	Habitat modification/ degradation (e.g. development, pollution) (note, coastal habitat degradation and anthropogenic activities in near-coast areas are of primary relevance as they are often a preferred habitat)	**Section 7.5 and Section 7.3**

Species	EPBC Act Management Plan / Recovery Plan / Conservation Advice	Key Threats Identified in relevant Management Plan / Recovery Plan / Conservation Advice	Cross-reference to Impact and Risk Evaluation
Speartooth shark Northern river shark Green sawfish Largetooth sawfish Dwarf sawfish	Sawfish and River Sharks Multispecies Recovery Plan (November 2015) (DoE 2015m) Conservation advice on speartooth shark (*Glyphis;* ; April 2014; DoE 2014c), northern river shark (*Glyphis garricki*; April 2014; DoE 2014d), dwarf sawfish (*Pristis clavata*; October 2009)(DEWHA 2009b), and green sawfish (*Pristis zijsron*; 2008; DEWHA 2008b)	Habitat degradation and modification (note, the recovery plan focusses on river and estuarine barriers that affect the migration of river sharks/sawfish)	**Section 7.5**
		Marine debris (potential threat)	**Section 7.3**

3.4.3.7.3. Other Protected Fish Species

Syngnathids

The PMST reports identified 28 fish species (excluding sharks and rays) that may occur or have habitat in the OA, and 31 fish species which may occur in the EMBA (see **Appendix B**). These species are ray-finned fishes and are either pipefish or seahorses (family Syngnathidae). All species of Syngnathidae are listed marine species under the EPBC Act.

Syngnathidae may transit through the offshore waters of the OA but are more likely to be associated with shallow waters around the nearby islands and shoals/banks (such as Heywood Shoal and Cartier Island; **Section 3.4.1.1**) and close to the WA coastline where benthic communities provide suitable shelter and foraging habitats (DSEWPaC 2012g). Knowledge about the distribution, abundance and ecology of Syngnathidae within the NWMR is limited, however, almost all species live in nearshore and inner shelf habitats, usually in shallow coastal waters (DSEWPaC 2012g). Therefore, these species are likely to be present within the OA, particularly at Heywood Shoal.

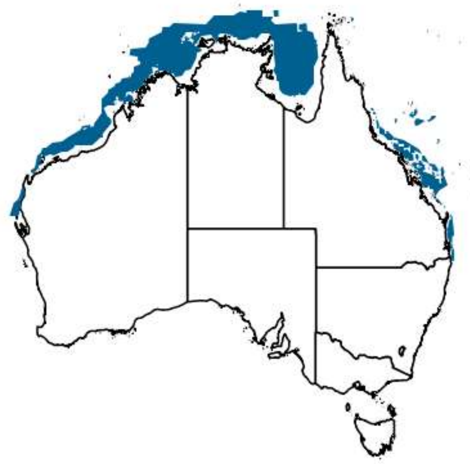
3.4.3.7.4. Demersal and Pelagic Commercial Fish

Commercial fish species targeted within the OA include both demersal species, such as Lutjanidae (snapper species), as well as pelagic species, such as Scombridae (mackerel species) and Carangidae (Trevallies and Jacks). These species rely less on benthic habitat (as opposed to the site-attached species described below), have increased swimming ability and would be more likely to flee an acoustic source. These findings are consistent with the main demersal and pelagic commercial fisheries operating within the survey area and the range of tropical snappers and mackerel species. Based on information from the Department of Primary Industry and Regional Development – Fisheries (DPIRD), the main commercial species likely to be found within the EMBA are Goldband snapper (*Pristipomoides multidens*) and Blue spotted emperor (*Lethrinus laticaudis*), other species potentially found in the operational are listed in **Table 3-12**.

Table 3-12 – Commercial fish species likely to occur within the Factory OA

Species	Depth Range	Description	Spawning season	Key spawning ground
Goldband snapper *Pristipomoides multidens*	50-200m	Goldband snapper is widely distributed throughout northern Australia and the tropical Indo-West Pacific (**Figure 3-24**). Goldband snapper inhabit deep tropical and sub-tropical waters. They are schooling fish and live in areas of hard, rocky and uneven sea floor and off islands and shoals. This species is not considered site attached due to its good swimming ability and minimal reliance on reef structures for shelter (ALA 2019a).	Kimberley: November-May (extended peak spawning period)	Spawns throughout their distribution range (rather than aggregating at specific locations).
Red emperor *Lutjanus sebae*	10-180m	The red emperor is native to the Indian Ocean and the western Pacific Ocean. This species is an inhabitant of both rocky and coral reefs, preferring flat areas with either a sandy or gravel substrate. They occur near coral reefs, often over adjacent sand flats. Also trawled in deeper water on relatively flat bottoms. Small juveniles are frequently commensal with sea urchins, or sometimes found in mangrove areas. The species feed on fishes, crabs, stomatopods, and other benthic crustaceans and cephalopods (ALA 2019b).	September-June (with bimodal peaks from September-November and January-March)	Spawns throughout their distribution range (rather than aggregating at specific locations).
Rankin cod *Epinephelus multinotatus*	10-150m	Rankin cod is distributed from as south as the Abrolhos Islands up to as north as Cape Leveque in WA waters. They inhabit clear to turbid water in shallow as well as deep water. Juveniles are found in inshore coral reefs, while adults are more common in deeper water. The species feed on small fishes and crabs (ALA 2019c).	June-December and March (peak spawning period August-October)	Spawns throughout their distribution range (rather than aggregating at specific locations).
Bluespotted emperor *Lethrinus laticaudis*	5-110m	The bluespotted emperor is native to the western Pacific Ocean where they occur on coral reefs. Juveniles inhabit beds of sea grass and mangrove swamps, while adults can be found over coral reefs, often in schools. The species feed mainly on crustaceans and fishes (**Figure 3-25**) ALA 2019d).	July-March (extended peak spawning period)	Spawns throughout their distribution range (rather than aggregating at specific locations).
Spanish mackerel *Scomberomorus commerson*	1 m to at least 50m	Spanish mackerel are widely distributed throughout the Indo-West Pacific region, particularly in tropical and sub-tropical waters. In WA, they're found from Cape Leeuwin northwards to the NT border. They are offshore, pelagic (surface-dwelling) fish and live around offshore and	Kimberley: September-January (peak spawning period)	Form spawning schools around inshore reefs in the North Coast Bioregion (Pilbara/Kimberley) which extends from the

		coastal reefs. Adults form groups to feed and spawn in coastal areas (DPIRD 2013). The Spanish mackerel are known to undertake lengthy longshore migrations; however, permanent resident populations also exist. They are found in small schools, feeding primarily on small fishes like anchovies, clupeids, carangids, squids and penaeoid shrimps (ALA 2019e).		Ashburton River (south of Onslow) to the WA/NT border.
Blacktip shark *Carcharhinus tilstoni*	0-30m	The blacktip shark occurs throughout the tropical Indo-West and Central Pacific. In Australia it is recorded from the central coast of WA around the tropical north and south to southern Queensland. The species favour the upper and middle parts of the water column, being found in shallow marine waters around coral reefs (McGrouther 2019). Primarily piscivorous, the blacktip shark forms large groups of similar size and sex that tend to remain within a local area (ALA 2019f).	November to December	Spawns throughout their distribution range (rather than aggregating at specific locations).
Sandbar shark *Carcharhinus plumbeus*	0-280m	The sandbar shark is widely distributed in Australia from Esperance, WA, around the tropical north to at least Nambucca Heads, NSW. The species is also widespread in the Atlantic and Indo-Pacific. The sandbar shark inhabits coastal waters, including shallow estuaries with sandy or muddy bottoms, bays, estuaries and harbours. It also occurs around offshore, around islands, banks and reef flats. Juveniles are usually found in warm temperate offshore waters. The species is carnivore and forages near the seafloor, feeding on small bottom dwelling fishes, crustaceans and molluscs (Fisheries of Australia 2019a).	October to January	Spawns throughout their distribution range (rather than aggregating at specific locations).



Source: modified from Fishes of Australia (2019)

Figure 3-24 - Distribution of Goldband Snapper

Source: modified from Fishes of Australia (2019)

Figure 3-25 - Distribution of Blue Spotted Emperor

3.4.3.7.5. Site-attached species

Fishes have evolved ways of feeding on every edible part of a reef community. As such, different parts of the same bank or shoal may host very different fish assemblages. Herbivores, such as rabbitfishes (Siganidae) graze on benthic algae, while some damselfishes (Pomacentridae) and surgeonfishes (Acanthuridae) defend 'garden patches'. Many butterflyfishes (Chaetodontidae) use elongated mouths to extract coral polyps from their protective skeletons while parrotfishes (Scaridae) use strong beaks to scrape algae encrusting dead, hard coral colonies.

Other species have an opportunistic and more varied diet; angelfish (Pomacanthidae), for example supplement a preference for sponges with a range of other benthic invertebrates. Some angelfish species form schools above or adjacent to the reef and capture zooplankton (Heyward *et al*. 1997).

Within the OA, Heywood Shoal supports a variety of fish species, as described in **Section 3.4.1.1.** The majority of these species are associated with shallow water environments and are reliant upon habitats such as reef, shoals, terrace, bank features (Heywood *et al*. 2017, 2017b). Subsequently, species associated with Heywood shoal (such as angelfish (Pomacanthidae), angelfish (Pomacanthidae), rabbitfishes (Siganidae), damselfishes (Pomacentridae) and surgeonfishes (Acanthuridae)) are expected to be restricted to the shallow shoal habitats and site attached fishes are not expected to occur throughout the deep and soft sandy substrates of the OA.

3.4.3.8. Migratory seabirds and shorebirds

A number of seabirds and migratory shorebirds are known to occur within the NWMR as they range over large distances to forage or migrate over the open ocean (DSEWPaC 2012f). Migratory shorebirds often utilise what has been termed the East Asian-Australasian (EAA) Flyway while transiting between summer and winter breeding and foraging areas. The PMST reports identified 14 listed threatened and/or migratory bird species as potentially occurring within the OA, and 27 species identified as potentially occurring within the EMBA. There are 10 bird species with BIAs within the EMBA, five of which also overlap the OA; these are indicated in **Table 3-13** and shown in **Figure 3-26**.

Ashmore Reef and Cartier Island are listed National Heritage Nature Reserves as well as AMPs and are defined together as a KEF (refer **Sections 3.5.2.3**, **3.5.3** and **3.4.2**). They are located approximately 52 km north-west of the OA and 9 km north of the OA respectively (within the EMBA). The two protected areas comprise critical nesting habitat as well as important foraging areas for shorebirds and support large populations of seabirds (Commonwealth of Australia 2002). Migratory and/or threatened seabird and shorebird species identified as potentially occurring within the OA are discussed in detail below.

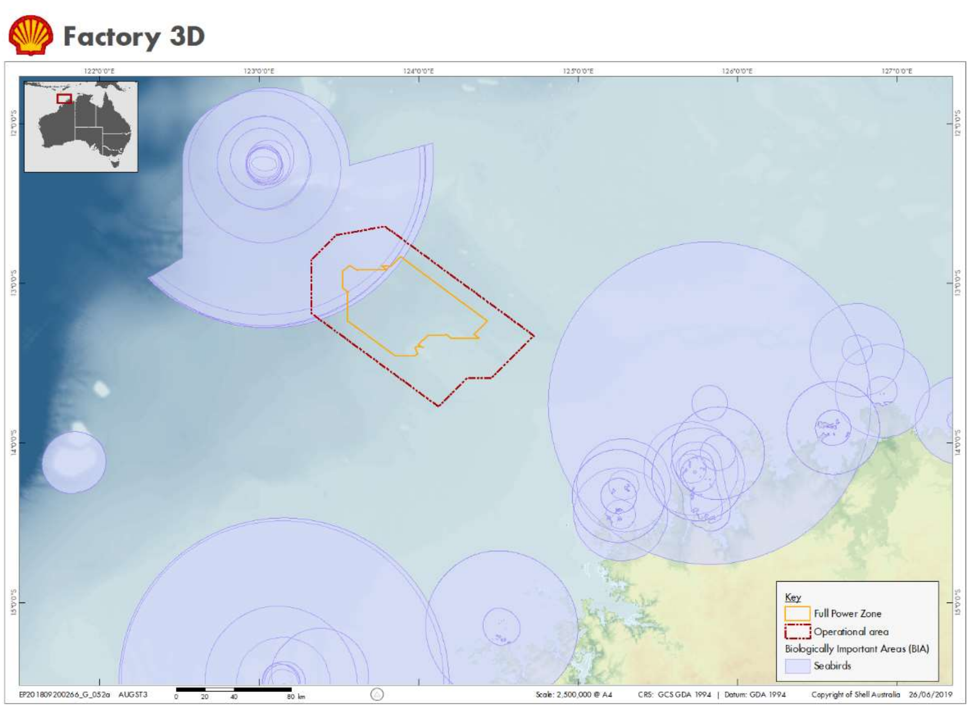


Figure 3-26 – Seabird and Shorebird BIAs and Within the Vicinity of the OA and FPZ

Australian Lesser Noddy

The Australian lesser noddy is a tropical species of tern endemic to Australia (DoEE 2018w; DEWHA 2015a). Whilst the Australian lesser noddy has a large range, the species utilises primarily a small area in Houtman Abrolhos for breeding (outside the EMBA; DoEE 2018w; DEWHA 2015a). The species is also known to breed in small numbers at Ashmore Reef (Menkhorst *et al*. 2017). Individuals generally remain in close proximity to the breeding islands throughout the year. Therefore, while some individuals may occur within the OA and are likely to occur within the EMBA, they are not expected to occur in significant numbers.

Red Knot

The red knot is an omnivorous wading bird which utilises the intertidal mudflats, sandflats and sandy beaches of sheltered coastal areas, estuaries, bays and other similar marine habitats. The red knot may also utilise saline wetlands but rarely freshwater water sources (DoEE 2018x). The red knot is present throughout coastal and offshore Australia, including Christmas and Cocos Keeling Islands (outside the EMBA). Notably, large numbers of red knot are regularly recorded in the north-west of Australia (specifically at 80 Mile Beach and Roebuck Bay) and the species is present along the Ningaloo coast and at Lake Macleod (DoEE 2018x; Bamford *et al*. 2008). The species has also been recorded within the area of Ashmore Reef (Clarke 2011).

While the species utilises the EAA Flyway, the exact migration route of Australian populations of red knot to their Arctic breeding grounds is unknown (DoEE 2018x, Watkins 1993). It is, however, thought that individuals may begin the journey by moving south across the west Pacific Ocean and then north along the east Asian coast (DoEE 2018x). The species is thought to make minimal stop overs during this migration. At the end of the breeding season the species returns south, arriving in northern Australia in late August to early September to take up residence, as well as settling in other areas primarily in eastern Australia and New Zealand (DoEE 2018x; Watkins 1993).

Given the species' habitat preference and recorded sightings, individuals may occur within the OA and EMBA, however, they are not expected to occur in significant numbers or for significant durations.

Curlew Sandpiper

The curlew sandpiper has a vast distribution, being recorded along the coasts of all Australian states and territories (DoEE 2018u). The species preferred habitat is intertidal mudflats in sheltered coastal areas as they forage in nearshore waters or mud at the edge of wetlands (DoEE 2018u). However, they are also widespread inland; albeit in smaller numbers. The curlew sandpiper migrates along the EAA Flyway from their breeding grounds in Siberia to Australia, generally arriving in Australia around late August/early September and departing by mid-April (DoEE 2018u). Some non-breeding individuals may not undertake the migration northward and stay in Australia (DoEE 2018u).

The species has also been recorded within the area of Ashmore Reef (Clarke 2011). Based on the known distribution and recorded sightings, as well as preferred feeding and roosting habitats, low numbers of curlew sandpiper may occur within the EMBA and OA.

Eastern Curlew

The eastern curlew is the world's largest species of shorebird (Menkhorst *et al*. 2017; DoEE 2018v). The species known distribution is restricted to the EAA Flyway. They undertake annual migrations to breeding grounds in Russia and north-eastern China, before returning to Australia in August to forage, primarily in intertidal mudflats on larger prey items such as crab (Bamford *et al*. 2008; DoEE 2018v; Menkhorst *et al*. 2017). There are two internationally important non-breeding sites in northern WA; Roebuck Bay and Eighty Mile Beach (Bamford *et al*. 2008).

The species has also been recorded within the area of Ashmore Reef (Clarke 2011). Considering the species preferred habitat and diet and recorded sightings, low numbers of eastern curlew may occur within the EMBA and OA.

Abbott's Booby

The Abbott's booby spends the majority of its time at sea and generally only comes ashore to breed. Within Australia, the Abbott's booby breeds exclusively on Christmas Island (outside the EMBA), displaying a preference for nesting in the forests on the island and foraging in the surrounding waters (DEWHA 2015b). Recent population estimates on Christmas Island are of 2,500 breeding pairs (Menkhorst *et al*. 2017).

The species' restricted geographical location is thought to be attributed to areas of upwelling in the waters surrounding Christmas Island, which may provide prey items that are seasonal and necessary for raising offspring. However, data suggests that individuals may travel up to hundreds of kilometres from Christmas Island in order to forage (DoEE 2018y). There is one record of Abbott's booby within the area of Ashmore Reef, however, the occurrence was considered vagrant (i.e. outside it's normal range) with the individual found deceased (Clarke 2011). Considering the OA is greater than 2,000 km east of Christmas Island, it is unlikely that the species will occur within the OA or EMBA.

Common Noddy
The common noddy has a widespread distribution in tropical and subtropical areas of the Pacific, Indian and Atlantic Oceans. The common noddy is a seabird that forages in coastal waters around nesting sites, taking prey such as small fish. Nesting occurs broadly across tropical and subtropical Australia in coastal areas, particularly on islands such as the Houtman Abrolhos island group (outside the EMBA). The common noddy is thought to undertake seasonal movements and has been recorded in the area of Ashmore Reef (Clarke 2011).

Given the species' known distribution and recorded sightings, individuals are likely to occur within the OA and EMBA.

Streaked Shearwater
The streaked shearwater is a migratory seabird with a broad distribution in the western Pacific Ocean. The species breeds and nests on offshore islands in temperate East Asia, including Japan and the Korean peninsula. During winter months the species migrates south, between Papua New Guinea and northern Australia, where the species occurs around islands and inshore waters. The species has also been recorded within the area of Ashmore Reef (Clarke 2011). The species may occur in the OA and EMBA, particularly during winter months.

Lesser Frigatebird
The lesser frigatebird occurs throughout the tropical and warmer waters of northern and eastern Australia (DSEWPaC 2012f), breeding on islands such as Ashmore Reef and North Keeling, as well as at a number of other islands located off the north coast of WA (Menkhorst *et al*. 2017). Two breeding and foraging BIAs for the lesser frigatebird overlap the EMBA, with one also overlapping the OA at Ashmore Reef (**Figure 3-26**). Satellite tracking studies have also shown the species transits within the EMBA (Mott 2016).

The lesser frigatebird feeds on prey items such as flying fish by catching their prey at or just above the ocean surface (DSEWPaC 2012f). This species also occasionally feeds on squid, octopus and other species' chicks, and typically does not forage far from the breeding colony (DSEWPaC 2012f; Birdlife International 2017b). As with the greater frigatebird (below), individuals are likely to utilise the open waters within the OA based on the species' distribution, location of defined BIAs for the species and their feeding preferences.

Greater Frigatebird
The greater frigatebird is widespread and breeds on a number of small and remote tropical and sub-tropical islands (DSEWPaC 2012f; Birdlife International 2017a). Whilst the species typically nests in mangroves or bushes, it may also nest on the bare ground (Birdlife International 2017a). The great frigatebird forages both inland and along coastlines, potentially straying up to 200 km from the colony to forage during the early breeding season (Birdlife International 2018; DSEWPaC 2012f). The species' diet consists largely of fish, squid and the chicks of other bird species (Birdlife International 2017a; DSEWPaC 2012f).

There are large breeding populations of this species in the tropical waters of the Pacific and Indian Oceans (Birdlife International 2017a). Within WA, the greater frigatebird has a small breeding colony at Ashmore Reef and is found throughout the north and eastern coastal and offshore areas of Australia (DoEE 2018z; DSEWPaC 2012f). The species also breeds on Christmas and North Keeling Islands (outside the EMBA; Menkhorst *et al*. 2017).

A breeding BIA for the greater frigatebird has been defined around Ashmore Reef (overlapping the OA and EMBA; **Figure 3-26**). Considering the species' distribution and foraging habits, individuals are likely to utilise the open waters within the OA and EMBA. Satellite tracking studies undertaken from Ashmore Reef have also shown the species traverses the EMBA (Mott 2016).

White-tailed Tropicbird
The white-tailed tropicbird, like other tropicbirds, is predominately a pelagic species of seabirds, which generally come to shore only to breed (DSEWPaC 2012b). The species forages in warm waters long distances from breeding areas. White-tailed tropicbirds breed on Christmas Island, however, have been recorded foraging up to 1,660 km from the island to forage (Dunlop *et al*. 2001, as cited in DSEWPaC 2012b). The species has been recorded within

the area of Ashmore Reef (Clarke 2011). Given the species known distribution and foraging behaviour, individuals are likely to occur within the OA and EMBA.

Red-footed Booby

The species has also been recorded within the area of Ashmore Reef (Clarke 2011) and is known to breed on Ashmore and Cartier Islands (Nelson 2005 as cited in DSEWPaC 2012b). A BIA for the species has been defined around Ashmore Reef and Cartier Island which overlaps the OA and EMBA. The species relies on areas of high productivity to forage on flying fish and squid and is known to occur around underwater slopes in proximity to breeding islands. Given their known distribution and breeding locations the species is likely to occur within the OA and EMBA.

Common, Sharp-tailed and Pectoral Sandpipers

The common, sharp-tailed and pectoral sandpipers are migratory wading shorebirds. These species breed in the northern hemisphere and undertake long distance seasonal migrations to the southern hemisphere for the austral summer (Bamford *et al*. 2008). The three species occur throughout the mainland Australia between spring and autumn months. The common sandpiper and sharp-tailed sandpiper have been recorded at Ashmore Reef (Clarke 2011) and the area is considered an important staging point for migratory wading birds (Commonwealth of Australia 2002).

Given their known distribution and migratory movements, sandpipers may occur within the OA and EMBA between spring and autumn months.

3.4.3.8.1. Foraging Behaviour

Many seabird and shorebird species feed on fish, cephalopods and crustaceans by means of plunge diving (brown booby), scooping/surface seizing (lesser frigatebird, streaked shearwater), foraging (terns, common noddy, white-tailed tropicbird), and/or stealing from other birds (lesser frigatebird) (DSEWPAC 2012; DSEWPaC 2012e). A summary of seabird and shorebird foraging behaviour and prey types is provided as an example below in **Table 3-13**.

Table 3-13 - Bird Foraging Behaviour and Prey Species

Species	Foraging Behaviour	Diet (Prey Species)
Brown booby	Plunge diver and often forages closer to land than other booby species	fish cephalopods
Great frigatebird	Scoops up prey species from the surface of the water and takes flying fish from just above the surface	flying fish cephalopods
Lesser frigatebird	Scoops up prey species from the surface of the water and takes flying fish from just above the surface. Also known to steal prey off other seabirds (boobies and terns)	fish cephalopods
Red-footed booby	Dives briefly beneath the waves to seize flying fish and squid	fish cephalopods
Roseate tern	Known as a specialist forager. Forages in sheltered estuaries, creeks, inshore waters and up to several kilometres offshore	small pelagic fish
White-tailed tropicbird	Plunge-diving	fish cephalopods
Little tern	Feeds at low tide on the exposed sand flats	small fish (less than 10 cm in length); crustaceans insects; worms; molluscs

Modified from DSEWPaC (2012)

3.4.3.8.2. EPBC Act Management/Recovery Plans and Conservation Advice

EPBC Act Management/Recovery Plans and conservation advices have been developed for a number of shorebird and seabird species that have been identified by the PMST reports as occurring within the OA and EMBA. Relevant key threats identified within these plans are summarised **Table 3-14**. A number of threats were considered not to be relevant to the

Factory 3D MSS based on the following criteria: (1) the species was not identified as occurring within the OA and the threat was specific to risks/impacts restricted to this area, or (2) if the threat was specific to terrestrial areas (e.g. onshore anthropogenic lighting) or a location outside the EMBA (e.g. the Yellow Sea (DoE 2015h; 2015i).

Table 3-14 - Summary of EPBC Act Management/Recovery Plans and Conservation Advices Relevant to Birds

Species	EPBC Management Plan/Recovery Plan/Conservation Advice	Key Threats Identified in relevant Management Plan /Recovery Plan/ Conservation Advice	Cross-reference to Impact and Risk Evaluation
Sandpiper species	Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015e)	Modification habitat (e.g. from acute pollution from oil/ chemical spills	Consideration is given in the context of habitat degradation from pollution associated with unplanned waste management (**Section 7.3** and **Section 7.5**) and emergency/unplanned events (**Section 7.2.1**).
Australian lesser noddy	Conservation advice on Australian lesser noddy (*Anous tenuirostris melanops*; October 2015) (DoE 2015j)	Habitat loss from pollution	**Section 7.5**
Red knot	Conservation advice on red knot (*Calidris canutus*; May 2016; DoE 2016a)	Pollution/contamination	**Section 7.3** and **Section 7.5**
		Direct mortality from chemical spills and oil spills	Consideration is given to this species in the context of disturbance from chemical/oil spills (**Section 7.3** and **Section 7.5**).

3.4.3.9. Timing of Key Ecological Sensitivities

A matrix of environmental sensitivities (**Table 3-15**) was generated to understand the timing of key life stages of fauna species and to identify the optimal window for acquiring the seismic data required under Shell's petroleum title commitments to the Australian Federal Government. In using the sensitivity matrix in Shell's business decision making process, Shell also must consider safety, operational and commercial constraints.

Table 3-15 – Timing of Key Ecological Sensitivities; Nesting, Migration, Spawning, Weather Events

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Coral spawning												
Key Commercial Demersal Fish Species Spawning												
Humpback whale – north and south migration												
Pygmy blue whale migration												
Bryde's whale												
Fin whale												
Turtle nesting												
Whale shark migration												
Migratory shorebirds												
Cyclone season (NWMR)												

3.5. Socio-Economic Environment

3.5.1. Commonwealth Marine Area

The OA and EMBA are located within the Commonwealth marine area, a MNES which includes "any part of the sea, including the waters, seabed and airspace, within Australia's exclusive economic zone and/or over the continental shelf of Australia, that is not state or NT waters. The Commonwealth marine area stretches from three to 200 nm from the coast (DoEE 2018aj).

3.5.2. Heritage

3.5.2.1. World Heritage Properties

There are no World Heritage properties within or in the immediate surrounds of the OA or EMBA. Therefore, World Heritage Properties are not considered further in this EP.

3.5.2.2. Aboriginal Heritage

There are no recorded Indigenous heritage sites within or in the vicinity of the OA or EMBA. Considering the water depths and distance offshore, the proposed OA is not expected to support any Aboriginal heritage values. Aboriginal fishing activities are largely confined to inshore and coastal waters. Therefore, Aboriginal heritage is not considered further in this EP.

3.5.2.3. National Heritage Places

The National Heritage List is Australia's list of natural, historic and Aboriginal places of outstanding significance to the nation. There are no National Heritage properties overlapping the OA or EMBA. The nearest National Heritage Place is the West Kimberley, located approximately 25 km south-east of the EMBA. Therefore, National Heritage Places are not considered further in this EP.

3.5.2.4. Commonwealth Heritage Places

The Commonwealth Heritage List is a list of Aboriginal, historic and natural heritage places owned or controlled by the Australian Government. The OA does not overlap any Commonwealth Heritage places. The Ashmore Reef National Nature Reserve Commonwealth Heritage Place lies approximately 25 km from the OA and within the EMBA.

The Ashmore Reef National Nature Reserve protects Ashmore Reef, a large platform reef with coral reefs, sand flats and three vegetated islands (DoEE 2018ae). Ashmore Reef is also protected as an AMP and KEF. Specific values of this site include (DoEE 2018ae; Environment Australia 2002):

- Breeding and foraging habitat for marine turtles;
- Considered to have the world's greatest abundance and diversity of sea snakes;
- Habitat for 569 species of fish, 255 species of corals and 433 species of mollusc, as well as species not previously recorded or rarely recorded in Australia;
- An important seabird rookery and provides an important staging/feeding area for many seabirds and migratory shorebirds; and
- Provides breeding and feeding habitat for a small dugong population (< 50 individuals).

3.5.2.5. Maritime Heritage

Information on historic shipwrecks is maintained in the Australasian Underwater Cultural Heritage Database, a searchable database of Australian shipwrecks, plane wrecks and other heritage containing records provided by the Australian State and Territory Governments. A search of the Australasian Underwater Cultural Heritage Database did not locate any shipwrecks, aircraft wrecks or other maritime cultural heritage sites in the OA, however, 4 shipwrecks were identified to occur within the EMBA (**Figure 3-27**; DoEE 2018ay). The closet shipwreck to the OA, the Ann Millicent was lost to sea in 1888 travelling from Port Darwin to Port Adelaide when it ran aground reef near Cartier Island (DoEE 2018ay). The Ann Millicent is located approximately 15 km from the OA.

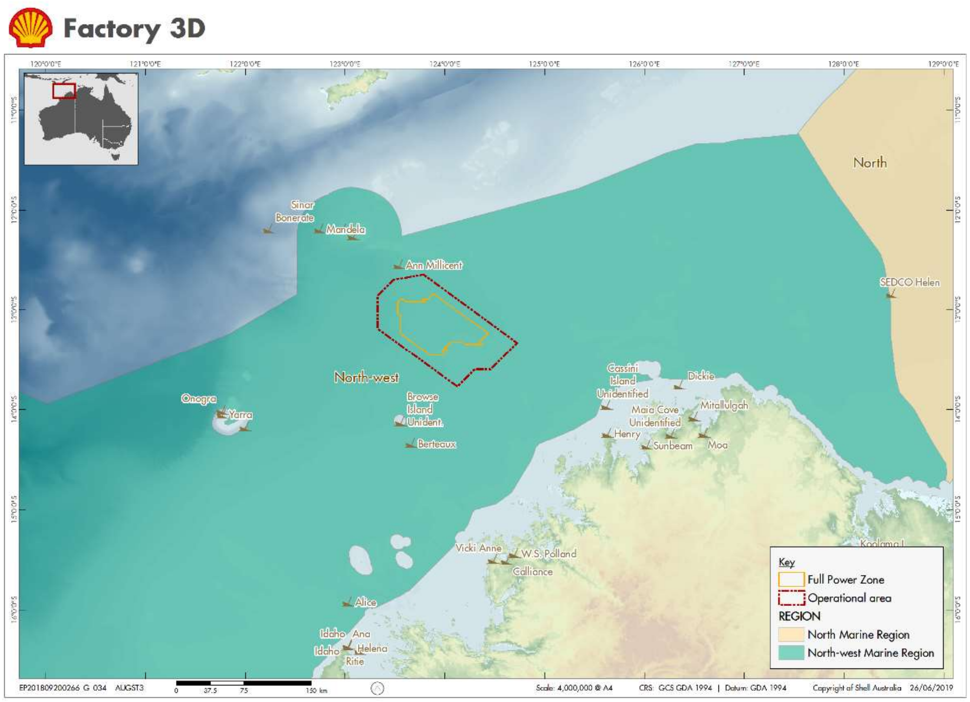


Figure 3-27 - Known Shipwrecks in the North-west Marine Region.

3.5.2.6. Wetlands of Importance, Ramsar Wetlands

No "Wetlands of International Importance" under the Convention on Wetlands of International Importance (Ramsar 1975) directly overlap the OA, however, the Ashmore Reef Commonwealth Marine Reserve Ramsar site, is also the Ashmore Reef AMP, a KEF and National Heritage Nature Reserve (**Figure 3-28**), lies 52 km from the OA and within the EMBA. Ashmore Reef Commonwealth Marine Reserve Ramsar site was designated a Ramsar site primarily due to its importance in supporting large seabird breeding colonies and as a resting place for migratory shorebirds. The boundary of the Ramsar site coincides with the defined AMP (Hale and Butcher 2013).

Notably, Ashmore Reef has been managed for conservation purposes for more than thirty years. The five wetland types that have been identified within this Ramsar site are permanent shallow marine waters; sand, shingle or pebble shores; marine subtidal aquatic beds; coral reefs; and intertidal mud, sand or salt flats. Each of these wetland types are in near natural condition and have been recorded as having low densities of coral predators and disease (Hale and Butcher 2013).

The three islands of the Ashmore Reef Commonwealth Marine Reserve Ramsar site are the only vegetated islands in the Timor Province bioregion. At the time of listing, this Ramsar site boasted 62 threatened species, including 42 corals, five sea cucumber, eight fish, six reptile and one mammal species. Historically, the site was also significant with regards to sea snake abundance and diversity. The site supports breeding and/or foraging areas for green, loggerhead and hawksbill turtles, and breeding areas for dugongs (Hale and Butcher 2013). The site has been identified as hotspot of biological diversity within the Timor province bioregion, and broader NWMR.

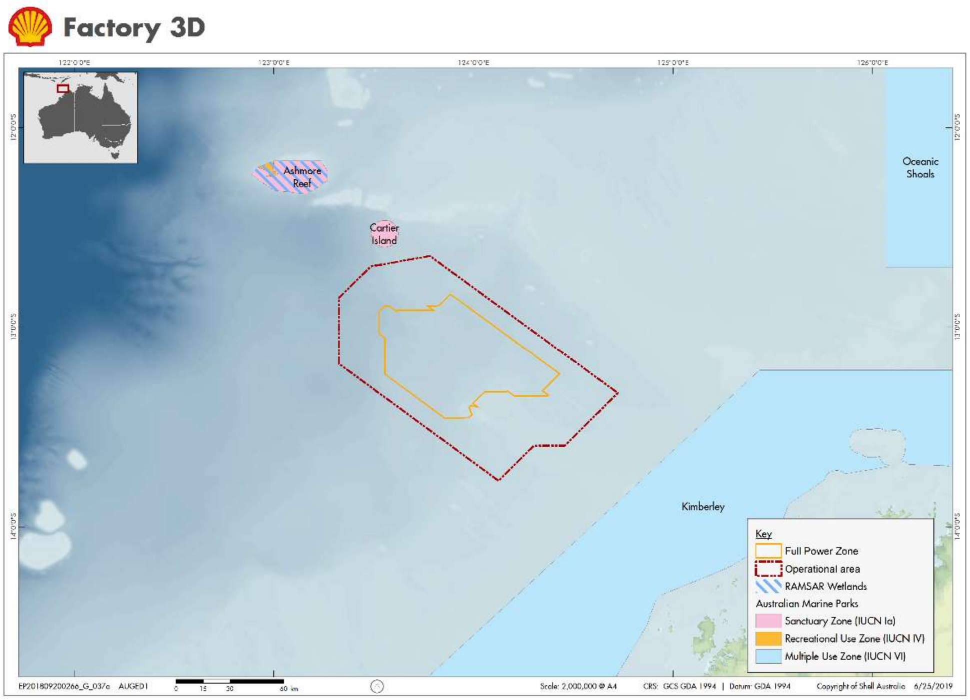


Figure 3-28 - Australian Marine Parks, RAMSAR wetlands and the OA and FPZ

3.5.3. Australian Marine Parks

Australian Marine Parks (AMPs; formerly Commonwealth Marine Reserves) are recognised under the EPBC Act for protecting and maintaining biological diversity and contributing to a national representative network of marine protected areas. Under the relevant management plans, AMPs are allocated conservation objectives (International Union for Conservation of Nature (IUCN) Protected Area Category) based on the Australian IUCN reserve management principles in Schedule 8 of the EPBC Regulations 2000. These principles determine what activities are acceptable within a protected area under the EPBC Act. **Table 3-16** outlines the management principles for Commonwealth Marine Protected Areas and how the activity is consistent with these principles.

Table 3-16 - Australian IUCN Reserve Management Principles for Commonwealth Marine Protected Area Category II and VI and Management of the Activity Consistent with these Principles

IUCN Rating	Reserve Management Principles (Director of National Parks 2018)	Survey Consistent with the IUCN Reserve Management Principles
Strict nature reserve (IUCN category Ia) *Managed to conserve ecosystems, habitats and native species in as natural and undisturbed a state as possible. The zone allows only*	1.01 The reserve or zone should be managed primarily for scientific research or environmental monitoring based on the following principles.	
	1.02 Habitats, ecosystems and native species should be conserved in as undisturbed a state as possible.	**Section 6.3, 6.5, 7.3, 7.4, 7.5** Yes - survey activities will adhere to the Environmental Performance Outcomes (Section 6)
	1.03 Genetic resources should be maintained in a dynamic and evolutionary state.	Not applicable – Survey activities are not expected to impact the evolutionary state of genetic resources within any AMP

IUCN Rating	Reserve Management Principles (Director of National Parks 2018)	Survey Consistent with the IUCN Reserve Management Principles
authorised scientific research and monitoring.	1.04 Established ecological processes should be maintained.	**Section 6.5, 7.1, 7.5** Yes - survey activities will adhere to the Environmental Performance Outcomes (Section 6)
	1.05 Structural landscape features or rock exposures should be safeguarded.	Not applicable – No activities will be undertaken within any AMP during the survey.
	1.06 Examples of the natural environment should be secured for scientific studies, environmental monitoring and education, including baseline areas from which all avoidable access is excluded.	Not applicable – No activities will be undertaken within any AMP during the survey.
	1.07 Disturbance should be minimised by careful planning and execution of research and other approved activities.	**Section 6.3, 6.5, 7.3, 7.4, 7.5** Yes - survey activities will adhere to the Environmental Performance Outcomes (Section 6)
	1.08 Public access should be limited to the extent it is consistent with these principles.	Not applicable – No activities will be undertaken within any AMP during the survey.
Multiple Use Zone/Managed resource protected area (IUCN category VI) *Managed to allow ecologically sustainable use while conserving ecosystems, habitats and native species. The zone allows for a range of sustainable uses, including commercial fishing and mining where they are consistent with park values.*	7.01 The reserve or zone should be managed mainly for the sustainable use of natural ecosystems based on the following principles.	
	7.02 The biological diversity and other natural values of the reserve or zone should be protected and maintained in the long term.	**Section 6.3, 6.5, 7.3, 7.4, 7.5**
	7.03 Management practices should be applied to ensure ecologically sustainable use of the reserve or zone.	**Section 6.3, 6.5, 7.3, 7.4, 7.5**
	7.04 Management of the reserve or zone should contribute to regional and national development to the extent that this is consistent with these principles.	Not applicable – OA does not overlap any AMP. Mining operations including exploration are allowable, subject to assessment, in accordance with a Licence issued by the Director of Marine Parks.

A search of the EPBC Protected Matters Database confirmed that the OA does not overlap any AMPs. However, the Ashmore Reef, Cartier Island and Kimberley AMPs overlap the EMBA (**Figure 3-28**). These features are described in **Table 3-17**. Given no AMPs directly overlap the OA where the petroleum activities will be undertaken, no approval is required from the Director of National Parks for the Factory 3D MSS, however, the Director is considered a relevant stakeholder. Refer to **Section 10** for information on stakeholder consultation.

Table 3-17 - Australian Marine Parks and the Factory EMBA and OA

AMP	Description	Occurence	
		EMBA	OA
Cartier Island *IUCN category 1a*	The Cartier Island Marine Park encompasses an area 172 km^2, the entirety of which is a Sanctuary Zone (IUCN category Ia). The Marine Park is located approximately 45 km south-east of Ashmore Reef Marine Park and has water depths ranging from less than 15 m to 500 m (Director of Parks 2018). The Marine Park includes Cartier Island, an unvegetated sand island, and is surrounded by a mature reef flat, two shallow pools to the north-east of the Island and Wave Governor Bank, a small submerged pinnacle (DoEE 2018 am; Director of National Parks 2013; Director of Parks 2018). Conservation values of Cartier Island include a high diversity of hard and soft corals, sponges, sea fans and encrusting organisms (Director of National Parks 2013). The reef crests surrounding Cartier Island are algal dominated and the reef flats feature large seagrass areas and ridges of coral rubble (Director of Parks 2013; Director of Parks 2018). The Marine Park is a biodiversity hotspot and is representative of the key habitats, species and ecological communities associated with the Timor Province (Director of Parks 2018). The Marine Park provides an important area for a number of EPBC Act listed species, including sea snakes, turtles and migratory seabirds. Additionally, Cartier Island supports some of the most important seabird rookeries on the NWS and nesting populations of marine turtles (DoEE 2018am). Biologically important areas (BIAs) within Cartier Island Marine Park include the following (**Section** Ecological Environment**3.4**): •Breeding and foraging habitats for seabirds. •Internesting, nesting and foraging habitats for marine turtles. •Foraging habitats for whale sharks. The marine park also overlaps two KEFs (**Section 3.4.2**); Ashmore Reef and Cartier Island and surrounding Commonwealth waters and Continental slope demersal fish communities. The former KEF has high productivity and biodiversity in an otherwise low-nutrient environment (Director of Parks 2018). This KEF is regionally important for feeding and breeding aggregations of birds and marine life (Director of Parks 2013; Director of Parks 2018). The latter KEF also supports high diversity of demersal fish assemblages in the marine park and is considered regionally important due to high levels of endemism (Director of Parks 2018).	✓	× (9 km from the OA)

AMP	Description	Occurence	
		EMBA	OA
Ashmore Reef *IUCN category 1a*	The Ashmore Reef Marine Park encompasses an area 583 km^2, comprising of a Sanctuary Zone (IUCN category Ia) that overlaps the EMBA, and a Recreational Zone (IUCN category II; outside the EMBA). The marine park has water depths ranging from less than 15 m to 500 m and includes the West, Middle and East islands, three vegetated sand cays permanently above water which comprise Ashmore Reef (Director of Parks 2018). Ashmore Reef is also the largest of three emergent oceanic reefs in the region and is recognized as a critical nesting and interesting habitat for green turtles, supporting genetically distinct breeding populations in the NWMR (Director of Parks 2013). Habitats within the marine include two extensive lagoons, sand flats, shifting sand cays, large areas of seagrass and an extensive reef flat (Director of Parks 2013). Like the Cartier Island Marine Park, Ashmore Reef Marine Park is a biodiversity hotspot and is representative of the key habitats, species and ecological communities associated with the Timor Province (Director of Parks 2018). The Marine Park provides an important area for a number of EPBC Act listed species, including sea snakes, turtles, migratory seabirds, pelagic and benthic marine species. Ashmore Reef also supports a small population of dugong (Director of Parks 2013). In 2003, the Ashmore Reef Marine Park was declared a Ramsar Wetland of International Importance due to its conservation values (refer to **Section 3.5.3** for further information; DoEE 2018al). Seabird rookeries within the North West Shelf are supported by West, Middle and East islands. This includes colonies of bridled terns, common noddies, brown boobies, eastern reef egrets, frigatebirds, tropicbirds, red-footed boobies, roseate terns, crested terns and lesser crested terns (Director of Parks 2013). Ashmore Reef is also internationally significant for its abundance and diversity of sea snakes and feeding areas for migratory birds (Director of Parks 2018). Biologically important areas (BIAs) within the Marine Park include the following: •Breeding foraging and resting habitats for seabirds. •Resting and foraging habitat for migratory shorebirds. •Foraging, mating, nesting and interesting habitat for marine turtles. •Foraging habitat for dugong. •Migratory pathways for pygmy blue whales. Two KEFs are represented in the Ashmore Reef Marine Park (described in **Section 4.4.2**): •Ashmore Reef and Cartier Island and surrounding Commonwealth waters. •Continental slope demersal fish communities.	✓	× (52 km from the OA)

AMP	Description	Occurence	
		EMBA	OA
Kimberley	*IUCN category VI* The 74,469 km^2 Kimberley Marine Park extends from north of the Lacepede Islands to Holothuria Banks. It is comprised of a National Park Zone (IUCN category II), Habitat Protection Zone (IUCN category IV; specifically intended to protect humpback whale calving) and Multiple Use Zone (IUCN category VI). The Multiple Use Zone (VI) is the only zone to overlap the EMBA. The marine park ranges in depth from less than 15 m to 800 m and provides protection for the communities and habitats of waters offshore of the Kimberley coastline. The marine park's numerous conservation values include important foraging areas for migratory seabirds, dugongs, dolphins, marine turtles and a migration pathway and nursery areas for humpback whales. The marine park also lies adjacent to important foraging and pupping areas for sawfish and important nesting sites for green turtles. The Kimberley Marine Park contains ecosystems representative of the Northwest Shelf Province, Northwest Shelf Transition and Timor Province provincial bioregions. The includes diverse and endemic benthic and pelagic fish communities and ancient geomorphic features in a dynamic and often turbid oceanic environment (DoEE 2018aq). The geomorphic features within the marine park include the Ancient coastline at the 125 m depth contour and Continental slope demersal fish communities KEFs (**Section 4.4.2**). The Kimberley Marine Park supports recreational and commercial fishing and tourism activities. The marine park is adjacent to the West Kimberley, a national heritage place, and contains significant cultural heritage value, including approximately 3,400 km^2 of the Wunambal Gaambera people's sea country (DoEE 2018aq).	✓	× (43 km from the OA)

3.5.1. WA State Marine Parks and Nature Reserves

WA marine parks and Nature Reserves are managed by the Department of Biodiversity, Conservation and Attractions (DBCA). There are no State marine parks within the OA or EMBA, as the OA is located within Commonwealth waters. There is, however, one Nature Reserve within the EMBA; the Browse Island Nature Reserve (**Figure 3-28**). This Nature Reserve comprises the State Territorial Waters surrounding Browse Island, which extend to a distance of three nm. As mentioned in **Section 3.4.1.1**, Browse Island is a small (approximately 13 ha) sand and limestone cay with coral reef, known to support nesting green turtles (Shell 2009). Historically the island has also supported large numbers of seabirds (Department of Biodiversity, Conservation and Attractions 2010).

The Scott Reef Nature Reserve (**Figure 3-28**)., similarly comprised of three nm of State Territorial Waters surrounding Scott Reef, is located approximately 60 km south-west of the EMBA and is included for completeness here as oil spill modelling indicates shoreline accumulation may occur at this receptor. As mentioned in **Section 3.4.1.1**, Scott Reef supports a variety of marine fauna, including marine turtles and seabirds, and is recognized as a KEF (**Section 3.4.2**).

3.5.2. Commercial Fisheries

The OA overlaps with a number of Commonwealth and WA State commercial fishing management areas. This section identifies fishery interests within the OA and broader EMBA. This assessment has been validated through direct engagement with fisheries and fisheries organisations who have interests in the area and other relevant stakeholders (e.g. DPIRD, WAFIC and NDSF (DoF; see **Section 10**).

A description and status of each of the WA and Commonwealth managed commercial fisheries relevant to the context of the Factory 3D MSS is provided in **Table 3-18**.

These fisheries have the right to fish within the OA and therefore there is the potential that these commercial fishers may interact with the Factory seismic activity (**Section 3.4**).

Table 3-18 – Commonwealth and State Managed Fisheries and the Factory EMBA and OA

Fishery	Description	Method	Aquatic Zone Fished	Number of Licences/Vessels and Effort	Occurrence EMBA	Occurrence OA	Likelihood of Fishing to Occur within OA/EMBA
WA State Managed Fisheries							
Mackerel Managed Fishery (MMF)	The Mackerel Fishery extends north from the West Coast Bioregion to the NT border (Department of Primary Industries and Regional Development (DPIRD; 2018a; **Figure 3-30**).	Dominant fishing method is trolling; however, jigging methods are also used to catch grey mackerel in some areas (Mackie *et al*. 2010).	Pelagic: waters greater than 40 m isobath and less than 100 m isobath	Catch effort in the 2016/17 season was 276 tonnes (DPIRD 2018b). The primary fishing effort is typically concentrated in the North Coast Bioregion, which encompasses the Pilbara and Kimberley coastline (DPIRD 2018a).	✓	✓	Fishery is unlikely to operate within the area given water depths in the majority of the OA/EMBA is greater than 100 m. Stakeholder consultation (with WAFIC) have indicated there are no licenses active within the OA (**Section 10**).
Marine Aquarium Fish Managed Fishery (MAFMF)	The MAFMF encompasses all WA State waters. The Fishery has the capacity to target 950 marine aquarium fish species (DPIRD 2018d; **Figure 3-30**).	Primarily a dive-based using hand-held nets (DPIRD 2018d).	Nearshore: waters of 0-20 m isobath	In recent years effort has been in waters from Esperance to Broome, with a focus around the Capes region, Perth, Geraldton, Exmouth and Dampier (DPIRD 2018b). The total catch in the MAFMF and Hermit Crab Fishery in 2016 was 128,610 fishes, 16.4 tonnes of coral, live rock and living sand, and 75 L of marine plants (DPIRD 2018d).	✓	✓	Fishery is unlikely to operate within the area given water depths in the majority of the OA/EMBA is greater than 20 m.
North Coast Managed Prawn Fisheries (including the Broome and Kimberley Prawn Managed Fisheries)	This fishery is comprised of the Onslow, Nickol Bay, Broome, and Kimberley Prawn Managed Fisheries, two of which overlap the OA/EMBA. The fishery extends south from Cape Londonderry (and the Northern Prawn Managed Fishery boundary) to the north-eastern extent of the Exmouth Gulf Prawn Fishery (WAFIC 2018b; **Figure 3-30**).	Trawl fishery (WAFIC 2018b). Most of the fishing occurs at night, except for targeted fishing for banana prawns which occurs mostly during the day (DPIRD 2018c).	Inshore Marine/Shelf: waters of the 20-40 m isobath	Catch effort from the 2016 (DoF 2017) season for sub-fisheries overlapping the OA/EMBA was: • Kimberley: 155 tonnes • Broome: Negligible	✓	✓	Fishery is unlikely to operate within the area given water depths in the majority of the OA/EMBA is greater than 40 m. Stakeholder consultation (with WAFIC) has indicated there are no licenses active within the area (**Section 10**).
Northern Demersal	The NDSF includes all waters of the Indian Ocean and Timor Sea	The fishing method is restricted to either	Inshore Demersal:	Fishing effort for the 2016 season was 1,173 tonnes (DoF 2017).	✓	✓	Fishing occurs within the OA (including the FPZ).

Fishery	Description	Method	Aquatic Zone Fished	Number of Licences/Vessels and Effort	Occurrence		Likelihood of Fishing to Occur within OA/EMBA
					EMBA	OA	
Scalefish Managed Fishery (NDSF)	off the north coast of WA that are east of 120° 00.079’ and north of 19°59.917’. There are some restricted areas within the fishery. The fishery is divided into two fishing areas; Area 1 – inshore and Area 2 – offshore. Area 2 is further divided into Zone A, B and C (DoF 2016). OA overlaps Area 2 (Zone B and C; **Figure 3-29**)	hand-line, drop-line or fish traps (DoF 2016).	waters of 20-250 m isobath	From 2007 to 2018 fishing effort[2] (based on both fishing days and catch weight) within the OA has accounted for ~9% of the total fishing effort within the NDSF and the area where behavioural impacts may occur, up to 45 km from the FPZ, accounts for ~20% of the total fishing effort within the NDSF. Fishing occurs all year round with a peak in fishing effort occurring during the months from June – November (based on both fishing days and catch weight).			Stakeholder consultation (with WAFIC and NDSF) identified that there are two active fishing licence permit holders operating within the OA. Both active licence holders have been consulted as outlined in the stakeholder section (**Section 10**).
Northern Shark Fishery (NSF)	The Northern Shark Fishery comprises the WA North Coast Shark Fishery (Pilbara and Kimberley regions) and the Joint Authority Northern Shark Fishery (JANSF; Eastern Kimberley; DPIRD 2018b; **Figure 3-29**).	Pelagic net and longline fishery (DEH 2003).	N/A: This fishery is not currently active	No catch effort has been recorded since the 2008/09 season (DPIRD 2018b).	✓	✓	Fishery unlikely to operate within the area. Stakeholder consultation (with WAFIC) indicated this fishery is not currently active within the OA (**Section 10**)
Pearl Oyster Managed Fishery (POMF)	This fishery targets only the silver lipped pearl oyster (*Pinctada maxima*) and operates from Exmouth to the NT border, effort is predominately focused along the shallow coastal waters of the NWS (Fletcher *et al*. 2006; **Figure 3-29**).	This is a dive-based fishery. Divers collect oysters individually as they are towed along behind the fishing vessel, using hookah or surface compressor supplied air (Fletcher *et al*. 2006).	Nearshore: waters of 0-20 m isobath	Catch effort for the 2016 season was 541,260 oysters (DoF 2017). Historically as many as 16 vessels would operate each season, however, since 2009 numbers have been much lower and only 5 were active in 2013 (WAFIC 2018a).	✓	✓	Fishery is unlikely to operate within the area given water depths in the majority of the OA/EMBA is greater than 20 m. Stakeholder consultation (with WAFIC) has indicated the fishery does not operate in the area (**Section 10**)

[2] Note that any blocks with "less than 3" vessels were not included in the dataset by DPIRD from commercial reasons, so analysis excludes these

Fishery	Description	Method	Aquatic Zone Fished	Number of Licences/Vessels and Effort	Occurrence		Likelihood of Fishing to Occur within OA/EMBA
					EMBA	OA	
Specimen Shell Managed Fishery	Fishery encompasses the entire WA coastline between the high-water mark and the 200 m isobath (DEH 2005b; **Figure 3-29**).	Dive based fishery (some new methods include controlled underwater vehicles at depths of 60 – 300 m, and baited habitat structures at depths; DPIRD 2018d)	Nearshore: waters of 0-20 m isobath	Primary areas of effort include Broome, Karratha, Shark Bay, metropolitan Perth, Mandurah, the Capes area and Albany. Total catch in 2016 was 8,531 shells (DPIRD 2018d).	✓	✓	Fishery is unlikely to operate within the area given water depths in the majority of the OA/EMBA is greater than 20 m.
West Coast Deep Sea Crustacean Managed Fishery (WCDSCMF)	The fishery operates off the WA coast from 34° 24' S to the NT border, from the 150 m isobath out to the Australian Exclusive Economic Zone (DoF 2015; **Figure 3-30**).	Fishery uses fish traps with an average of 120 per line (DoF 2015).	Offshore demersal: water depths of 500-800 m isobath	Catch effort for the 2016 season occurred primarily south of Exmouth and totalled 153.3 tonnes of crystal crab (99.6% of catch) and 30 kg of champagne crab (DPIRD 2018d).	✓	✓	Fishery is unlikely to operate within the area. Stakeholder consultation (with WAFIC) advised this fishery mostly operates in water depths of 500-800 m along the continental shelf of the West Coast and Gascoyne Bioregions (i.e. outside the OA; **Section 10**)
Commonwealth Managed Fisheries							
North West Slope Trawl Fishery (NWSTF)	The NWSTF operates within the 200 m isobath and the Australian Fishing Zone, between 114 E and 125 E. The MOU box falls within this fishery. Target species is scampi, including Australian scampi, velvet scampi and Boschma's scampi (**Figure 3-37**).	The NWSTF primarily uses demersal trawl methods.	Offshore demersal: waters seaward of the 200 m isobath from Montebello Islands to Scott Reef	Since 2008-09 the number of active fishing vessels per season has been one to two. Total catch in the entire permit area for the 2015-16 season was 54.8 tonnes from two fishing vessels, 33 tonnes of which was scampi. There were five fishing permits in the 2015-16 season.	✓	✓	Fishery is unlikely to operate within the area given recent fishing effort is west of Scott Reef. Stakeholder consultation occurred with two letters being sent to all licence holders, but no response was received. (**Section 10**)
Western Tuna and Billfish Fishery (WTBF)	Fishery operates within the Australian Exclusive Economic Zone and the high seas of the Indian Ocean. Key species in the WTBF are swordfish, striped marlin, yellowfin	Main method is pelagic longline with some minor-line fishing.	Pelagic: waters seaward of the 200 m isobath from Shark Bay to Cape Leeuwin	After peaking in 2000 at 50 active vessels, fishing effort has declined and since 2005 there has been less than five vessels active each season. Catch effort for the fishery was 320 tonnes in the 2016 season with 95 boat statutory fishing rights	✓	✓	Fishery is unlikely to operate within the area given recent fishing effort is south of Shark Bay. Stakeholder consultation (with AFMA) have confirmed that there are only a few active permit

Fishery	Description	Method	Aquatic Zone Fished	Number of Licences/Vessels and Effort	Occurrence		Likelihood of Fishing to Occur within OA/EMBA
					EMBA	OA	
	tuna and bigeye tuna (**Figure 3-38**).			(SFRs), and three active fishing vessels. Notably, whilst the fishery extends throughout the Operational Area, fishing effort in the 2016 season did not extend north of Exmouth. Effort was concentrated off the south-west of WA and South Australia.			holders in the fishery and that they do not currently operate within the OA (**Section 10**).
Southern Bluefin Tuna Fishery (SBTF)	The SBTF fishery extends throughout the AFZ. There is a single spawning location for southern bluefin tuna located in the north-east Indian Ocean. Juveniles move southwards from this location along the WA coast.	The majority of catch is taken by purse-seine netting methods. Pelagic long-line (of which southern bluefin tuna is bycatch) and minor line (troll and poling) catch methods are also used.	Pelagic: waters >200 m isobath in South Australia (Kangaroo Island)	During the 2015-16 season there were 89 SFR owners; 6 active Purse-seine and 19 active long-line vessels within the fishery. The majority of fishing effort is currently focused in the Great Australian Bight (GAB) and waters off South Australia, targeting juveniles for transfer to aquaculture farming operations off Port Lincoln, South Australia. In the 2015-16 season a total effort of 5,636 t was recorded for the fishery.	✓	✓	Fishery is unlikely to operate within the area given fishing effort is concentrated in southern Australian waters in the GAB. Stakeholder consultation (with WAFIC) have confirmed there are no active vessels operating within the OA (**Section 10**)
Western Skipjack Fishery (WSF)	Fishery comprises the same area as the Western Tuna and Billfish Fishery. Part of the Skipjack Tuna Fishery which collectively describes the Western and Eastern Skipjack Tuna Fishery.	Majority of fishing effort uses purse-seine gear, small amount of pole-and-line effort.	N/A: this fishery is not currently active	14 fishing permits for the 2015-16 season, however there were no active vessels. No effort since the 2008-09 fishing season, coinciding with the closure of the main cannery in Port Lincoln in 2010.	✓	✓	Unlikely due to fishery not active since 2008-09. Stakeholder consultation (with WAFIC) have confirmed there are no active vessels operating within the Operational Area (**Section 10**)

3.5.2.1. WA State Administered Fisheries

Eight WA State managed commercial fisheries were identified as overlapping the OA and EMBA (**Figure 3-29** to **Figure 3-38**). Only one of these fisheries, the NDSF, was identified as operating within the OA (**Figure 3-34**).

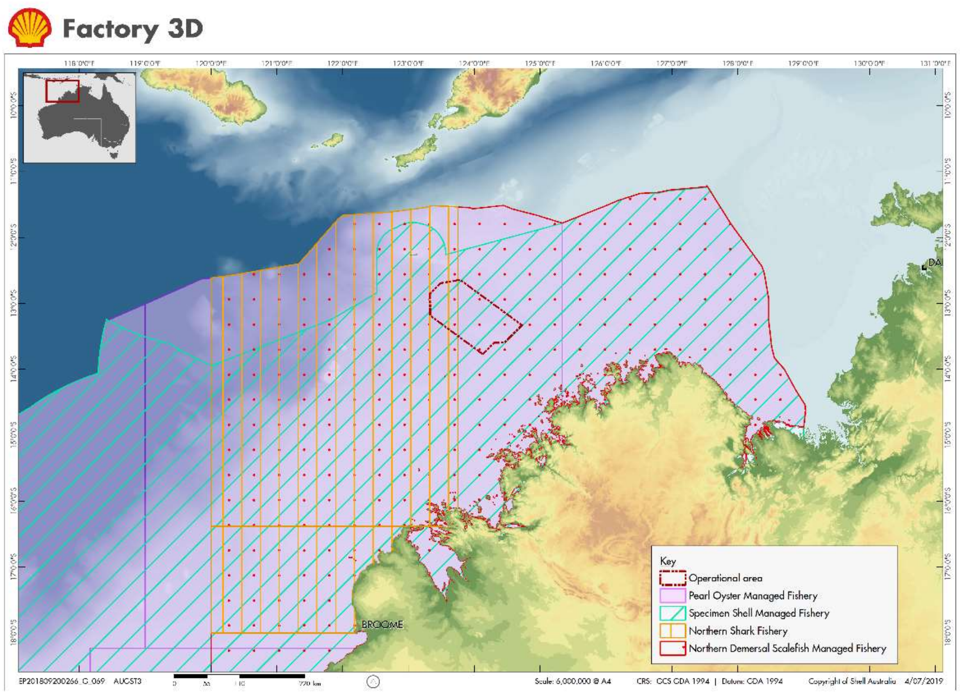


Figure 3-29 - WA State Fisheries and the OA (1)

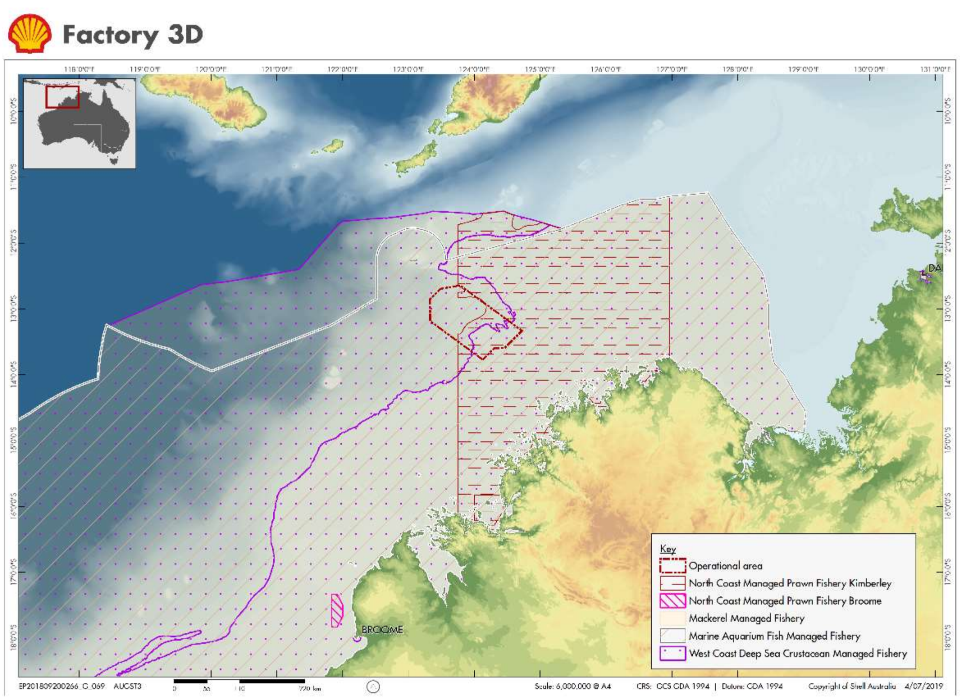


Figure 3-30 - WA State Fisheries and the OA (2)

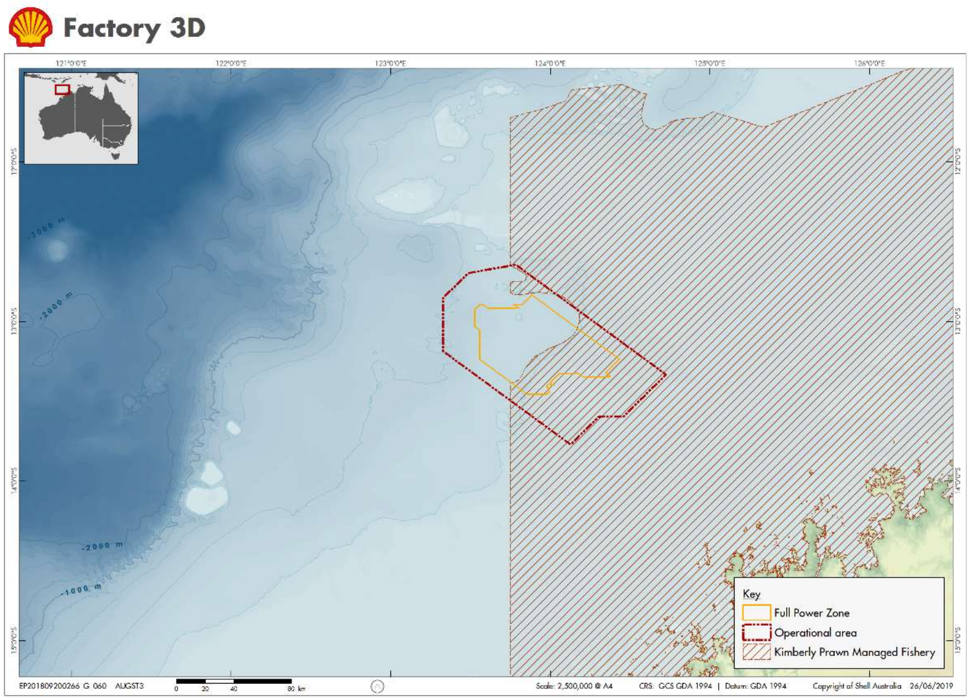


Figure 3-31 - North Coast Managed Prawn Fisheries - Kimberley Prawn Managed Fishery Licence Area and the OA and FPZ

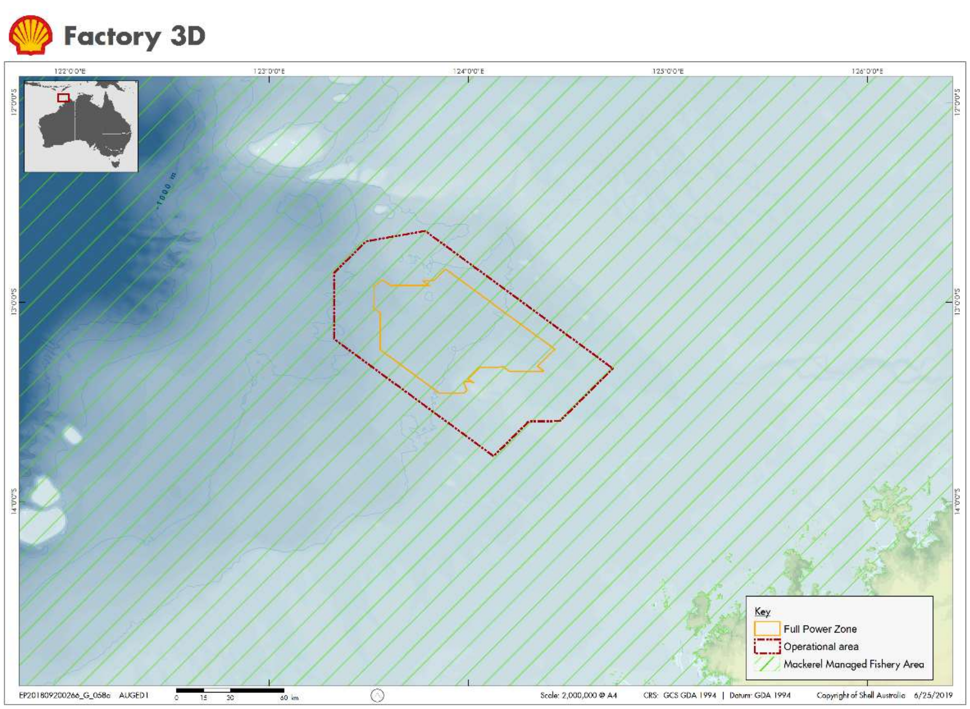
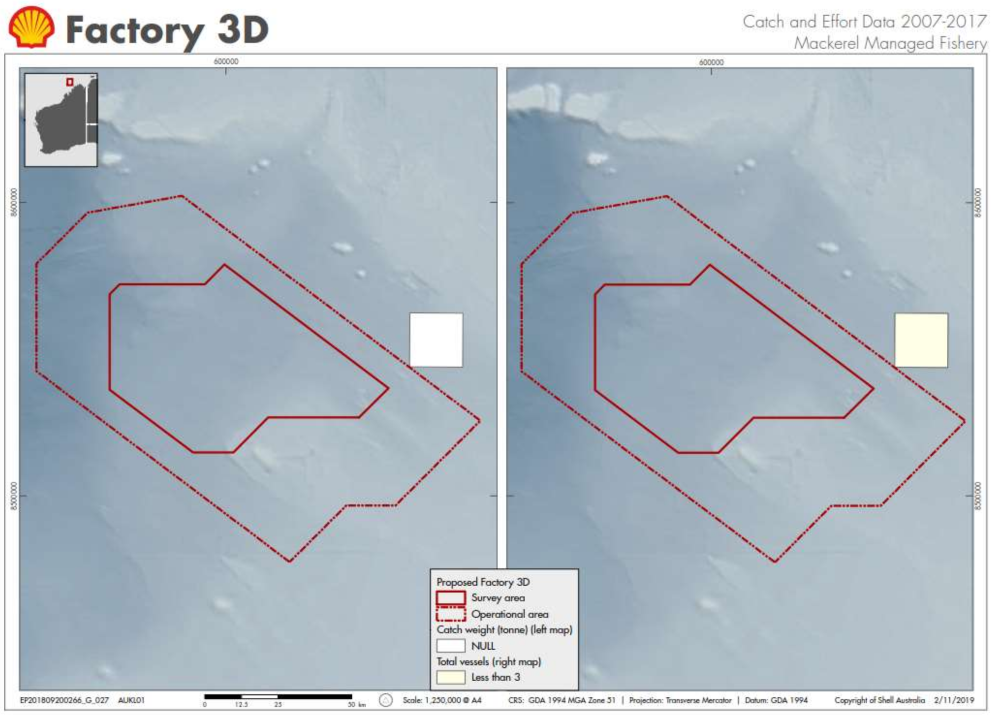


Figure 3-32 - Mackerel Managed Fishery Licence Areas and the OA and FPZ



Source: modified from DPIRD (2018)

Figure 3-33 - Mackerel Managed Fishery - Catch and Effort Data 2007-2017

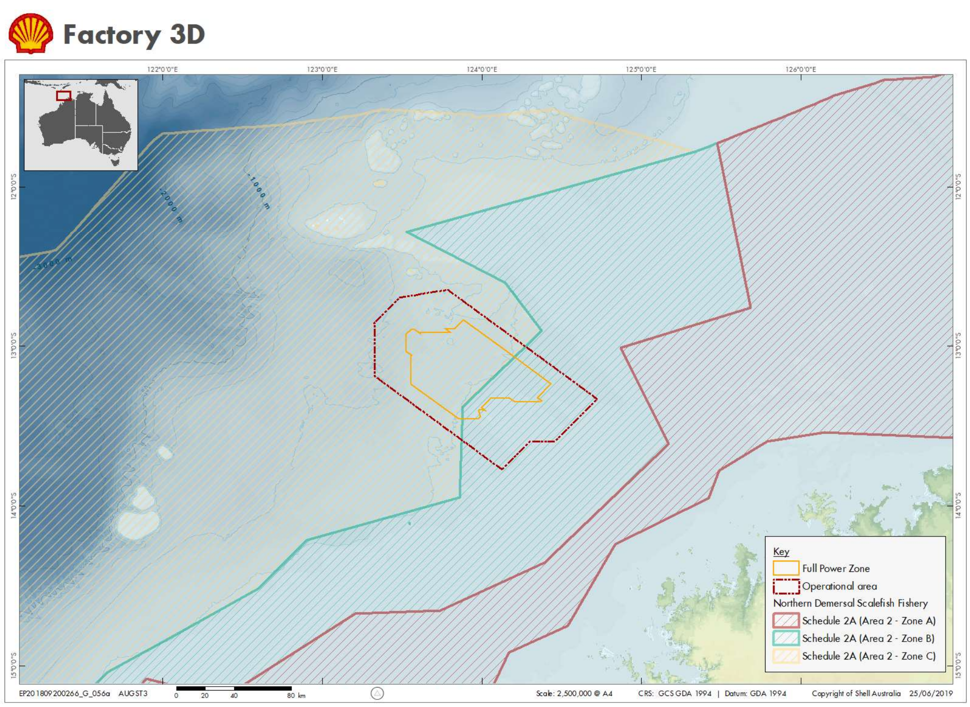


Figure 3-34 - Northern Demersal Scalefish Fishery Licence Areas and the OA and FPZ

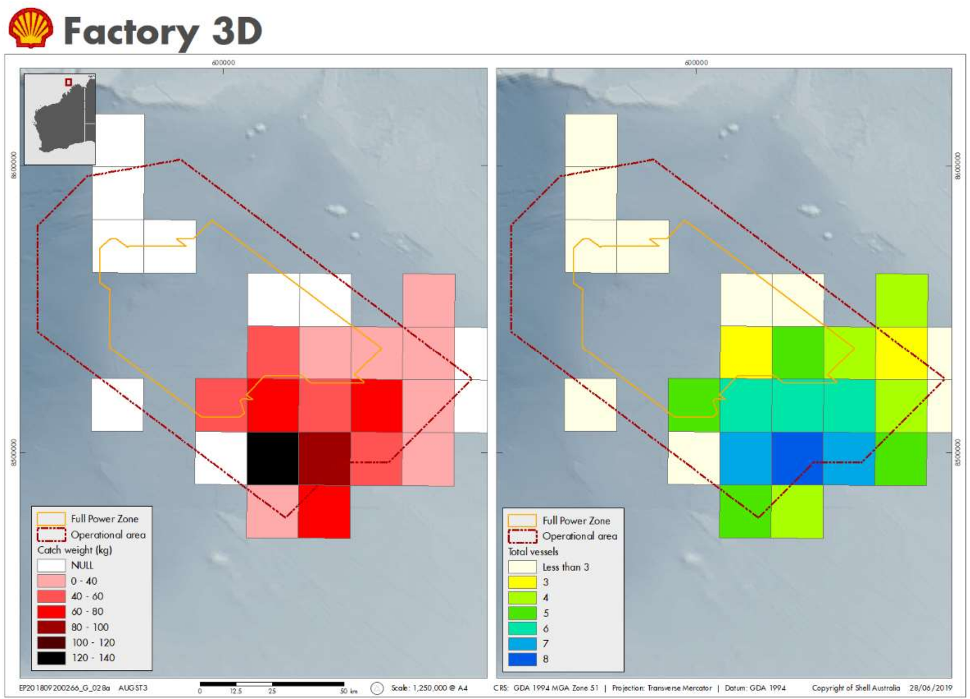


Figure 3-35 – Northern Demersal Scalefish Fishery - Catch and Effort Data 2007-2017

3.5.2.2. Commonwealth Administered Fisheries

Four Commonwealth fisheries were indicated to overlap the OA and within the EMBA (**Figure 3-31** to **Figure 3-35**). None of these fisheries were identified during stakeholder consultation as actively fishing within the OA. A description and status of each of the Commonwealth managed commercial fisheries relevant to the context of the Factory 3D MSS is provided in **Table 3-18**.

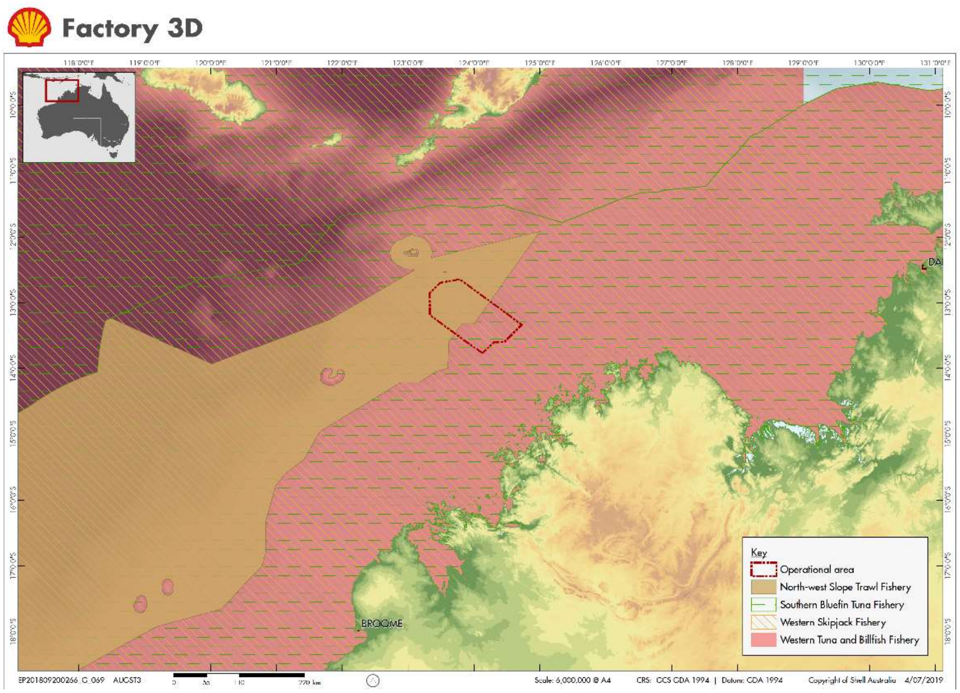


Figure 3-36 - Commonwealth Fisheries and the OA

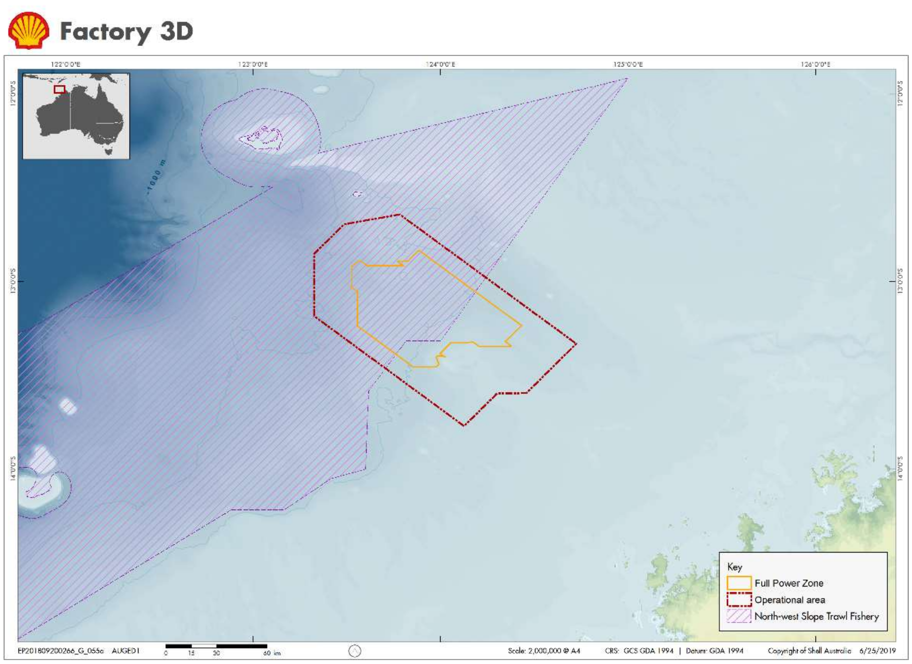


Figure 3-37 - Northern West Slope Trawl Fishery Licence Areas and the OA and FPZ

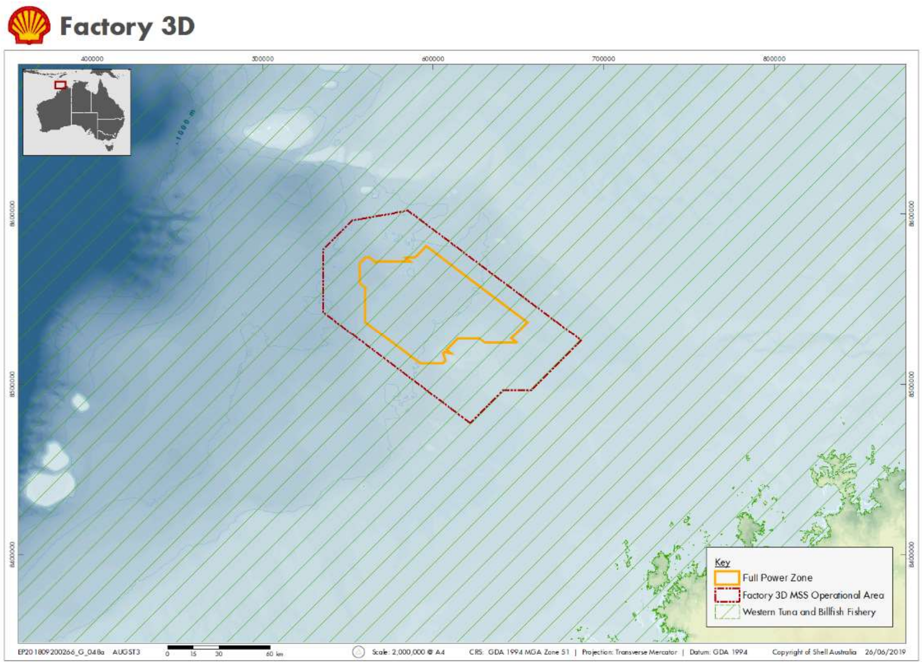


Figure 3-38 – Western Tuna and Billfish Fishery Licence Areas and the OA and FPZ

3.5.3. Traditional Fisheries

In 1974, Australia recognised access rights for traditional Indonesian fishers in shared waters to the north of Australia, granting long-term fishing rights in recognition of the long history of traditional Indonesian fishing in the area (Department of Agriculture and Water Resource (DAWR) 2018). The resulting MOU between the Governments of Australia and Indonesia enables Indonesian traditional fishers to continue their customary practices. This includes the harvest of species such as trepang, trochus, clams, finfish, abalone, shark (for dried fins) and sponges in Australian waters, using traditional fishing methods only (Environment Australia 2002; DAWR 2018). This area is known as the 'MOU Box'.

The OA and EMBA overlap a portion of the defined MOU Box. Given this and that only shallow water species are targeted, there is a potential for interactions with traditional Indonesian fishers during the Factory 3D MSS. However, fishers are most likely to occur within the EMBA transiting past Cartier Island en-route to Scott Reef, rather than fishing within the OA. There is a very low likelihood for fishing to occur within the OA or near Heywood Shoal as traditional fishing is permitted at Scott Reef, 60 km from the OA.

3.5.4. Tourism and Recreational Activities

Fishing and diving charters operate out of Broome and Derby with the occasional charter vessel visiting Ashmore Reef and Browse Island (both within the EMBA). Birdwatching tours also occasionally operate out of Broome, with annual expeditions visiting Ashmore Reef and associated offshore islands including Browse Island. The closest identified dive site to the OA and EMBA lies on the north side of Ashmore Reef (greater than 52 km north of the OA and 96 km from the FPZ). The EMBA includes shallow/emergent features including Heywood Shoal (within the OA) and Cartier Island (outside the OA); there is a low potential for recreational fishing and other tourism to occur within these areas of the EMBA. Consultation with RecFishWest indicated that that given the location of the activity, the Factory 3D MSS is highly unlikely to affect recreational fishing industry.

3.5.5. Military / Defence Activities

The Australian Border Force undertake civil and maritime surveillance (and enforcement) in and around the OA and EMBA (Department of Home Affairs (DHA) 2018a; 2018b). The primary purpose of the activity is to monitor the passage of suspect illegal entry vessels and illegal foreign fishing activity within and beyond Australia's Exclusive Economic Zone, which extends to approximately 200 nm from the mainland (DHA 2018a).

There are no designated military/defence exercise areas in the OA and surrounds (**Figure 3-39**). However, regionally relevant activities include the North Australian Exercise Area (NAXA) offshore training area and the Browse Basin and Northern Carnarvon Basin offshore air-to-air weapons ranges, which are maritime military zones administered by the Department of Defence. The NAXA extends approximately 300 km north and west from just east of Darwin into the Arafura Sea and is used for offshore naval exercises and onshore weapon-firing training (Department of Defence 2015). The Browse Basin (Curtin) and Northern Carnarvon (Learmonth) situated air-to-air weapons ranges are more than 500 and 1,500 km from the OA, respectively.

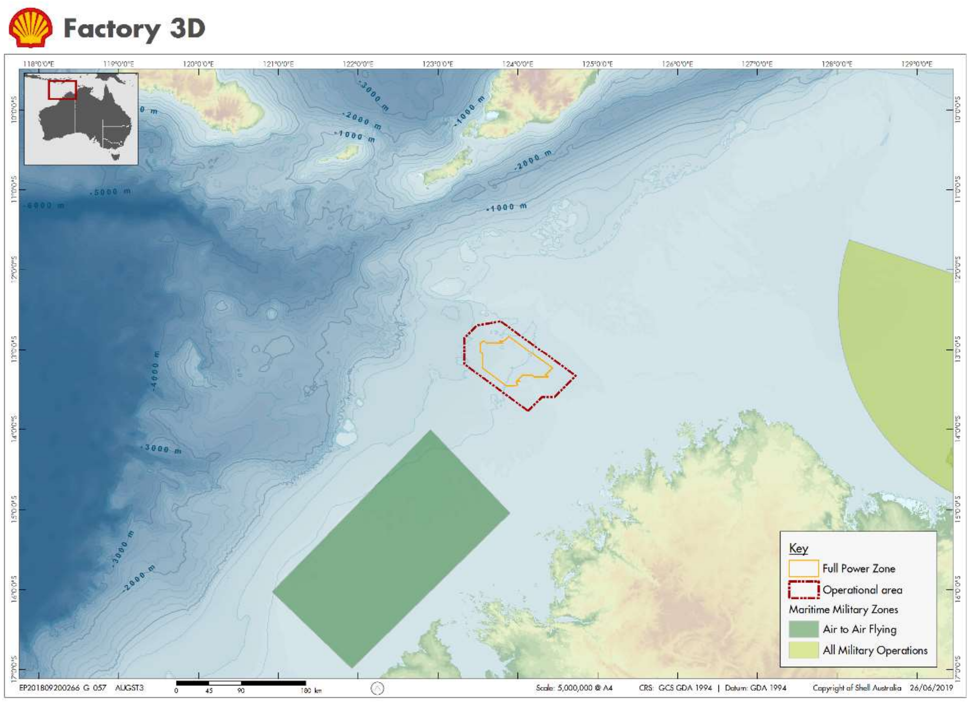


Figure 3-39 – Department of Defence MEA and the OA and FPZ

3.5.6. Ports and Commercial Shipping

There is one major shipping fairways intersecting the southern portion of the OA, a shipping small channel, the Osborne Passage passes through the north of the OA (**Figure 3-40**; **Figure 3-41**). Consultation with AMSA identified nearest major shipping channel is south-west of the OA (vessels servicing Prelude FLNG), and an increase in shipping traffic travelling to and from the Montara Venture to the north-east. AMSA also noted heavy traffic in permit block AC/P65 and WA-534-P, particularly in the southern and south-eastern section of WA-534-P. A summary of the regional shipping movements and port areas relevant to the OA is presented in **Figure 3-40**.

There is a potential for coastal ships to traverse the OA supporting other petroleum activities in the vicinity, as well as the major State and Territory ports of Broome, Derby, Wyndham and Darwin. Additionally, Civil and maritime surveillance in and around the OA may occur by the Australian Border Force Maritime Border Command to monitor the passage of illegal entry vessels and illegal foreign fishing activity (DHA 2018b).

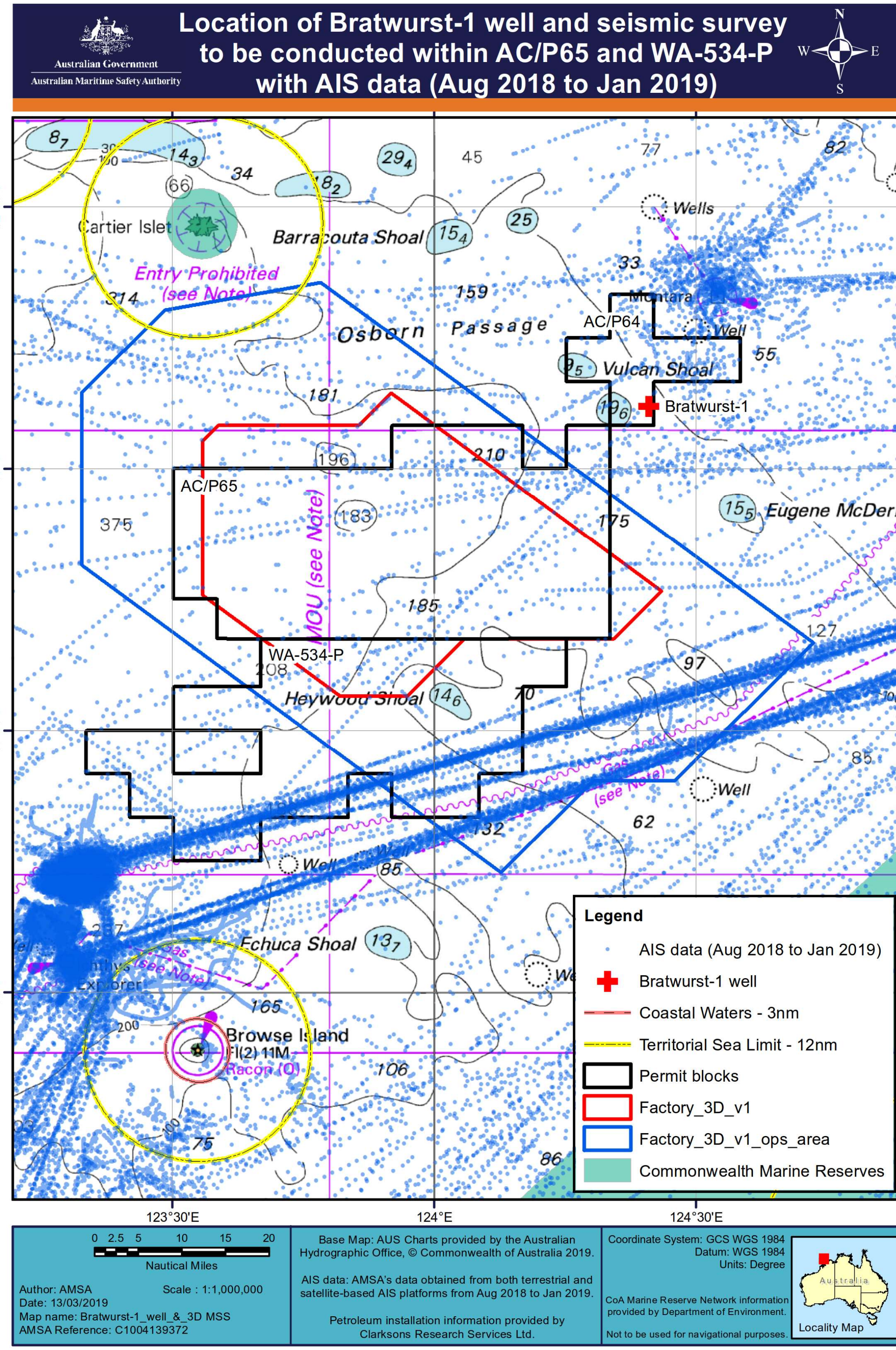


Figure 3-40 – AMSA AIS data and the OA

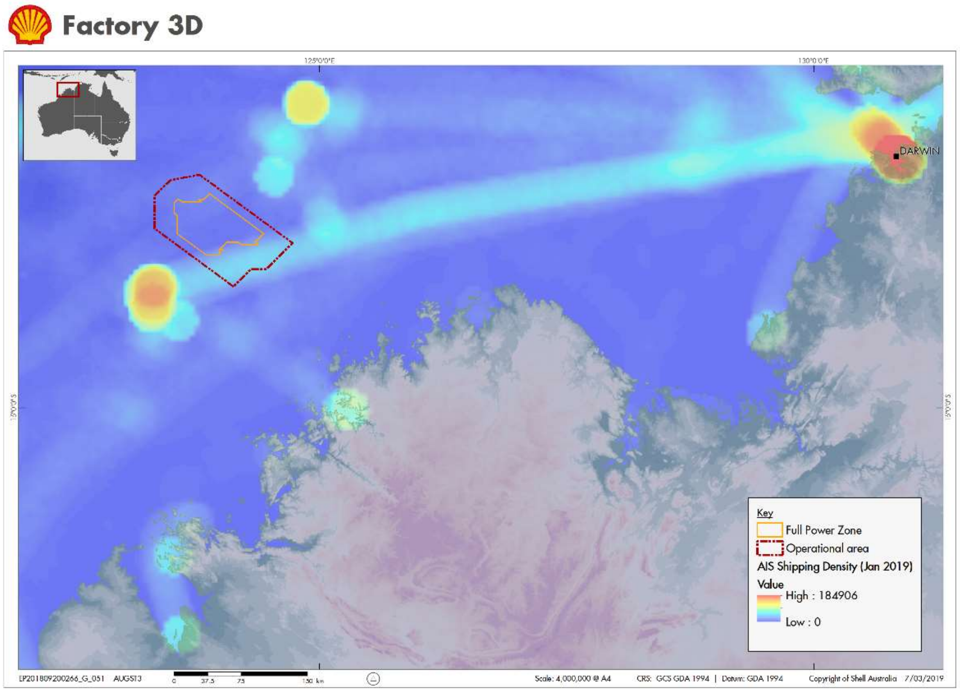


Figure 3-41 - Shipping Lanes of the NWMR and the OA and FPZ

3.5.7. Offshore Petroleum Exploration and Production

Since the 1960s there has been significant growth in exploration, production and the oil and gas market. Energy companies have undertaken petroleum activities such as seismic and exploration in WA State and Commonwealth waters for a number of years. Specifically, petroleum exploration commenced in the Browse Basin in 1967, with several commercial discoveries since that time. The fourth well drilled in the basin, Scott Reef 1 (completed in 1971), was significant in discovering the large Torosa gas field. Since then, more than 105 wells have been drilled and there have been over 20 hydrocarbon discoveries.

The petroleum exploration and production industry are a significant user of offshore waters in northern WA, particularly within and adjacent to the Browse and Northern Bonaparte basins (DMP 2014). Currently the closest facility to the OA is the Montara production FPSO facility, which is located approximately 46 km from the OA, within the EMBA (**Figure 3-42**). The Ichthys project offshore facilities and the Prelude FLNG are also within the EMBA, and the Ichthys gas export pipeline traverses through the OA and EMBA.

Future petroleum exploration and development within the area include the planned drilling of an exploration well in AC/P64 20 km outside the OA, and possible development of the Crux Offshore Project Proposal (OPP; overlapping the EMBA), of which Shell is the titleholder of both projects. These projects are subject to regulatory assessment and approval.

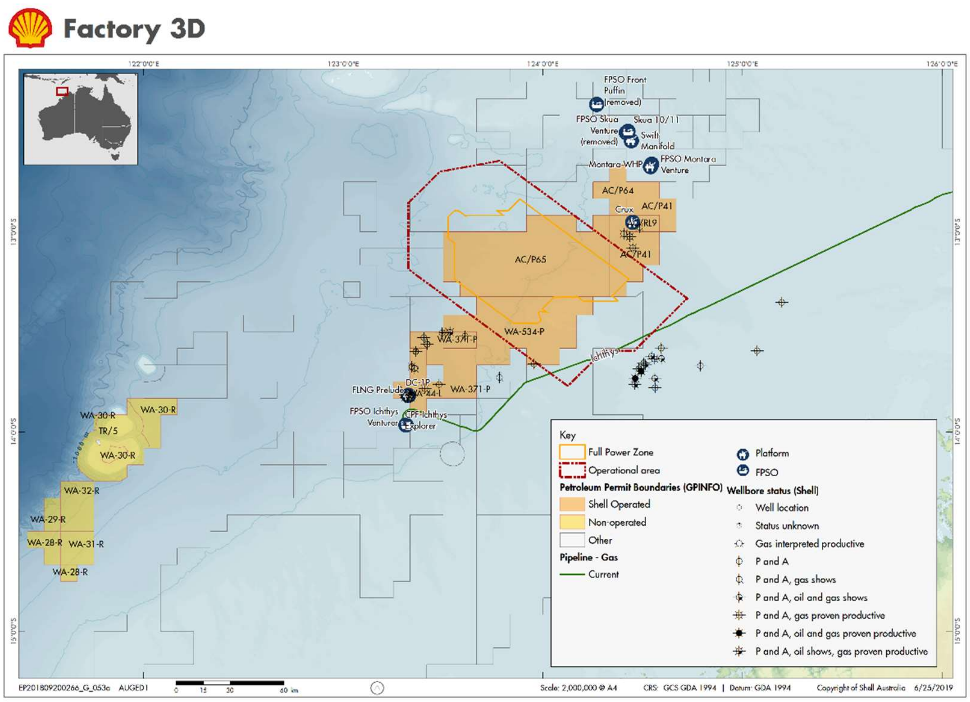


Figure 3-42 - Production Facilities and Pipelines and the OA and FPZ

4. Environmental Risk Assessment Methodology

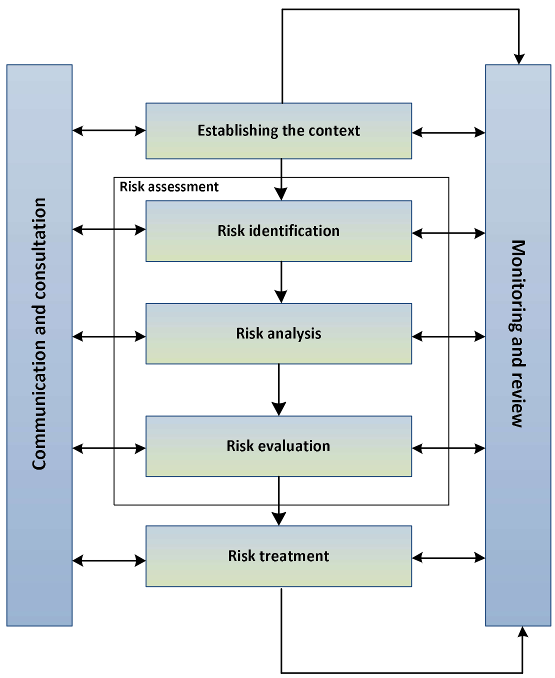
4.1. Introduction

This section documents the process used to identify and evaluate potential environmental and socio-economic impacts and risks of the Factory 3D MSS and develop means of mitigating the identified impacts and risks. The process enables the management of impacts and risks to a level which is acceptable and ALARP, as required by the OPGGS (E) Regulations.

The proposed management controls form the basis of the Environmental Performance Framework (**Section 9**) which will be implemented during the Factory 3D MSS.

4.2. Shell Company Approach to Risk Management

The Hazards & Effects Management Process (HEMP) is the process by which Shell identifies and assesses hazards, implements measures to manage them, and demonstrates that risks are reduced to a level that is ALARP. This is consistent with the principles outlined in the Australian Standard AS/NZS ISO 31000:2018 Risk Management and HB 203:2012 Environmental Risk Management (**Figure 4-1**). The HEMP is a fundamental element of the Shell Group HSSE & SP Control Framework and is a process that is applied at every phase of projects and operations.



Source: modified from AS/NZS ISO 31000:2018 Risk management

Figure 4-1 – Risk Management Framework (AS/NZS 4360:2004 Risk Management)

4.3. Impact Assessment Methodology

A risk analysis was undertaken for all aspects of the Factory 3D MSS in accordance with the Shell HSSE and SP Control Framework, which is consistent with the principles outlined in the Australian Standard AS/NZS ISO 31000:2018 Risk Management and HB 203:2012 Environmental Risk Management.

Planned activities give rise to environmental impacts, while unplanned and accidental events pose a risk of environmental impact, if they occur. The risk of environmental impacts resulting from unplanned or accidental events is evaluated by taking the likelihood of the event occurring into consideration. For this assessment, key terminology is defined in **Table 4-1**.

Table 4-1 - Definition of Key Terminology for Impact Assessment

Term	Definition
Activity	Components or elements of work associated with the project. All activities associated with the project have been considered at a broad level (as outlined in **Section 4.3.1**).
Aspect	Elements of the proponent's activities or products or services that can interact with the environment. These include planned and unplanned (including those associated with emergency conditions) activities.
Event	An occurrence of a particular set of circumstances. An event can be one or more occurrences and can have several causes.
Value/ Sensitivity (i.e. Factor)	An element or aspect of the environment (ecosystems, natural and physical resources, qualities and locations of places and area, heritage value of places) including its social, economic and cultural features.
Impact	Any change to the environment, whether adverse or beneficial, wholly or partially resulting from a proponent's environmental aspects.
Inherent Impact (planned activities)	The level impact when existing controls are in place, but before the application of additional controls arising from impact assessment. ** The Inherent Impact rating is derived from Magnitude and Sensitivity*
Magnitude	Magnitude of an impact or predicted change which considers: • nature of the impact and its reversibility duration and frequency of an impact extent of the change, and potential for cumulative impacts.
Sensitivity	The sensitivity of the receiving receptors, based on: • important of the receptor at local, national or international level, sensitivity/vulnerability of a receptor and its ability to recover, and sensitivity of the receptor to certain impacts.
Inherent risk (unplanned events)	The level of risk when existing controls are in place, but before the application of additional risk controls arising from risk assessment processes. ** The Inherent Risk rating is derived from Significance and Likelihood*
Significance	As determined from magnitude and sensitivity for planned impacts, significance is used in combination with likelihood to determine inherent risk for unplanned events.
Likelihood	Description of probability or frequency of a consequence occurring with safeguards in place.
Control	A measure which mitigates risk through the reduction of the likelihood for a consequence to occur. Controls include existing controls (i.e. Company management controls or industry standards) or additional controls (i.e. additional measures identified during the risk assessment processes).
Residual Risk/Impact	The level of risk/impact remaining after treatment, i.e. application of additional controls (inclusive of unidentified risk).

4.3.1. Impact Identification and Aspects

The identification of potential impacts from planned activities is carried out prior to any detailed assessment of the relative importance of each issue, the sensitivity of the existing environmental and/or socio-economic values or the magnitude of the potential impact and does not consider potential mitigation measures.

As summarised in **Section 6**, the key planned activities arising from the Factory 3D MSS have been identified as:

- Physical presence;
  - Interactions with other marine users.
- Discharges;
  - Deck drainage and bilge water.
  - Treated sewage, grey water and putrescible waste.
- Light emissions;
- Atmospheric emissions;
- Acoustic emissions (seismic); and
- Acoustic emissions (non-seismic).

The following key unplanned events (**Section 7**) were assessed for the Factory 3D MSS risk review:

- Invasive Marine Species (IMS) biofouling of vessel hull, other niches and immersible equipment.
- Emergency anchoring of project vessels.
- Accidental loss of hazardous or non-hazardous materials;
  - Unplanned loss of solid waste (hazardous/non-hazardous) or dropped objects overboard.
  - Unplanned discharge of chemicals or hazardous liquid waste.
- Accidental collision between vessels / towed array and marine species; and
- Accidental hydrocarbon releases.
  - Accidental hydrocarbon release during bunkering.
  - Accidental hydrocarbon release caused by vessel collision.

4.3.2. Evaluation of Impacts

The significance of environmental impacts is assessed in terms of:

- magnitude based on the size, extent and duration/frequency of the impact;
- the sensitivity of the receiving receptors; and
- the likelihood of an unplanned event occurring.

These are described further below.

4.3.2.1. Magnitude

Levels of magnitude of environmental impacts are outlined in **Table 4-2**. The magnitude of an impact or predicted change is defined by taking into account the following criteria:

- The nature of the impact (i.e. does the impact cause any damage);
- Its reversibility (can the impact be reversed or will is cause permanent damage);
- Duration and frequency of the impact;
- Extent of the change (is the impact localised, or is it widespread?); and
- Potential for cumulative impacts.

The level of magnitude depends on the scale of each of these criteria, for example a slight impact (magnitude is defined as slight effect in **Table 4-2**) will cause slight damage within the OA and the impact will be short-term or localised whereas an impact of moderate magnitude (moderate effect) will spread beyond the OA, may have cumulative effects and can cause widespread change in habitats that last approximately 1-2 years.

The impact magnitude is defined differently according to the type of impact. For readily quantifiable impacts, such as noise or liquid discharge plume extent, numerical values can be used whereas for other topics (e.g. communities and habitats) a more qualitative definition is applicable. These criteria capture high level definitions, adapted as appropriate to the offshore context of the Factory 3D MSS.

Table 4-2 - Magnitude Criteria

Term	Definition
Positive effect	Net positive effect arising from a proposed aspect of the Project.
No effect	No environmental damage or effects.
Slight effect	• Slight environmental damage contained within the Project boundary (i.e. OA) • Effects unlikely to be discernible or measurable • No contribution to trans-boundary (i.e. outside the OA) or cumulative effects • Short-term or localised decrease in the availability or quality of a resource, not effecting usage
Minor effect	• Minor environmental damage, no lasting effects or persistent effects are highly localised • Minor change in habitats or species • Unlikely to contribute to trans-boundary (i.e. outside the OA) or cumulative effects • Short-term or localised decrease in the availability or quality of a resource, likely to be noticed by users
Moderate effect	• Moderate environmental damage that will persist or require cleaning up • Widespread change in habitats or species beyond natural variability • Observed off-site effects or damage, e.g. fish kill or damaged habitats • Decrease in the short-term (1-2 years) availability or quality of a resource affecting usage • Local or regional stakeholders' concerns leading to complaints • Minor trans-boundary (i.e. outside the OA) and cumulative effects
Major effect	• Severe environmental damage that will require extensive measures to restore beneficial uses of the environment • Widespread degradation to the quality or availability of habitats and/or wildlife requiring significant long-term restoration effort • Major oil spill over a wide area leading to campaigns and major stakeholders' concerns • Trans-boundary effects (i.e. outside the OA) or major contribution to cumulative effects • Mid-term (2-5 year) decrease in the availability or quality of a resource affecting usage • National stakeholders' concern leading to campaigns affecting Company's reputation
Massive effect (to be used only for unplanned events)	• Persistent severe environmental damage that will lead to loss of use or loss of natural resources over a wide area • Widespread long-term degradation to the quality or availability of habitats that cannot be readily rectified • Major impact on the conservation objectives of internationally/nationally protected sites • Major trans-boundary (i.e. outside the OA) or cumulative effects • Long-term (>5 y) decrease in the availability or quality of a resource affecting usage • International public concern

4.3.2.2. Receptor Sensitivity

For this EP, receptors are categorised into different groups (as described in **Section 4**):

- physical environment;
- disturbance of non-conservation significant populations/communities;
- threatened species and ecological communities; and
- socio-economic and cultural environment.

Receptor sensitivity criteria are classified as low, medium and high (**Table 4-3**) and are based on the following key factors:

- importance of the receptor at local, national or international level – for instance, a receptor will be of high importance at international level if it is categorised as a designated protected area (such as a Ramsar wetland site);

- sensitivity/vulnerability of a receptor and its ability to recovery – for instance, certain species could adapt to changes easily or recover from an impact within a short period of time. Thus, as part of the receptor sensitivity criteria, professional judgement considers immediate or long-term recovery of a receptor from identified impacts. This also considers if the receptor is under stress already; and
- sensitivity of the receptor to certain impacts – for instance, atmospheric emissions from Project Vessels engines will potentially cause air quality impacts but do not affect receptors such as the seabed.

Table 4-3 - Receptor Sensitivity Criteria

Sensitivity	Definition
Low	• Receptor with low value or importance attached to them, e.g. habitat or species which is abundant and not of conservation significance, or • Immediate recovery and easily adaptable to changes
Medium	• Receptor of importance, e.g. recognised as an area/species of potential conservation significance for example, KEF or listed threatened species, or • Recovery likely within 1-2 years following cessation of activities, or localised medium-term degradation with recovery in 2-5 years.
High	• Receptor of key importance, e.g. recognised as an area/species of potential conservation significance with development restrictions for example marine parks or conservation reserves, threatened MNES as defined by the EPBC Act, or habitat critical to the survival of a species including defined BIAs, or • Recovery not expected for an extended period (>5 years following cessation of activity) or that cannot be readily rectified

4.3.2.3. Significance Criteria for Planned Activities

The magnitude of the impact and sensitivity of receptors is then combined to determine the impact significance as shown in **Table 4-4**. Key management controls are then identified to reduce the potential magnitude of the impact, which enables the residual impact to be determined and informs an assessment of acceptability.

Table 4-4 - Impact Significance Matrix (Planned)

		Sensitivity		
		Low	**Medium**	**High**
Magnitude	**+1 – Positive**	Positive effect	Positive effect	Positive effect
	0 – No effect	No effect	No effect	No effect
	1 – Slight effect	Slight	Slight	Minor
	2 – Minor effect	Minor	Minor	Moderate
	3 – Moderate effect	Minor	Moderate	Major
	4 – Major effect	Moderate	Major	Major

4.3.2.4. Likelihood and Significance Criteria for Unplanned Events

For unplanned events the likelihood of such an event occurring also requires consideration. For example, based on magnitude and sensitivity alone a hydrocarbon spill associated with a vessel collision would be classed as having major impact significance, however, the likelihood of such an event occurring is very low. In addition, the mitigation measures for unplanned events focus on reducing the likelihood of the event occurring as opposed to reducing the magnitude of the impact itself. Thus, unplanned events also require assessment in terms of environmental risk.

As with planned activities, the potential impacts of unplanned events are identified, and the impact significance is determined, which inherently considers the sensitivity of the relevant receptor(s). The significance of the impact is then combined with the likelihood of the event occurring (**Table 4-5**) in order to determine its overall environmental risk as summarised in **Table 4-6**. Key management controls are then identified to reduce the risk of such an event occurring in order to determine residual risk and inform assessment of acceptability.

Table 4-5 - Likelihood Criteria

Likelihood	Definition
A – Extremely Remote	• Never heard of in the industry • Frequency of <10^{-5} per year • Has never occurred within the industry or similar industry but theoretically possible
B – Remote	• Heard of in the industry • Frequency of 10^{-5} – 10^{-3} per year • Similar event has occurred somewhere in the industry or similar industry but not likely to occur with current practices and procedures
C – Unlikely	• Has happened in the Company or more than once per year in the industry • Frequency of 10^{-3} – 10^{-2} per year • Event could occur within lifetime of similar facilities. Has occurred at similar facilities
D – Possible	• Has happened at the location or more than once per year in the Company • Frequency of 10^{-2} – 10^{-1} per year • Could occur within the lifetime of the development
E – Likely	• Has happened more than once per year at the location • Frequency of 10^{-1} – >1 per year • Event likely to occur more than once at the facility

Table 4-6 - Environmental Risk Matrix (Unplanned Events)

		Likelihood				
		A	**B**	**C**	**D**	**E**
Impact Significance	**0 – No effect**	No effect				
	1 – Slight	Negligible	Negligible	Minor	Minor	Minor
	2 – Minor	Negligible	Minor	Minor	Moderate	Moderate
	3 – Moderate	Minor	Minor	Moderate	Moderate	Major
	4 – Major	Moderate	Moderate	Moderate	Major	Major
	5 – Massive	Major	Major	Massive	Massive	Massive

4.3.3. Method for demonstrating that environmental impacts and risks will be reduced to As Low As Reasonably Practicable

Controlling risks to ALARP for Shell means meeting legal requirements and other agreed tolerability criteria (e.g. Shell/ industry standards; for the purpose of this EP tolerability is deemed to satisfy the 'acceptability criteria' – see next section) and going beyond them to the extent that is reasonably practicable i.e. the option which is at least acceptable and with the lowest residual risk achievable without incurring significant incremental costs or effort that is grossly disproportionate to the additional risk reduction obtained.

There is no scientific formula to calculate ALARP. ALARP can be achieved through several mechanisms via:

- a quantitative method, where the costs of the various options can be compared with the respective risk reduction;
- semi quantitative method where risks within a certain level on the Risk Matrix require a pre-defined number of barriers of a certain effectiveness in place to prevent this hazard being released; or via
- qualitative analysis, whereby ALARP is established using standards, legislative requirements and judgement based on experience.

Quantitative and semi-quantitative ALARP demonstration methods are generally employed for major installation investment decisions, design or major facilities, where ensuring that the decision-making process is transparent and systematically addresses the full spectrum of business risks is important.

Where the residual risk is **green**, **blue** or **yellow**, Shell demonstrates that risks are reduced to ALARP by:

- Ensuring the legislative and other requirements have been applied; and
- Carrying out a consistent assessment process; and
- Monitoring and applying industry practice or comparable standards.

In these cases, there is little environmental benefit to be gained from the adoption of any further measures to reduce risk and thus all alternative, additional, and improved control measures would be grossly disproportionate to adopt.

Where the residual risk is **orange, red,** or **dark red,** Shell demonstrates that risks are reduced to ALARP by:

- Ensuring the legislative and other requirements have been applied; and
- Carrying out a consistent assessment process; and
- Monitoring and applying industry practice or comparable standards; and
- Analysing alternative, additional, and improved control measures and their associated performance standards.

In these cases, there is consideration of the sacrifice of adopting the control measure or improving its performance against the environmental benefit that can be gained from its adoption. Where an alternative or additional control measure, or any improved performance of an adopted control measure, is rejected the reasons for rejection are documented.

4.3.4. Method for demonstrating that environmental impacts and risks will be of an acceptable level

In determining whether an acceptable level of impact and risk has been achieved by the impact and risk assessment process (and can therefore subsequently be achieved by the activity itself), it is first necessary to establish the context for the assessment and ultimately what the acceptable levels of impact and risk are. Once these levels are set a prediction of the nature and scale of impacts and risks are considered in an environmental assessment process with the legislative and other requirements, and adopted control measures, in place.

Where the residual risk is **green**, **blue** or **yellow (without material stakeholder concerns raised)**, Shell demonstrates that risks are of an acceptable level by:

- Ensuring the legislative and other requirements have been applied; and
- Carrying out a consistent assessment process; and
- Monitoring and applying industry practice or comparable standards; and
- Considering whether the impact or risk is consistent with the principles of ESD.

Where the residual risk is **yellow (with material stakeholder concerns raised)**, **orange, red,** or **dark red,** Shell demonstrates that risks are of an acceptable level by:

- Comparing the acceptable levels of risk and impact against Shell's prediction. This will be done for individual features or broader values and sensitivities, depending on the nature and scale of the risk or impact; and
- Ensuring the legislative and other requirements have been applied; and
- Carrying out a consistent assessment process; and
- Monitoring and applying industry practice or comparable standards; and
- Considering whether the impact or risk is consistent with the principles of ESD.

The iterative impact assessment process takes into account the mitigation measures that have been adopted as part of the activity design and plan. As such, each impact will be re-assessed taking controls measures into account in order to determine the residual impact (or risk for unplanned events). In the evaluation of residual impacts and risks, all controls are assumed to be implemented effectively and functioning as intended.

The residual impact detailed in Section 4.3.2 represents a summary of the various individual environmental value/sensitivity rankings defined from by specialist environmental scientists together with key members of the Shell project team who are directly responsible for the activity. The residual impact rankings provided represent the highest residual impact for that value or sensitivity, and therefore may be a conservative assessment for some individual environmental features.

Where the levels of predicted impact exceed the set acceptable level, control measures and their associated levels of performance are considered for improvement and either adopted or rejected in further reducing the predicted impacts and risks. This assessment is different to the ALARP methodology in that control measures may be adopted that are grossly disproportionate to the environmental benefit gain if the impact exceeds the acceptable level set. This assessment process is iterative and continues until the predicted levels of impact are less than the set acceptable levels.

4.4. Risk Treatment

Once the impact and risk assessment process is complete and it is evident that pre-determined levels of acceptability can be met, EPOs are established against the set acceptable levels of impact; this is done to ensure acceptable levels of impact and risk are achieved by the activity, and where practicable, may be established at levels of performance which are higher than the pre-determined levels of acceptability.

The EPS's for the control measures adopted because of the evaluation to reach ALARP and acceptable levels of impact and risk are set, and measurement criteria assigned. Collectively the EPO's, EPS's, and measurement criteria form the basis of environmental management for the activity.

5. Establishing the context

Establishing the context of the activity requires the consideration of the following:

- Legislative and other requirements – the proposed controls and residual risk level are consistent with national and international standards, laws and policies.
- Principles of Ecological Sustainable Development (ESD) as defined under the EPBC Act.
- Internal context – the activity including the proposed controls and residual risk level are consistent with Shell policies, procedures and standards.
- External context – consideration of the environment consequence and stakeholder expectations, through consultation with relevant persons.

This section of the EP documents Shell Australia's consideration of these items and is concluded by setting the acceptable levels of environmental impact and risk associated with the Factory activity.

5.1. Legislative and other requirements

Appendix A provides important information for the context of the EP by identifying the laws, other approvals and conditions, standards or other environmental requirements that apply to the activity. Each requirement has been considered in relation to the impact or risk that to which it has relevance. Where a requirement has been determined not to be relevant reason has been provided. As such, **Appendix A** describes the requirements that apply to this activity and how each is relevant to the environmental management of the activity.

Appendix A also provides a demonstration of how the requirements will be met by recording how each relevant requirement has been complied with either through the legislative or administrative arrangements in place, or through the adoption of control measures and associated performance standards, or through the implementation strategy.

5.2. Principles of ecologically sustainable development

The principles of ESD are summarised as:

- Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.
- If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
- The principles of inter-generational equity – that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.
- The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making.
- Improved valuation, pricing and incentive mechanisms should be promoted.

Shell has considered the principles of ESD in defining acceptable levels of impacts and risks, as defined in Section 3A of the EPBC Act. The environmental impacts and risks of the activity need to be consistent with these principles and as such will be considered in the assessment of each planned or unplanned event.

5.3. Internal context

5.3.1. The description of activity and implementation strategy

Shell recognises that each petroleum activity has a unique context and an associated impact and risk profile. The description of activity is provided in **Section 2** and provides the activity context. It is this information that is analysed against the description of environment to determine what the environmental aspects of for assessment. The implementation strategy provided in **Section 9** is also relevant internal context because it contains information about ongoing management of environmental impacts and risks will be achieved.

5.3.2. Shell HSE & SP Framework

The Shell Commitment and Policy on Health, Security, Safety, the Environment & Social Performance (Shell HSSE & SP Policy) applies across Shell globally and is designed to protect people and the environment. The Shell HSSE & SP Policy is outlined below and is presented in **Figure 5-1**.

Key features of the policy are:

- Systematic approach to HSSE & SP management designed to ensure compliance with the law and to achieve continuous performance improvement;
- Targets for improvement and measurement, appraisal and performance reporting;
- Requirement for contractors to manage HSSE & SP in line with this policy; and
- Effective engagement with neighbours and impacted communities.

All Shell's operations are conducted in accordance with Shell's HSSE & SP Control Framework, a comprehensive corporate management framework. This Framework contains the HSSE and SP requirements that apply to every Shell company, contractor and joint venture under Shell's operational control. It contains a simplified set of mandatory requirements that define high level HSSE & SP principles and expectations, which are documented in a set of supporting manuals. The framework covers areas including contractor HSSE & SP management, safety, environment, health, security and social performance management systems.

The requirements of Shell's HSSE & SP Control Framework and Shell Australia HSSE & SP Management System are included in the Shell Australia Business Management System and are included in the contractual requirements for all contractors.

Shell Commitment and Policy on Health, Security, Safety, the Environment and Social Performance.

Commitment

In Shell we are all committed to:

- Pursue the goal of no harm to people;
- Protect the environment;
- Use material and energy efficiently to provide our products and services;
- Respect our neighbours and contribute to the societies in which we operate;
- Develop energy resources, products and services consistent with these aims;
- Publicly report on our performance;
- Play a leading role in promoting best practice in our industries;
- Manage HSSE & SP matters as any other critical business activity; and
- Promote a Culture in which all Shell Employees share this commitment.

In this way we aim to have an HSSE & SP performance we can be proud of, to earn the confidence of customers, shareholders and society at large, to be a good neighbour and to contribute to sustainable development.

Policy

Every Shell Company:

- Has a systematic approach to HSSE & SP management designed to ensure compliance with the law and to achieve continuous performance improvement;
- Sets targets for improvement and measures, appraises and reports performance;
- Requires Contractors to manage HSSE & SP in line with this policy;
- Requires joint ventures under its operational control to apply this policy, and uses its influence to promote it in its other ventures;
- Engages effectively with neighbours and impacted communities; and
- Includes HSSE & SP performance in the appraisal of staff and rewards accordingly.

Originally published in March 1997 and updated by the Executive Committee December 2009.

General Disclaimer: The companies in which Royal Dutch Shell plc directly and indirectly owns investments are separate entities. In this Policy the expression "Shell" is sometimes used for convenience where references are made to companies within the Shell group or to the group in general. Likewise, the words "we", "us" and "our" are also used to refer to Shell companies in general or those who work for them. These expressions are also used where no useful purpose is served by identifying specific companies.

Terms in green are included in the HSSE & SP Control Framework Glossary.
Terms in blue reference manuals and manual sections in the HSSE & SP Control Framework.
This document is not controlled when printed. See the Change Log for version control information.

Figure 5-1 - Shell Commitment and Policy on HSSE & SP

5.4. External context

5.4.1. Consultation with relevant persons

Consultation with relevant persons provides important context to the assessment of impacts and risks. The consultation process undertaken in preparation of the EP is provided in **Section 10**. The outcome of the consultation is that appropriate measures are to be adopted to manage any adverse effect to relevant persons and their functions, interests, and activities. **Table 5-1** captures this outcome and demonstrates that the measures adopted are appropriate. Information on the objections and claims raised by relevant persons can be found in **Appendix A.**

Table 5-1 - Summary of Measures Adopted Because of the Consultation

Relevant persons who raise this objection or claim	Measures adopted because of the consultations	Appropriateness of the measures
WA Department of Primary Industries and Regional Development - Department of Fisheries	No seismic acquisition during the months of October or March. Reduce timing of the proposed survey	Since peak fishing effort occurs between June and November and peak fish spawning times for key species (goldband snapper and red emperor) occurs between September and May, there are no months where the seismic activity could eliminate potential impacts to either fish spawn or commercial fishing activity. The months of October and March still fall within the peak spawning period and peak fishing season (October only). Therefore it is considered appropriate for Shell to exclude the months of October and March still on this basis. Reduce the window of time for validity of the EP from 2 years to 11 months. The Factory 3D MSS will be acquired wholly within the period of November 2019 to the end of February 2020 or April 2020 to the end of September 2020. This improves the understanding of the window of the survey which helps affected fisheries to better understand when they might be affected.
WA Department of Primary Industries and Regional Development - Department of Fisheries	No operations of the acoustic source outside of the Operational Area Operation of the acoustic source array at full power will only occur in water depths >70m No seismic acquisition during peak spawning for key fisheries species during March and October Reduce timing of the proposed survey	OA has been designed to be as small as possible whilst achieving the geological and commercial objectives of the survey No operation of the power acoustic source will be in the water depths shallower than 70m to minimise noise impacts to shallow areas such as Heywood Shoal, where potential demersal species aggregate to spawn No definitive spawning areas are known for key species, they are broadcast spawners. Reduce the window of time for validity of the EP from 2 years to 11 months. The Factory 3D MSS will be acquired wholly within the period of November 2019 to the end of February 2020 or April 2020 to the end of September 2020. This improves the understanding of the window of the survey which helps affected fisheries to better understand when they might be affected.

Relevant persons who raise this objection or claim	Measures adopted because of the consultations	Appropriateness of the measures
Northern Demersal Scalefish Fishery - Northern Wildcatch Seafoods Australia (NWSA)	No seismic acquisition March and October Reduce timing of the proposed survey	The months where the least impact to commercial fishing occurs from the seismic acquisition is December to May. In addition to this, the only months where the activity would not impact peak spawning periods for goldband snapper or red emperor would be the months from June – August. Since the peak spawning periods and peak fishing periods cover the entire year, it is not possible to avoid seismic acquisition for both periods. On this basis, and considering other environmental priorities that have been considered, it is Shell's intention to preferentially carry out the survey between the November – February window proposed in the EP. This would minimise impacts to commercial fishing and other environmental receptors. It is also important to note with this that Shell cannot guarantee the survey timing will occur from November - February as there are numerous factors which could result in pushing the survey to occur sometime in the second window from April – September. Reduce the window of time for validity of the EP from 2 years to 11 months. The Factory 3D MSS will be acquired wholly within the period of November 2019 to the end of February 2020 or April 2020 to the end of September 2020. This improves the understanding of the window of the survey which helps affected fisheries to better understand when they might be affected.
Northern Demersal Scalefish Fishery - Northern Wildcatch Seafoods Australia (NWSA)	Communication procedure included as a control measure in Appendix A	Effective communications with fisheries licence holders will reduce potential impacts to fishers actively fishing and feedback will inform planning
Western Australian Fishing Industry Council (WAFIC)	Communication procedure included as a control measure in Appendix A Reduce timing of the proposed survey	Effective communications with fisheries licence holders will reduce potential impacts to fishers actively fishing and feedback will inform planning Reduce the window of time for validity of the EP from 2 years to 11 months. The Factory 3D MSS will be acquired wholly within the period of November 2019 to the end of February 2020 or April 2020 to the end of September 2020. This improves the understanding of the window of the survey which helps affected fisheries to better understand when they might be affected.
Western Australian Fishing Industry Council (WAFIC)	Development of communication procedure with Fisheries licence holders Reduce timing of the proposed survey Ongoing consultation with affected commercial fishing licence holders to seek to agree a compensation process	Effective communications with fisheries licence holders will reduce potential impacts to fishers actively fishing and feedback will inform planning Reduce the window of time for validity of the EP from 2 years to 11 months. The Factory 3D MSS will be acquired wholly within the period of November 2019 to the end of February 2020 or April 2020 to the end of September 2020. This improves the understanding of the window of the survey which helps affected fisheries to better understand when they might be affected. A compensation process, if able to be established, is intended to establish a fair and equitable process for NDSF to provide evidence-based claims to Shell. Establishing the process is reliant on successfully engaging directly with the NDSF (see Section 10.12).

Relevant persons who raise this objection or claim	Measures adopted because of the consultations	Appropriateness of the measures
Western Australian Fishing Industry Council (WAFIC)	Use of new fish spawning information provided by DPIRD Assess FishCube data on a month by month basis to assess when peak commercial fishing activity occurs within the OA Ongoing consultation with affected commercial fishing licence holders to seek to agree a compensation process	DPIRD provide information on the status and key information relating to the fisheries. Considiering DPIRD was copied on the email, it is clearly providing the most up to date information on fish spawning timing and other related information. This task helps better understand the NDSF and their activities within the OA. This enables a more robust impact assessment to be carried out. A compensation process, if able to be established, is intended to establish a fair and equitable process for NDSF to provide evidence-based claims to Shell. Establishing the process is reliant on successfully engaging directly with the NDSF (see Section 10.12).
Western Australian Fishing Industry Council (WAFIC)	Moved table with contextual information on percentage overlap with fisheries licence areas to the description of the environment	This table is contextual information only, therefore it is more appropriate in the description of the environment, as opposed to in the impact assessment.
AMSA, AHO, DAWR, DMIRS, DNP, Mareterram and NDSF	Communication procedure included as a control measure in Appendix A	Effective communications with AMSA, AHS, DAWR, DMIRS, Mareterram and NDSF will reduce potential impacts to the stakeholder. Communications will be included within the communication procedure in line with requests made by the relevant persons.

5.4.2. Description of environment

Section 3 provides a comprehensive description of the environment which may be affected by the Factory activity. To become useful in the impact assessment the information in the description of environment needs to be considered with a view to setting the acceptable levels of impact for each value and sensitivity. Shell's consideration in this regard is provided below.

5.4.2.1. Key Ecological Features

Key ecological features are elements of the Commonwealth marine environment that are considered to be of regional importance for either a region's biodiversity or its ecosystem function and integrity. The acceptable levels of impact/risk for this EP have been derived from the North-west Marine Bioregional Plan, as prepared under section 176 of the EPBC Act. The plan aims to strengthen the operation of the EPBC Act in the Commonwealth marine area of the North-west Marine Region to help ensure that the marine environment of the region remains healthy and resilient.

The overarching principle of acceptability is to have no effect to the interconnectedness, biodiversity, ecosystem function and integrity of the marine ecosystem in the North-west Marine Region. In the context of the Factory 3D MSS and the KEFs proximate to this activity the acceptable level is when there is no increase in the regional pressures as a direct result of the planned activity. The KEFs in the North-west Marine Region that are relevant to the Factory EP are described in Section (**Section 3.4.2**).

The pressures analysed by the DoEE are listed in Schedule 1 of the North-west Marine Bioregional Plan and are classified into four levels of concern, these being (from highest to lowest level) *of concern*, *of potential concern*, *of less concern* and *not of concern* (Commonwealth of Australia 2012). For the KEFs within the OA and / or EMBA, there were no pressures *of concern* (the highest status of concern) relevant to the Factory 3D MSS. The only pressure *of concern* for these KEFs is the extraction of living resources by traditional Indonesian fishers at the Seringapatam Reef and Commonwealth waters in the Scott Reef complex. A number of pressures *of potential concern* for KEFs are listed in the North-west Marine Bioregional Plan and are provided in **Section 3.4**. The pressures relevant to the Factory 3D MSS are highlighted in bold text and the EP section that assesses the potential impact / risk from the relevant pressures is provided in brackets.

Table 5-2 – Acceptable levels for KEFs

KEF	Pressures *of Potential Concern*	Acceptable Level Statement
Ancient Coastline at 125 m Depth Contour	– Ocean acidification	No increase in status of the relevant regional pressures as a direct result of the planned activity.
Continental Slope Demersal Fish Communities	– Changes in sea temperature – Ocean acidification – **Physical habitat modification** (**Section 7.3** - unplanned loss of materials, **7.5**- unplanned hydrocarbon release) – Bycatch	
Ashmore Reef and Cartier Island and Surrounding Commonwealth Waters	– Sea level rise – Changes in sea temperature – Ocean acidification – **Marine debris** (**Section 7.3** - unplanned loss of materials) – **Physical habitat modification** (**Section 7.3** - unplanned loss of materials, **7.5**- unplanned hydrocarbon release) – Extraction of living resources – Oil pollution (oil rigs) – **Invasive species (Section** Invasive Marine Species**7.1)**	
Carbonate Bank and Terrace System of the Sahul Shelf	– Changes in sea temperature – Ocean acidification – Extraction of living resources	
Seringapatam Reef and Commonwealth waters in the Scott Reef Complex	– Sea level rise – Changes in sea temperature – Ocean acidification – **Marine debris** (**Section 7.3** - unplanned loss of materials) – **Physical habitat modification** (**Section 7.3** - unplanned loss of materials, **7.5**- unplanned hydrocarbon release)Oil pollution – **Invasive species (Section** Invasive Marine Species**7.1)**	

5.4.2.2. Physical Environment (including Heritage)

The Commonwealth marine environment is a MNES protected under the EPBC Act. The preparation of marine bioregional plans represents an important step towards a genuine "ecosystem approach" to biodiversity conservation and marine resource management. The ecosystem approach is one of the most important principles of sustainable environmental management. Essentially, it recognises that all elements of an ecosystem are interconnected and requires that the effects of actions on the different elements of an ecosystem be taken into consideration in decision-making.

In the context of the Factory 3D MSS and the physical environment (Commonwealth marine environment) in which the survey will take place, the acceptable level is defined as no long-term effect that results in substantial impact on the existing physical environment or geomorphic features. Specifically, it is defined as no substantial impact on heritage values, water quality, important habitat or ecological function of a species or population of conservation value.

The definition for substantial impact has been adopted from the EPBC Act Policy Statement 1.1—Significant Impact Guidelines, which considers substantial impact on a Commonwealth Marine Area to occur when there is reasonable possibility that an action will:

- result in a known or potential pest species becoming established in the Commonwealth marine area

- modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results
- have a substantial adverse effect on a population of a marine species or cetacean including its life cycle (for example, breeding, feeding, migration behaviour, life expectancy) and spatial distribution
- result in a substantial change in air quality or water quality (including temperature) which may adversely impact on biodiversity, ecological integrity; social amenity or human health
- result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity, social amenity or human health may be adversely affected, or
- have a substantial adverse impact on heritage values of the Commonwealth marine area, including damage or destruction of an historic shipwreck.

Table 5-3 shows the relationship between the potential substantial impacts on the Commonwealth Marine Area (as defined by EPBC Act Policy Statement 1.1—Significant Impact Guidelines) and the relevant section of this EP that assess the possibility of the Factory 3D MSS result in these impacts.

Table 5-3 – Acceptable levels for Physical Environment

Physical Environment	Relevant Effects Assessed for	Acceptable Level Statement
Commonwealth marine environment	– **known or potential pest species** (**Section 7.1 -** Invasive Marine Species) – **habitat modification, destruction, fragmentation, isolation or disturbance** (**Section 7.2** - unplanned seabed disturbance, **7.5** - unplanned hydrocarbon release) – **adverse effect on a population of a marine and spatial distribution** (**Section 7.5** - unplanned hydrocarbon release) – **change in air quality or water quality** (**Section 6.2** - discharges, **6.4** atmospheric emissions, **7.3** - unplanned loss of materials, **7.5** - unplanned hydrocarbon release) – **result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment** (**Section 6.2** - discharges, **7.3** - unplanned loss of materials, **7.5** - unplanned hydrocarbon release) – **impact on heritage values of the Commonwealth marine area** (Section **6.1** physical presence, **6.5.14** – acoustic emissions, **7.5** - unplanned hydrocarbon release)	No long-term effect on the existing physical environment or geomorphic features

5.4.2.3. Benthic Communities

The benthic communities within the OA and wider EMBA are described in **Section 3.4.1**. In general, epifaunal abundance is low in the EMBA and this appears to be due to the lack of hard substrate. The exception to this is the shoals in the area which support benthic communities that are typical of shallow tropical reef systems in the region, with many coral and algae species shared between the shoals and the emergent coral reefs. Shoals in the EMBA are Heywood Shoal, Eugene McDermott Shoal, Goeree Shoal, Vulcan Shoal, Barracouta Shoals and Echuca Shoal.

Heywood Shoal is also located within the OA and consists of a mix of sand, rubble and generally low-relief consolidated reef supporting corals (hard and soft), invertebrates, fish and algae (**Section 3.4.1.1**). The seabed within the remainder of the OA comprises mainly soft sediments with little, if any, available hard substrate and generally low abundance of epifaunal benthic communities (**Figure 3-8**).

In the context of the Factory 3D MSS and defining a tolerable amount of environmental impact and risk to benthic communities that may be affected by the Activity, the acceptable level is defined as no unrecoverable or long-term effects on fish, benthic or coral assemblages. This definition aligns with the broad principles of acceptability evaluation (**Section**) including the EPBC Act principles of ESD (specifically that decision making processes should effectively integrate both long and short-term considerations) and Shell's HSSE & SP Policy.

5.4.2.4. Listed Threatened and Migratory Species

The North-west Marine Bioregional Plan considers the pressures on listed threatened and migratory species and provides specific advice on MNES in the region. The EPBC Act also publishes information about the threats faced by marine species, how to prevent and mitigate those threats, and recovery plans for some species.

Various listed threatened and migratory species have been identified as occurring or potentially occurring within the OA and wider EMBA (**Section 3.4.3**). It is recognised that different species have different requirements for survival and maintenance of sustainable population levels, therefore when defining the level of tolerable amount of environmental risk and impact to threatened species, the definitions have been selected to be broad enough to apply to all species (regardless of their specific requirements) with a focus on maintaining sustainable population levels. This approach incorporates the EPBC Act Policy Statement 1.1—Significant Impact Guidelines definition for significant impact on listed threatened species and ecological communities, which defines significant impact on listed threatened species to be actions that have a realistic possibility of:

- leading to a long-term decrease in the size of a population
- reducing the area of occupancy of the species
- fragmenting an existing population into two or more populations
- adversely affecting habitat critical to the survival of a species
- disrupting the breeding cycle of a population
- modifying, destroying, removing, isolating or decreasing the availability or quality of habitat to the extent that the species is likely to decline
- resulting in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat
- introducing disease that may cause the species to decline, or
- interfering with the recovery of the species.

The overall defined level of acceptability for listed threated and migratory species is no substantial adverse effect on a population of listed threatened or migratory species, including its lifecycle (e.g. breeding, feeding, migration behaviour or life expectancy) and spatial distribution.

5.4.2.5. Offshore Reefs and Islands

There are no reefs or islands within the OA. The offshore islands and reefs within the wider EMBA are Cartier Island, Ashmore Reef and Browse Island; these are described in Section (**Section 3.4.1.1**). Areas of reef are also associated with the Ancient Coastline at 125 m Depth Contour KEF (**Section 3.4.2**).

In order to define a tolerable amount of environmental impact and risk for offshore reefs and islands that may be affected by the Factory 3D MSS, the broad principles of acceptability evaluation have been applied, including Shell's HSSE & SP Policy, the EPBC Act principles of ESD (specifically that decision making processes should effectively integrate both long and short-term considerations, and that economic growth is strong and diversified whilst protecting environmental values) and the North-west Marine Bioregional Plan objectives (in particular the conservation of biodiversity and maintenance of ecosystem health). The acceptable level is defined as no unrecoverable or long-term effects on the biodiversity and ecosystem health of offshore reefs and islands from impacts and risk associated with the activity.

5.4.2.6. Australian Marine Parks

AMPs (formerly Commonwealth Marine Reserves) are recognised under the EPBC Act for protecting and maintaining biological diversity and contributing to a national representative network of marine protected areas. Under the relevant management plans, AMPs are allocated conservation objectives (International Union for Conservation of Nature (IUCN) Protected Area Category) based on the Australian IUCN reserve management principles in Schedule 8 of the EPBC Regulations 2000. .

There are three AMPs within the EMBA; Cartier Island, Kimberley, and Ashmore Reef (**Section 3.5.3**). These AMPs are all within the North-west Marine Parks Network. Cartier Island and Ashmore Reef AMPs are International Union for Conservation of Nature (IUCN) Category IA. Kimberley AMP has areas that are IUCN Category II, IV, and VI.

Acceptable levels of impact and risk can be derived from the literature, specifically, from the IUCN reserve management principles and guidance from the IUCN[3] and Australia's Director of National Parks. In relation to the AMPs within the EMBA and defining acceptability for the Factory 3D MSS, acceptable levels can be set by adapting the IUCN primary objectives for the category of marine park and considering the reserve management principles (DNP 2018) including the vision and objectives of the North-west Marine Parks Network Management Plan 2018 (specifically that marine parks are healthy, resilient and well-managed, and the values of AMPs are appreciated, conserved and protected; Director of National Parks 2018).

Table 5-4 - Acceptable levels for listed AMP / IUCN Categories

AMP/IUCN Category	IUCN Primary Objective	Acceptable Level Statement
1a	To conserve regionally, nationally or globally outstanding ecosystems, species (occurrences or aggregations) and/or geodiversity features: these attributes will have been formed mostly or entirely by non-human forces and will be degraded or destroyed when subjected to all but very light human impact.	No unrecoverable or long-term disturbance to the habitats, ecosystems, and native species of the AMP.
VI	To protect natural ecosystems and use natural resources sustainably, when conservation and sustainable use can be mutually beneficial.	No unrecoverable or long-term effect to the biological diversity or sustainable use of the natural ecosystem of the AMP.

5.4.2.7. Commercial, Recreational, and Traditional Fishers

Commercial, recreational and traditional fishing is described in detail in (**Section 3.5.2**). In terms of commercial fishing, consultation with stakeholders has identified that only one WA fishery, the NDSF, is active within the OA (**Section 3.5.2**). The OA and EMBA overlap a section of the MOU Box for traditional fishing and most recreational fishing is expected outside of the OA (**Section 3.5.3**).

Of primary importance to the fishery is its ongoing sustainability. The DPIRD is the regulator of such matters for the commercial fisheries in Western Australia. The acceptable level of impact from their perspective would be for no effect to the sustainability of the fish population and the sustainability of the fisheries in the Gascoyne and North Coast fishing marine bioregions.

In accordance with the OPGGSA, the overarching principle which informs the acceptable level of impact is to not interfere with fishing to a greater extent than is necessary for the exercise of right conferred by the titles granted to carry out exploration activities.

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[3] https://portals.iucn.org/library/sites/library/files/documents/PAPS-016.pdf

To understand what these levels mean needs to be put in context of the specifics of the fisheries and the proposed activity. To set an acceptable level of impact for a fishery three methods could be considered:

1. Temporal only: The logic here would be to understand the time available to fishers to access their resource and determine a percentage of that time that could be lost. If there is no temporal overlap with fisher's legal opportunity to fish, then the impact would be demonstrated to be of an acceptable level.
2. Spatial only: The logic here would be to overlay the Factory survey with the fished area and determine a percentage of overlap to then be able to examine the distribution and effort in the overlapped area versus other areas that may have been fished. If the fishery is broadly distributed and similar catch effort demonstrable in other locations, then the impact could be deemed to be of an acceptable level.
3. Temporal and spatial: The logic here would be to understand catch effort attributed to the overlapping area and explore the variations in catch effort over multiple years to determine what fluctuations can be experienced by fishers and agree with the fishers what amount of economic losses they might incur. Similarly, as per Item 2 in this list, the distribution and catch effort across the fishery would need to be considered setting the acceptable level. Again, if the fishery is broadly distributed and similar catch effort demonstrable in other locations, then the impact could be deemed to be of an acceptable level.
4. Biomass and catch effort: The logic here would be to gather the catch effort based on a combination of the numbers of vessels active, the number of days those vessels fished, and the catch weight from a licence block. Then, based on the fishing grounds actively fished and the biomass available to the fishers, a calculation of the amount of interference to the fishers (collectively) could be made.
5. Direct economic loss: There are two licence holders, both of which are private companies and Shell not access this information.

Through consultation it has become apparent that the NDSF is the only directly affected fishery and so further analysis of what may be an acceptable level of impact may be is required. It has not been possible to liaise directly with the NDSF although data regarding their reported catch effort has been received from DPIRD (FishCube). The data is limited however as most results are treated confidentially because of the small number of vessels active in the fishery. Shell has selected a spatial only acceptable level of impact to the NDSF as, the overall spatial access to the productive areas of fishing within the overall licence area does not result in quantifiable reduction in catch effort as a result of the survey. This level is considered appropriate because:

- The NDSF is fished over a broad spatial area.
- There are places they can go, at the times the Factory survey is proposed, that will be equally as productive from a catch effort perspective.
- Shell is exercising a right conferred under an exploration licence with a limited spatial area. The NDSF licence area, covers a broad area of productive areas which are fished year-round. The interference Shell will have as a result of this activity, is no greater than is necessary to exercise of right conferred by the titles granted to carry out exploration activities.

Another acceptable level statement for commercial fisheries is as follows: No effect to the sustainability of the fish population and the sustainability of the fisheries in the Gascoyne and North Coast fishing marine bioregions (Status report of the fisheries and aquatic resources of Western Australia, 2017/2018). Based on this, the following acceptable levels of impact have been set for the activity:

- No increased threat to the sustainability of the fishery.

This acceptable level of impact has been set based on objections raised by DPIRD.

5.4.2.8. Tourism and Recreational Activities

The primary activities that may occur proximate to the Factory MSS activity are recreational fishing and diving. There are no recognised diving sites within the OA. The closest identified dive site to the OA and EMBA lies on the north side of Ashmore Reef (greater than 52 km north of the OA and 96 km from the FPZ). Seismic surveys have the potential to injure divers, so the acceptable level of impact to divers is that no injury should occur to humans using the water by diving. Recreational fishing has been covered above.

5.4.2.9. Military and Defence Activities

Military and defence activities are generally unknown and training activities can be instigated at short notice. Any defence activity takes priority over the Factory MSS activities. Shell will consult with the Department of Defence and ensure that no interference occurs with any direction from that Department.

5.4.2.10. Ports and Commercial Shipping

Ports and commercial shipping activities take place across the high seas and they have rights set out by the International Maritime Organisation and the Australian Maritime Safety Authority. The OPGGS Act, in Section 280, stipulates the way in which the shipping industry may not be interfered with. This provision can be adapted to create the acceptable level of impact and risk being that there will be no interference with navigation to a greater extent than is necessary for the exercise of right conferred by the titles granted to carry out exploration activities.

5.4.2.11. Offshore Exploration and Production

Other titleholders can undertake activities over awarded acreage and 'off-title' across the high seas and they have rights set out by the National Offshore Petroleum Titles Administrator and are regulated by NOPSEMA. The OPGGS Act, in Section 280, stipulates the way in which the petroleum industry may not be interfered with. This provision can be adapted to create the acceptable level of impact and risk being that there will be no interference with other titleholders to a greater extent than is necessary for the exercise of right conferred by the titles granted to carry out exploration activities.

5.5. Summary of the acceptable levels of impact for the Factory 3D MSS

Having considered the legislative and other requirements, the principles of ESD, Shell's internal context, and the external context, **Table 5-5** presents the defined acceptable levels of impact/risk that have been determined for the Factory 3D MSS. These statements will be used as the basis for comparison to the predicted levels of impact/risk from the Factory activity in the impact and risk assessment process.

Table 5-5 - Defined Acceptable Levels of Impact and Risk

Value or Sensitivity	Acceptable Level Statement	
Key Ecological Features	No increase in status of the regional pressures as a direct result of the planned activity.	
Physical Environment	No long-term effect on the existing physical environment or geomorphic features.	
Benthic Communities	No unrecoverable or long-term effects on benthic communities from impacts and risk associated with the activity.	
Listed Threatened and Migratory Species	No substantial adverse effect[4] on a population of listed threatened or migratory species, including its lifecycle (e.g. breeding, feeding, migration behaviour or life expectancy) and spatial distribution.	
Offshore Islands and Reefs	No unrecoverable or long-term effects on the biodiversity and ecosystem health of offshore reefs and islands from impacts and risk associated with the activity	
Australian Marine Parks	IA	No unrecoverable or long-term disturbance to the habitats, ecosystems, and native species of the AMP.

[4] A substantial impact is defined in the North-west Marine Bioregional Plan and is based on EPBC Act Policy Statement 1.1 – Significant Impact Guidelines and are provided below.

(by IUCN Category)	VI	No unrecoverable or long-term effect to the biological diversity or sustainable use of the natural ecosystem of the AMP.
Commercial/Traditional Fisheries	No effect to the sustainability of the fish population and the sustainability of the fisheries in the Gascoyne and North Coast fishing marine bioregions.	
	No interference with fishing to a greater extent than is necessary for the exercise of right conferred by the titles granted to carry out exploration activities.	
Tourism and Recreational Activities	No injury to humans using the water by diving.	
Military and Defence Activities	No interference with defence activities as directed by the Department of Defence.	
Ports and Commercial Shipping	No interference with navigation to a greater extent than is necessary for the exercise of right conferred by the titles granted to carry out exploration activities.	
Offshore Exploration and Production	No interference with other titleholders to a greater extent than is necessary for the exercise of right conferred by the titles granted to carry out exploration activities.	

6. Planned Activities

6.1. Physical Presence

6.1.1. Interaction with Other Marine Users

6.1.1.1. Environmental Aspects Arising from the Activity

In relation to other marine users, the environmental aspect is the presence of the activity vessels in the OA. The other marine users identified as potentially affected are commercial fishers, tourism operators and commercial shipping vessels. During the preparation of this EP and associated stakeholder consultation, no overlap was identified with NT commercial fishers, active Commonwealth commercial fishers, Department of Defence activities, other petroleum activities and heritage values (such as shipwrecks and plane wrecks) hence they do not feature in this assessment further.

For WA commercial fishers, tourism operators, and commercial shipping the activity proposed in this EP may interact with them in the following ways.

- Temporary displacement of WA commercial fishers from known fish aggregation (previously fished) areas within the license area
- Temporary displacement of WA commercial fishers from fishing license areas
- Temporary reduction in catchability of fish from known aggregation areas
- Navigation hazard to fishers, tourist vessels and commercial shipping vessels

For the purposes of assessing this impact, the important detail from the description of the activity is the total amount of time the survey and supporting vessels are present, which is up to a maximum of 90 days.

The following environmental aspect was raised during consultation with relevant persons that are relevant to the impact assessment of other marine users, and has been addressed in the discussion below:

- displacement of NDSF commercial fisheries from the OA.
- A shipping channel south-west of the OA and heavy shipping traffic in the area.

No additional environmental aspects have been identified as a result of Shell's previous seismic activities.

6.1.1.2. Impact Assessment

Temporary displacement of WA commercial fishers from known fish aggregation (previously fished) areas within the license area

Four Commonwealth and eight State managed fisheries were identified as overlapping the OA (**Figure 3-29** to **Figure 3-38**). However, only the NDSF (with two active fishers) was identified as currently operating within the OA which was confirmed through consultation with WAFIC, NDSF, DPIRD, AFMA and the NDSF (**Section 3.5.2**). See below for *Temporary displacement from fishing licence areas* for the remaining commercial fisheries.

The main concern for interactions between seismic acquisition and commercial fisheries is fisheries with relatively small licence areas. The NDSF fisheries licence area covers from the southern end of Eighty Mile Beach to the NT/WA border, the licence area is then designated into three main fishing zones, and the majority of fishing effort is conducted in the smallest Zone B. No fishing is permitted in Zone A, and only occasional exploratory fishing is currently being conducted within the deeper water depths of Zone C. Shell spatially analysed the most recent Fish Cube catch and effort data provided by DPIRD (2007-2018) to assess potential overlap with the NDSF. The OA and FPZ were overlayed with the fishery licence area that may be actively fished within or adjacent to the OA to give an indication of the possible overlap and therefore the potential level of interaction (see **Section 3**; **Figure 3-29** to **Figure 3-38**.

The OA overlaps 5.75% of the Zone B Fishing area and the FPZ overlaps 1.44%, however, within the Zone B fishing area fishers may have a limited area to fish based on target species habitats. From the Fish Cube data spatial analysis of the NDSF, there is overlap with current fishing effort (total number of vessels and catch weight) within the FPZ and the OA. The block with the largest amount of effort is located within the OA and outside of the FPZ, this block shows up to 8 vessels fishing and up to 140 tonnes of catch over a ten year period (**Figure** 3-35). Within the FPZ, there are 2 blocks that had up to 5 active vessels and 2 blocks with up to 60 tonnes of catch weight over a ten-year period. Fish Cube data shows that there are 8 blocks outside the OA with greater catch than the block with the largest catch within the OA, for the period 2007 to 2018.

Vessels actively fishing within the NDSF within the OA at the time of the survey are likely to be temporarily displaced from a localised area around the seismic survey vessel, towed equipment and support vessels over a three-month period during the survey. However, this does not mean that fishers will be displaced from a previously fished area (represented by the Fish Cube data blocks) for the entire three-month period. The seismic vessel will be continuously moving at a speed of approximately 4.5 knots (8.3 km/h) during the survey, which means the vessel could travel over 190 km in a 24-hour period, therefore the displacement from previously fished areas within the licence area is expected to be in the vicinity of a day or two. Noting also, that the data shows there is a significant area outside the OA which is previously fished at comparative fishing effort, so there may be opportunities for NDSF to fish outside of the ensonified area, at the time the survey will occur.

Temporary displacement of WA commercial fishers from fishing license areas

In addition to the NDSF, there are a further 11 commercial fisheries that have licence areas overlapping the OA (**Figure 3-29**; **Figure 3-30**). It has been identified through consultation, review of past fishing effort and fishing methods/gear that these fisheries are not likely to be encountered during the activity.

Due to the nature of the seismic survey, whereby the vessel is moving at approximately 4.5 knots, fishers will be displaced from sections of fishing licence areas that overlap the OA for a short duration (in the vicinity of one to two days). This potential interference is necessary for Shell to exercise their rights under the work programme for the Exploration Permits AC/P65, AC/P41, WA-534-P. The potential interference is not greater than the extent necessary to undertake the seismic survey.

Temporary reduction in catchability of fish from known aggregation areas

Apart from potential physical exclusion of fishing vessels from the survey area, changes in the horizontal and vertical distributions of fish or other behavioural changes during or after exposure to seismic signals may influence catches of commercial and recreational fisheries. The seismic survey has the potential to cause temporary changes in commercial fish catch due to changes in catchability of target fish species (caused by behavioural responses to airgun noise) and therefore displacement of commercial fishers. As described in **Section 6.5.5** behavioural responses can include avoidance (leaving the area of the noise source) and startle/alarm response (changes in depth distribution). These responses can affect target fish species up to 45 km from the acoustic source. As described above only the NDSF fishery was identified as operating in waters overlapping the OA.

Carroll *et al*. (2017) recent critical review of the potential impacts of marine seismic surveys on fish and invertebrates found that studies on fish have found positive, inconsistent, or no effects of seismic surveys on catch rates or abundance. A desktop study of four species (gummy shark, tiger flathead, silver warehou, school whiting) in Bass Strait, Australia, found no consistent relationships between catch rates and seismic survey activity in the area, although the large historical window of the seismic data may have masked immediate or short-term effects which cannot therefore be excluded (Przeslawski *et al.* 2016). A number of studies have examined the effects of seismic activities on catch rates of commercial species. Carroll *et al*. (2017) recent critical review of the potential impacts of marine seismic surveys on fish and invertebrates found that studies on fish have found positive, inconsistent, or no effects of seismic surveys on catch rates or abundance. However, any changes to behaviour are expected to be temporary and short term with fish returning to survey areas within days. Both Egnas et al.(1996) and Slotte et al (2004) observed that fish moving back into areas within 3 to 5 days of the completion of the seismic activity. Therefore, any displacement of fish from the survey area would be limited to the duration of the survey with fish returning within days.

There has been recent efforts to relate fisheries catch data to seismic surveys however to date the results indicate that the effects of seismic surveys on catch seem transitory and vary among studies, species and gear types (Przeslawski *et al.* 2016). Bruce et al (2018) found that of the 15 species examined, nine had significantly different catch rates before and after the seismic survey. Six species (tiger flathead, goatfish, elephant fish, boarfish, broadnose shark and school shark) showed increase in catch rate and three species (gummy shark, red gurnard and sawshark) showed reductions. Another desktop study of four species (gummy shark, tiger flathead, silver warehou, school whiting) in Bass Strait, Australia, found no consistent relationships between catch rates and seismic survey activity in the area, although the large historical window of the seismic data may have masked immediate or short-term effects which cannot therefore be excluded (Przeslawski *et al.* 2016).

Impacts on catch rates of benthic invertebrates are not predicted. This is based on the Carroll *et al.* 2017 review which concluded that: "*For marine invertebrates, the potential effects of seismic signals on catch rates or abundances have been tested on cephalopods, bivalves, gastropods, decapods, stomatopods, and ophiuroids with no significant differences detected in any of these studies between sites exposed to seismic operations and those not exposed*".

It is possible that individual fish may be displaced from the survey area, and up to 45 km away, however the total number of fish within the fishery stock remains unchanged (**Section 6.5.4** concludes that mortality of adult fish are unlikely) and the fish are expected to return within days. In addition, no impacts on catch rates of benthic invertebrates are expected.

Northern Demersal Scalefish Managed Fishery

To understand the potential impacts to catch rates an analysis was undertaken to determine the percentage of overlap of the OA (5.75%) and the FPZ (1.44%) with the Zone B Fishing area. In addition to the spatial overlap there is likely to be a temporal overlap of 25% of the year (excluding any peaks in fishing effort during the year), as the fishery operates year-round. A further assessment was undertaken to understand the overlap with fish catch and effort with the OA and FPZ and further refine the temporal overlap (**Figure 6-1, Figure 6-2)**.

Fish catch and effort data was obtained from WA DPIRD for the years 2007 to 2018 (Fish Cube data). The data is presented in 10 NM x 10 NM blocks, data is not available when less than three vessels report catch within an individual block. Therefore, the data may underestimate the fishing catch and effort.

The total catch weight over this time period indicated that a number of blocks which overlap OA and are within 45 km of the OA have high catch weights relative to other areas of the fishery (**Figure 6-1**). From 2007 to 2018 fishing effort[5] (based on both fishing days and catch weight) within the OA has accounted for ~9% of the total fishing effort within the entire NDSF and the area where behavioural impacts may occur, up to 45 km from the FPZ, accounts for ~20% of the total fishing effort within the entire NDSF.

In addition, the Fish Cube data identified that peaks in fishing effort occurred in March and then from August to November across the entire NDSF while within the OA fishing effort seems to peak from June to November. The current proposed timings for the survey are November to February and April to September which have the potential to overlap with part of the identified peaks for the OA. However, fishing within these blocks is limited temporally and it is likely that the overlap of commercial fishing with the seismic survey would be one to two weeks over the survey period. **Figure 6-2** illustrates the total number of days fished in each block over a 12-year period (2007 to 2018). The block within the OA with the highest fishing effort had on average 10 days / year of fishing, while the highest block within the 45 km zone had on average 16 days / year of fishing.

[5] Note that any blocks with "less than 3" vessels were not included in the dataset by DPIRD from commercial reasons, so analysis excludes these

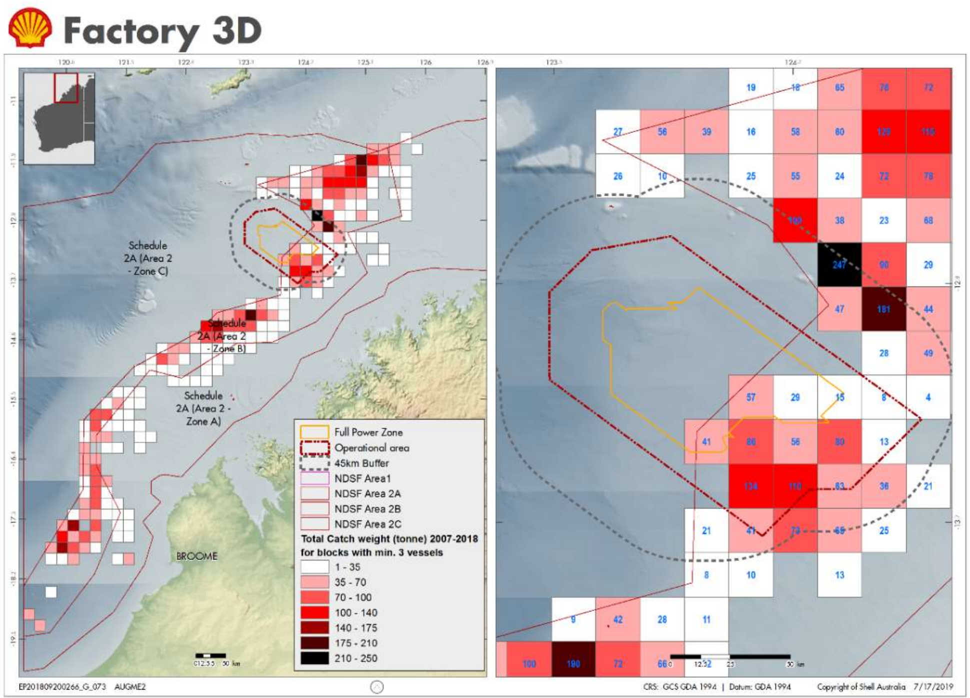


Figure 6-1 - Total catch weight for the Northern Demersal Scalefish Fishery from 2007 to 2018

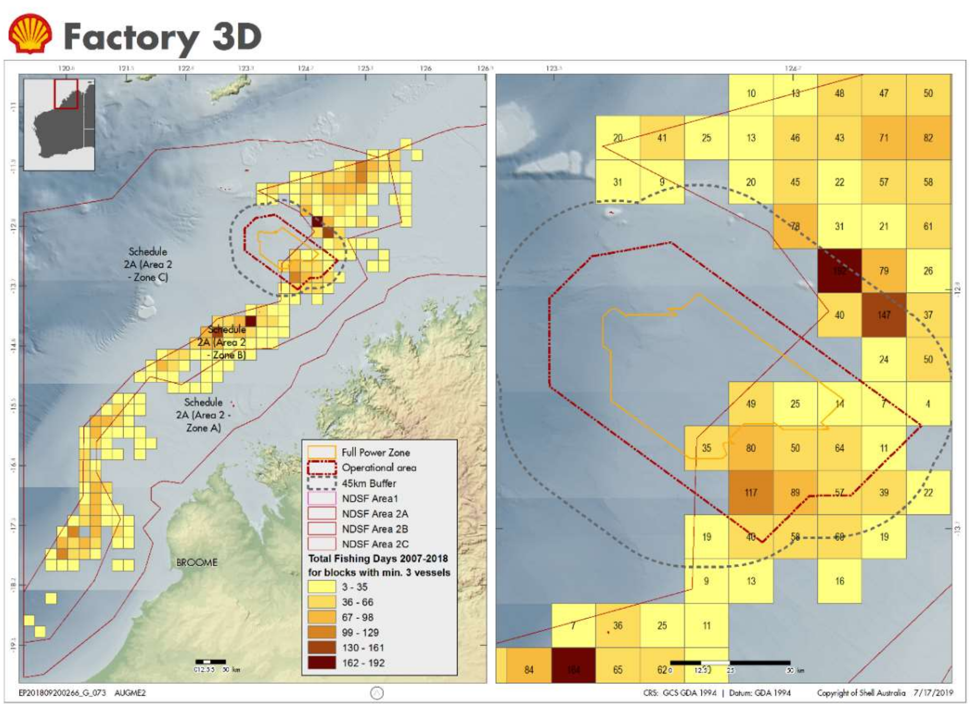


Figure 6-2 - Total fishing days within the Northern Demersal Scalefish Fishery from 2007 to 2018

Potential impacts to commercial catch rates in the NDSF are not likely to be significant based on:

- the total number of fish within the fishery stock remains unchanged (e.g. mortality of fish is highly unlikely; **Section 6.5.4**)
- potential impacts to spawn, larvae and eggs are considered localised and will not impact the commercial fish species at a population level (**Section 6.5.3**)
- displacement of fish from the survey area would be limited to the duration of the survey in that immediate area, with fish returning within days.
- the area of potential behavioural impacts to fish (i.e. 45 km from the FPZ) is highly conservative.
- the spatial and temporal overlap with the fishery is limited. A very large proportion of the actively fished area (80%) of the NDSF is still available to fish, outside the ensonified area during the proposed survey time
- The latest stock assessment for all target species indicate the biological stocks of the Kimberley Demersal Fishery are classified as sustainable-adequate (Gaughan, D.J. and Santoro, K. (eds). 2018).

Therefore, potential behavioural changes in commercial species may result in short-term and localised decrease in catch rates for the NDSF.

***Navigation hazards to fishers, tourism operators and* commercial shipping vessels**

Tourism and Recreational Fishers

No tourism activities are known to occur in the area due to the water depths and distance offshore. RecFishWest confirmed that it is highly unlikely that this survey will impact upon recreational fishers. Therefore, the only credible impact to both tourism and recreational fishing would be limited to interference with vessels transiting to Ashmore Reef and Cartier Island. Impacts would be limited to temporary avoidance of activity vessels while transiting through the area.

Traditional Fisheries

Survey activities will not overlap or exclude fishers from known fishing areas used by Indonesian traditional fishers. Although, there is a potential risk that the presence of survey activities or misinterpretation of information provided may act as a deterrent to traditional fishers wanting to transit through the OA to their fishing grounds located at Scott Reef. Scott Reef is 60 km from the OA, and therefore it is anticipated that interaction with Indonesian traditional fishers will be limited to those transiting through OA, and en route to or from the Scott and Seringapatam reef fishing grounds.

Shipping

Within the NWS, the Australian Maritime Safety Authority (AMSA) has introduced a network of commercial shipping fairways to reduce the risk of vessel collisions with offshore infrastructure (**Figure 3-40**). AMSA have indicated there is one major shipping fairway intersecting the southern portion of the OA, whereby there is heavy vessel traffic servicing Shell's Prelude FLNG and INPEX's Ichthys project, and another outside and to the north-east of the OA from vessels servicing the Montara Venture, 46 km from the OA. A smaller shipping channel, the Osborne Passage passes through the north of the OA (**Figure 3-40; Figure 3-41**). AMSA also noted heavy traffic in permit block AC/P65 and WA-534-P, particularly in the southern and south-eastern section of WA-534-P.

The survey vessel(s) and towed array present a potential navigational hazard and other vessels will need to avoid the seismic vessel to prevent collisions, entanglement of streamers, and other incidents. Loss of equipment may also interfere with shipping activity. Therefore, there is a potential for impacts to shipping vessels within the region, with the majority of interactions expected to be deviations in shipping routes when the survey vessel is conducting line changes along the eastern and western edge of the FPZ.

Table 6-1 – Risk Assessment for Physical Presence of Project vessels – Interaction with Other Marine Users

Environmental Aspect	Environmental Value/Sensitivity				Evaluation – Planned		
	Physical Environment	Threatened species and ecological communities	Ecosystems, communities and habitats	Socio-economic and cultural environment	Magnitude	Sensitivity	Residual Impact
Physical presence of Project vessels –interference with and/or exclusion of commercial fishers from licence areas	-	-	-	X	Minor	Low	Minor
Physical presence of Project vessels –interference with and/or exclusion of commercial fishers from known aggregation areas				X	Minor	Medium	Minor
Temporary reduction in catchability of fish from known aggregation areas				X	Minor	Medium	Minor
Physical presence of Project vessels –interference with commercial shipping, traditional fishing and recreational fishing				X	Slight	Low	Slight

Requirements, Control Measures, Environmental Performance Standards and ALARP Assessment
For details of the requirements that apply to the activity, adopted control measures, environmental performance standards and ALARP assessments applicable to this event, please refer to Appendix A.

Demonstration of Acceptability			
Value or Sensitivity	**Feature**	**Set acceptable levels of impact**	**Predicted impacts**
Commercial, Recreational and Traditional Fisheries	Northern Demersal Scalefish Fishery	The overall spatial access to the productive areas of fishing within the overall licence area does not result in quantifiable reduction in catch effort as a result of the survey	From 2007 to 2018 fishing effort (based on both fishing days and catch weight) within the OA has accounted for ~9% of the total fishing effort within the NDSF. With the data available, Shell has predicted that the area where behavioural impacts may occur, up to 45 km from the FPZ, accounts for ~20% of the total fishing effort within the NDSF. In terms of inference, on a spatial basis only, NDSF licence holders will continue

			to have access to 80% of their previously fished areas. Combined spatial and temporal displacement is predicted to be less than 5% interference with the fishery. Given the broad distribution of catch effort over a large fished area no reduction in catch effort is predicted as a result of this activity.
Ports and Commercial Shipping	Osbourne Passage	No alterations to a greater extent than is necessary of preferred shipping routes because of the survey	There is a potential for impacts to shipping vessels within the region, with the majority of interactions expected to be deviations in shipping routes when the survey vessel is conducting line changes. It is unlikely that this will occur frequently, if at all. If it does occur, it is likely the interaction will be well planned and measures will able to be readily adopted by the commercial vessel or the seismic vessel in line with controls outlined within Appendix A.
Principles of ESD	The impacts from the physical presence of the project vessels are consistent with the principles of ESD based on: • the socio-economic values/sensitivities within the OA are not expected to be significantly impacted; • the health, diversity and productivity of the environment is not expected to decrease; and the survey does not significantly impinge upon the rights of other parties to access environmental resources (e.g. commercial fishers or commercial shipping).		

Summary of Acceptability
The residual impact on other marine users associated with the physical presence of project vessels during the survey is minor given the application of the controls outlined in Appendix A and the following points: • The minimal disruption posed by the physical presence of project vessels; • Regulatory requirements are incorporated; • The Factory 3D MSS is consistent with Shell policy, standards and culture; • Good practice developed from Shell's global vessel operations, industry guidelines and practical mitigations to reduce the risk associated with the physical presence of the project vessels have been undertaken; and • Stakeholder concerns have been considered and incorporated into this EP (Appendix A). The predicted levels of residual impact have been assessed against the defined levels of acceptability, and overall the residual impacts associated with the physical presence of project vessels are considered acceptable.

6.2. Discharges

6.2.1. Discharge of Deck Drainage and Bilge Water from Project Vessels

6.2.1.1. Environmental Aspects Arising from the Activity

Deck drainage and bilge water will be generated on board project vessels. Deck drainage includes wash down water, seawater spray and rainwater and may contain small quantities of oil, grease and biodegradable detergents present on the deck. Bilge water can contain oil, solid particles and chemicals such as solvents and detergents.

Project vessels will have open and closed drain systems to manage deck drainage and bilge water. Open drainage systems are expected to discharge wash water directly to sea. Wash water will comprise low toxicity cleaning chemicals (Offshore Chemical Notification Scheme (OCNS) category D or E/Gold or Silver) and trace amounts of hydrocarbons or other chemicals. Rainfall will also be partially diverted through open drain systems.

Closed drain systems include the engine room. Liquids entering closed drain systems are diverted to oily water separation tanks. Following separation, water with oil in water content of less than 15 parts per million (ppm) is planned to be discharged overboard in accordance with MARPOL 73/78 Annex I. Oily waste material produced by this process is diverted to a dedicated holding tank to be disposed of onshore, in accordance with the Shell HSSE & SP Control Framework.

Only small volumes of deck drainage runoff and bilge water are expected during the Factory 3D MSS. Due to these low expected volumes, any discharged run-off is likely to rapidly dilute and disperse.

6.2.1.2. Impact Assessment

Deck drainage and bilge water have the potential to impact the marine environment through acute or chronic toxicity, oxygen depletion or salinity stress. The water quality in the immediate vicinity of each project vessel will be impacted during deck drainage and bilge water discharge, which has the potential to create surface sheens and localised reduction in water quality. Impacts will be short-term given discharge volumes will be relatively small and will readily dilute and disperse in the open ocean environment.

A whale shark and pygmy blue whale migration BIA overlaps the OA, however, only few individuals are expected to transit through the area, mainly during their northern migration from July and November (whale sharks) and March to June (pygmy blue whales). A small portion of the internesting BIA for green turtles around Cartier Island also overlaps the OA. Green turtles nest year-round in the area so may be present within this area of the OA at any time. Pollution and chemical discharge are key threats to whale sharks, pygmy blue whales and green turtles as well as other threatened and migratory marine mammals, marine turtles, and birds in Australia (Commonwealth of Australia 2017a; DEH 2005a; DEWHA 2008b; DEWHA 2009a; DEWHA 2009b; DoE 2014c; DoE 2014d; DoE 2015c; DoE 2015c; DoE 2015e; DoE 2015l; DoE 2015m; DoE 2016a; DoE 2016b; DoE 2016c; DoE 2016d; DoE 2016e; DSEWPaC 2011a; DSEWPaC 2013b). Individual animals (particularly whales, turtles, seabirds, rays and offshore dolphins) may transit through the OA and past project vessels as deck drainage or treated bilge water is being discharged. However, no adverse ecological effects are anticipated because of the low volumes and concentration of contaminants, the rapid dilution and dispersion of the discharges in the open ocean environment and the treatment standard for bilge water, as well as the lack of critical habitats and low abundance of fauna expected within the OA.

The OA overlaps one shallow feature, Heywood Shoal. Given the duration of the Factory 3D MSS, the small volumes and low concentrations of contaminants and the rapid dilution and dispersion of discharges, no impacts to this receptor are expected.

Table 6-2 – Risk Assessment for Discharge of Deck Drainage and Bilge Water

Project Component/ Activity y	Environmental Value/Sensitivity				Evaluation – Planned		
	Physical Environment	Threatened species and ecological communities	Ecosystems, communities and habitats	Socio-economic and cultural environment	Magnitude	Sensitivity	Residual Impact
Discharge of deck drainage and bilge water	X	-	-	-	Slight	Medium	Slight

Requirements, Control Measures, Environmental Performance Standards and ALARP Assessment
For details of the requirements that apply to the activity, adopted control measures, environmental performance standards and ALARP assessments applicable to this event, please refer to Appendix A.

Demonstration of Acceptability	
Principles of ESD	The risks and impacts from deck drainage and bilge water are consistent with the principles of ESD based on: • The environmental values/sensitivities within the OA are not expected to be significantly impacted; • The health, diversity and productivity of the environment is not expected to decrease; and • Biological diversity and ecological integrity is not expected to be significantly impacted.

Summary of Acceptability

The residual impact on water quality associated with deck drainage and bilge water discharge from project vessels during the survey is slight given the application of the controls outlined above and the following points:

- Regulatory requirements are incorporated;
- The survey is consistent with Shell policy, standards and culture;
- Good practice developed from Shell's global vessel operations, industry guidelines and practical mitigations to reduce the risk associated with deck drainage and bilge water will be implemented; and
- No stakeholder concerns have been raised.

The potential impacts of discharges are not considered to pose any risk to the values of any receptors identified in **Section 5**.

The residual level of impact and risk is considered acceptable.

6.2.2. Discharge of Treated Sewage, Grey-water and Putrescible Waste from Project Vessels

6.2.2.1. Environmental Aspects Arising from the Activity

Project vessels will generate sewage, grey-water and putrescible waste (i.e. food scraps). The survey vessel has accommodation for up to 70 persons. It is anticipated there will be a total of approximately 20,000 litres per day of domestic discharges, including sewage, grey water and kitchen (putrescible) scraps. Support vessels will typically be manned by 10 people, with estimated discharges of 3,000 litres per day of domestic discharges.

6.2.2.2. Impact Assessment

Disposal of domestic wastewater and putrescible wastes to the ocean may cause some temporary, localised nutrient enrichment of the surface waters surrounding the discharge point. Due to the rapid dilution in an open ocean environment and the high biodegradability/ low persistence of the wastes, any potential impacts to water quality are expected to be highly localised, temporary and slight.

A whale shark and pygmy blue whale migration BIA overlaps the OA, however, only few individuals are expected to transit through the area, mainly during their northern migration from July and November (whale sharks) and March to June (pygmy blue whales). A small portion of the internesting BIA for green turtles around Cartier Island also overlaps the OA. Green turtles nest year-round in the area so may be present within this area of the OA at any time. Pollution and chemical discharge are key threats to whale sharks, pygmy blue whales and green turtles as well as other threatened and migratory marine mammals, marine turtles, and birds in Australia (Commonwealth of Australia 2017a; DEH 2005a; DEWHA 2008b; DEWHA 2009a; DEWHA 2009b; DoE 2014c; DoE 2014d; DoE 2015c; DoE 2015c; DoE 2015e; DoE 2015l; DoE 2015m; DoE 2016a; DoE 2016b; DoE 2016c; DoE 2016d; DoE 2016e; DSEWPaC 2011a; DSEWPaC 2013b). Individual animals (particularly whales, turtles, seabirds, rays and offshore dolphins) may transit through the OA while project vessels are present. However, no adverse ecological effects are anticipated given the short duration of the Factory 3D MSS, low volumes and localised nature of discharges, and the solubility and dispersion properties of the treated wastes which will rapidly dilute and naturally attenuate.

The OA overlaps one shallow feature, Heywood Shoal. Given the duration of the Factory 3D MSS, the small volumes and low concentrations of contaminants and the rapid dilution and dispersion of discharges, no impacts to this receptor are expected.

Table 6-3 – Risk Assessment for Discharge of Treated Sewage, Grey-water and Putrescible Waste

Project Component/ Activity	Environmental Value/Sensitivity				Evaluation – Planned		
	Physical Environment	Threatened species and ecological	Ecosystems, communities	Socio-economic and cultural environment	Magnitude	Sensitivity	Residual Impact
Discharge of sewage, grey-water and putrescibles from Project vessels	X	-	-	-	Slight	Medium	Slight
Requirements, Control Measures, Environmental Performance Standards and ALARP Assessment							
For details of the requirements that apply to the activity, adopted control measures, environmental performance standards and ALARP assessments applicable to this event, please refer to Appendix A.							
Demonstration of Acceptability							
Principles of ESD	The impacts from discharge of treated sewage, greywater and putrescible waste from project vessels are consistent with the principles of ESD based on: • The environmental values/sensitivities within the OA are not expected to be significantly impacted; • The health, diversity and productivity of the environment is not expected to be significantly impacted; and						

	• Discharges are not expected to decrease biological diversity and ecological integrity.

Summary of Acceptability
The residual impact on water quality associated with discharge of treated sewage, greywater and putrescible waste from project vessels during the survey is slight given the application of the controls outlined above and the following points: • Regulatory requirements are incorporated; • The survey is consistent with Shell policy, standards and culture; • Good practice developed from Shell's global vessel operations, industry guidelines and practical mitigations to reduce the risk associated with the discharge of treated sewage, greywater and putrescible waste have been undertaken; and • No stakeholder concerns have been raised. The potential impacts of discharges are not considered to pose any risk to the values of any receptors identified in section 5. The residual level of impact and risk is considered acceptable.

6.3. Light Emissions

6.3.1. Light Emissions from Project Vessels

6.3.1.1. Environmental Aspects Arising from the Activity

Project vessels will be lit on a 24-hour basis to maintain operational safety and navigation requirements as outlined in the OPGGS Act and the Commonwealth *Navigation Act 2012*. Artificial light from activities associated with the Factory 3D MSS will result in light spill to the surrounding marine environment. Existing sources of light near the OA are limited to vessel movements and oil and gas development activities, with these resulting in temporary illumination. Therefore, the baseline illumination of the OA is predominantly from starlight and the lunar phase and cycle.

The amount of light spill generated in the OA from project vessels will be dependent on the number of light sources, the wavelength and intensity of the light sources, the location and/or placement of light fittings and the method of light switching.

6.3.1.2. Impact Assessment

Threatened Species and Ecological Communities

The presence of artificial lighting associated with activities during all phases of the Factory 3D MSS has the potential to impact marine fauna and birds, particularly those that use visual cues for orientation, navigation, or other purposes. Potential impacts from artificial lighting may include:

- disorientation, attraction or repulsion;
- disruption to natural behavioural patterns and cycles; and
- secondary impacts such as increased predation and reduced fitness.

Marine Reptiles

Although the OA contains no emergent features, one shallow feature (Heywood Shoal) is located within the OA. Marine turtles may occur around Heywood Shoal while foraging or during internesting periods.

Cartier Island lies approximately 9 km from the OA boundary, within the EMBA. Also within the EMBA, Ashmore Reef, Browse Island and Scott Reef lie approximately 52 km north-west, 67 km south and 60 km south-west from the OA, respectively. These islands and reefs are recognised nesting and foraging areas for marine turtles, specifically for green and hawksbill turtles (Commonwealth of Australia 2017a).

Five BIAs for green and hawksbill turtles overlap the EMBA at Ashmore Reef and Cartier Island (nesting, internesting, internesting buffer, and foraging BIA), with one internesting BIA for green turtles overlapping the OA at Cartier Island (**Figure 3-21**). Nesting BIAs for green and hawksbill turtles occur at Ashmore Reef within the EMBA. Green and hawksbill turtles nest year-round in the area, with peak nesting between December and November (green turtles) and October to January (hawksbill turtles). Refer to **Section 3.4.3.2** and **Section 3.4.3.6** for additional information.

Light pollution on nesting beaches can alter nocturnal behaviours in adult and hatchling turtles. Artificial lighting can disrupt or affect the choice of nesting location by female turtles, particularly light visible on the landward side of nesting beaches (Salmon 1992). Turtle hatchlings leaving nesting beaches are particularly sensitive to artificial lighting as they use celestial cues to orientate (Limpus 1997, Salmon *et al*. 1992). Once in the water, marine turtle hatchlings may still use celestial lights as navigational markers during oceanic migrations and are known to be attracted towards bright lights. Hatchlings can become disorientated and trapped within light spill around platforms and vessels, resulting in increased energy expenditure, increased predation and decreased survival rates.

Extensive light attraction studies have been conducted on turtle hatchlings, including at Barrow Island (Pendoley 2005). These studies demonstrated that hatchlings crawl away from tall, dark horizons (sand dunes and vegetation) towards lower and lighter horizons (the sea and stars), and that artificial lighting can alter this response. Studies have demonstrated that when on land, hatchlings are not significantly affected by artificial light at a distance of 800 m (Pendoley 2005). Once in the water, hatchling navigation is understood to be influenced predominantly by wave motion, currents and the earth's magnetic field.

Artificial lighting is a key threat to threatened and migratory marine turtles in Australia (Commonwealth of Australia 2017a, DEWHA 2009a). Given the distance to the nearest emergent land is 9 km (Cartier Island) there is a potential for light from vessels to reach Cartier Island, however, it is unlikely to disturb any hatchling turtles which need to be within approximately 500 to 1000 m of a vessel to become attracted to the light (Pendoley 2015).

Adult turtles passing through the OA during internesting periods or while foraging may temporarily alter their normal behaviour whilst attracted to the light spill from project vessels, however, there is no published evidence to suggest internesting turtles are impacted by light from offshore vessels (Pendoley 2015, Witherington and Martin 2003) therefore impacts are not expected to be significant.

Birds

Studies conducted in the North Sea confirmed that artificial light was the reason that seabirds were attracted to and accumulated around lit offshore infrastructure (Marquenie *et al*. 2008) and that lights can attract birds from large catchment areas (Wiese *et al*. 2001). Seabirds may be attracted by the light source itself or indirectly as structures in deep water environments tend to attract marine life at all trophic levels, creating food sources and shelter for seabirds. The light from large vessels may also provide enhanced capability for seabirds to forage at night. Negative potential impacts to seabirds attracted by artificial lighting are limited but include collisions with infrastructure and alteration of normal behaviours.

Migratory birds are thought to use the Earth's magnetic field as a reference when undertaking migrations (Archer 2017, Chernetsov 2016, Chernetsov *et al*. 2017, Heyers *et al*. 2017), although may rely on other cues such as visual cues for shorter-range movements. Light from offshore platforms in the North Sea have been shown to attract migrating birds and birds that migrate during the night are especially affected (Verheijen 1985). Light from project vessels during the Factory 3D MSS may potentially attract migratory birds, however given the Earth's magnetic field is the primary navigation cue, it is not expected to have any influence on large-scale bird migrations.

Fourteen listed threatened and/or migratory birds species were identified to occur within the OA, with an additional 13 species identified as potentially occurring within the EMBA. Ten of these species have BIAs overlapping the EMBA, five of which extend into the OA (**Section 3.4.3.2**). The BIAs are mainly situated around Ashmore Reef and Cartier Island, which comprise resting habitat as well as important foraging areas for shorebirds and support large populations of seabirds (Commonwealth of Australia 2002).

Given the location of the OA and EMBA there is a potential for impacts from lighting to birds, particularly during migratory or nesting periods. Any behavioural disturbances such as disorientation, attraction and/or exhaustion are considered to be slight given the short duration of the survey. Impacts may potentially affect a small proportion of individual birds, however, are not expected to result in any population level effects on even a local scale.

Other Fauna

Fish and zooplankton may be directly or indirectly attracted to lights. 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 (Milicich *et al*. 1992). Lindquist *et al*. (2005) concluded from a study of larval fish populations around an oil and gas platform in the Gulf of Mexico that an enhanced abundance of clupeids (herring and sardines) and engraulids (anchovies), both of which are highly photopositive, was caused by platform light fields. The concentration of organisms attracted to light results in an increase in food source for predatory species and marine predators are known to aggregate at the edges of artificial light halos.

Shaw *et al*. (2002), in a similar light trap study, noted that juvenile tunas (Scombridae) and jacks (Carangidae), which are highly predatory, may have been preying upon concentrations of zooplankton attracted to the light field of the platforms.

The OA overlaps a foraging BIA for whale sharks which covers their migration route northward from Ningaloo Reef along the 200 m isobath. Whale sharks feed on planktonic and nektonic species, and therefore, there is a potential for individuals to be indirectly attracted to project vessels. Other shark and ray species, as well as commercially important fish species are also expected to occur in low numbers within the OA and may be attracted to a higher abundance of prey species around project vessels. Impacts to fish species will be restricted to a small number of individuals in proximity to project vessels at night and will not result in population level impacts.

Any impacts arising from light emissions to fish, zooplankton and other fauna are considered to be slight.

Table 6-4 – Risk Assessment for Light Emissions from Project Vessels

Environmental Aspect	Environmental Value/Sensitivity				Evaluation – Planned		
	Physical Environment	Threatened species and ecological communities	Ecosystems, communities and habitats	Socio-economic and cultural environment	Magnitude	Sensitivity	Residual Impact
Light emissions from project vessels	-	X	-	-	Slight	Medium	Slight

Requirements, Control Measures, Environmental Performance Standards and ALARP Assessment
For details of the requirements that apply to the activity, adopted control measures, environmental performance standards and ALARP assessments applicable to this event, please refer to Appendix A.

Demonstration of Acceptability	
Principles of ESD	The risks and impacts from light emissions from the survey are consistent with the principles of ESD based on: The environmental values/sensitivities within the OA are not expected to be significantly impacted; and Significant impacts on the health, diversity, productivity and ecological integrity of the environment are not expected to occur.

Summary of Acceptability
The residual impact on fauna of conservation significance associated with light emissions from project vessels is slight given the application of the controls outlined above and the following points: • The minimal disruption posed by light emissions from project vessels; • Regulatory requirements and Shell standards are incorporated; • The survey is consistent with Shell policy, standards and culture; • Good practice developed from Shell's global vessel operations, industry guidelines and practical mitigations to reduce the risk associated with the physical presence of the project vessels have been undertaken; and • No stakeholder concerns have been raised. The potential impacts of emissions are not considered to pose any risk to the values of any receptors identified in section 5. The residual level of impact and risk is considered acceptable.

6.4. Atmospheric Emissions

6.4.1. Atmospheric Emissions from Fuel Combustion and Ozone Depleting Substances (ODS)

6.4.1.1. Environmental Aspects Arising from the Activity

The main source of atmospheric emissions from project vessels is the combustion of liquid fuel in the energy units (diesel-powered generators and pumps, emergency generator, vessel engines etc.). Atmospheric emissions from fuel combustion may include sulphur dioxide (SO_2), nitrogen oxides (NO_x), carbon dioxide (CO_2), carbon monoxide (CO), volatile organic compounds (VOC) and particulates. ODS may be found onboard project vessels in old air-conditioning and refrigeration systems.

6.4.1.2. Impact Assessment

The release of emissions to the atmosphere temporarily decreases local air quality and contributes to greenhouse gas (GHG) emissions. While emissions of GHG will add to global GHG concentrations, the volumes from the Factory 3D MSS are very small, comparable to emissions from commercial ships and are not considered to have a determinable local-scale impact. Due to the short duration and small scale of the Factory 3D MSS, low sensitivity of the receiving environment subject to local and regional air quality changes (absence of receptors in the open offshore context) and the open ocean environment in which air emissions are quickly dispersed, the impact of the additional pollutants is slight.

Table 6-5 – Risk Assessment for Fuel Combustion and ODS

Environmental Aspect	Environmental Value/Sensitivity				Evaluation – Planned		
	Physical Environment	Threatened species and ecological communities	Ecosystems, communities and habitats	Socio-economic and cultural environment	Magnitude	Sensitivity	Residual Impact
Atmospheric emissions from fuel combustion and ODS	X	-	-	-	Slight	Low	Slight
Requirements, Control Measures, Environmental Performance Standards and ALARP Assessment							
For details of the requirements that apply to the activity, adopted control measures, environmental performance standards and ALARP assessments applicable to this event, please refer to Appendix A.							
Demonstration of Acceptability							
Principles of ESD	The risks and impacts from atmospheric emissions during the survey are consistent with the principles of ESD based on: • The environmental resources within the OA are not expected to be significantly impacted; and • Significant impacts on the health, diversity, productivity and ecological integrity of the environment are not expected to occur.						
Summary of Acceptability							
The residual impact on the physical environment associated with atmospheric emissions from the Factory 3D MSS is slight given the application of the controls outlined above and the following points: • Regulatory requirements are incorporated; • The Factory 3D MSS is consistent with Shell policy, standards and culture; • Good practice developed from Shell's global vessel operations, industry guidelines and practical mitigations to reduce the risk will be implemented; and • No stakeholder concerns have been raised. The potential impacts of emissions are not considered to pose any risk to the values of any receptors identified in section 5. The residual level of impact and risk is considered acceptable.							

6.5. Acoustic Emissions (Seismic)

When the acoustic source array is operating, sound pulses will be generated at regular intervals, producing sound pulses of high-intensity low-frequency sound from the acoustic source array. Shell Australia will utilise two or three independent source arrays to generate acoustic pulses by alternatively discharging compressed air into the water column at ~6–7 seconds intervals. Note that both dual ('flip-flop') and triple ('flip, flop, flap') source arrays were assessed for acoustic emission impacts, as the seismic configuration had not been determined at that time because contracting and procurement was still in progress.

The Factory 3D MSS FPZ is identified as the area within which the acoustic source will be discharged at full power (during acquisition in the survey area and during run outs). Full power operation will only occur within the FPZ. There are no shoals located within the FPZ, Heywood Shoal is the closest shoal and is located 1.8 km from the boundary of the FPZ.

Within the SSZ, the acoustic source array will be 'ramped up' from the single smallest air gun, incorporating additional air gun units over the course of 30 minutes, until the source is operating at full power. The acoustic source may also be operated for brief periods elsewhere in the OA during maintenance, which may involve several discharges at less than 50% of the total array volume. However, no operation of the acoustic source array will occur at any level within the Acoustic Source Exclusion Zones surrounding Heywood Shoal and Cartier Island.

Heywood Shoal is located 1.8 km from the boundary of the FPZ. There are no other shoals within the FPZ or OA. The Acoustic Source Exclusion Zone surrounding Heywood Shoal excludes all water depths less than 70m and, therefore, excludes all shallow water areas where diverse and abundant benthic communities and associated site-attached fish assemblages may occur.

The Acoustic Source Exclusion Zone surrounding Cartier Island excludes any operation of the acoustic source within 7.32km of the green turtle internesting BIA and approximately 20km from the Cartier Island AMP.

6.5.1. Environmental Aspects Arising from the Activity

The environmental aspect associated with the Activity is the discharge of the seismic source array which generates of acoustic emissions (underwater noise).

When the acoustic source array is operating, sound pulses will be generated at regular intervals, producing sound pulses of high-intensity low-frequency sound from the acoustic source array.

For the purposes of assessing this impact, the important detail from the description of the activity is the total amount of acquisition days.

This aspect (discharge of the seismic source array) was raised during consultation with relevant persons that are relevant to the acoustic emissions impact assessment. No additional environmental aspects have been identified as a result of Shell's previous seismic activities.

<u>Sensitive Environmental Receptors with the Potential to Occur within the ensonified area)</u>

- Plankton
- Benthic Invertebrates, including commercial scampi species
- Fish, including commercial species
- Sharks
- Sea snakes
- Marine turtles
- Seabirds
- Dugong
- Cetaceans (Marine Mammals) - whales and dolphins
- Traditional Fisheries
- Marine Parks and Key Ecological Features

<u>Evaluation of Potential Environmental Sensitivities</u>

In relation to assessing the environmental impacts associated with acoustic emissions (seismic), this is best based on effects from a temporary ensonified area and its overlap with environmental values and sensitivities.

Due to the variables associated with predicting an ensonified area, Shell commissioned an independent acoustic study from a reputable expert organisation. The purpose of the study is to predict the extent of the ensonified area and the received sound levels at values and sensitivities within the environment. The prediction was based upon the discharge of the acoustic source array within the FPZ, noting that lower sound levels may also be produced for short periods within the SSZ or during maintenance tests in the OA.

The following values and sensitivities within the FPZ, OA and ensonified area may be exposed to acoustic emissions (seismic):

- Plankton
- Benthic Invertebrates
- Fish, including commercial species
- Sharks
- Seasnakes
- Marine turtles
- Seabirds
- Dugong
- Cetaceans (Marine Mammals) - whales and dolphins
- Traditional Fisheries
- Marine Parks and Key Ecological Features

Impact Thresholds Applied

The response of marine fauna to marine seismic survey sounds have the following ranges grouped in decreasing severity of effect:

- Mortality and potential mortal injury – physical injury that may result in the death of an individual.
- Impairment:
  - Permanent threshold shift (PTS) – a permanent reduction in the ability of an individual to perceive sound. Recovery is not expected to occur.
  - Recoverable injury – physical injury from which an individual is expected to recover;
  - Temporary threshold shift (TTS) – a temporary reduction in the ability of an individual to perceive sound. Recovery to a pre-exposure levels is expected to occur; and
  - Masking – no change in the ability for an individual to perceive sound, but biologically meaningful sounds may be “drowned out” by anthropogenic noise.
- Behavioural impacts – typically short-term behavioural responses such as avoidance, surfacing etc. Behaviour will return to normal following cessation of the anthropogenic noise.

Mortality

Immediate mortality and potential mortal injury effects are likely to be restricted to very short ranges and high sound intensities and are unlikely to occur for the majority of species, as the majority of free-swimming individuals will exercise avoidance manoeuvres well before they get within the ranges at which pathological effects may occur (McCauley *et al* 2000).

Shock waves produce severe pathological effects (such as mortality) at considerable ranges, which vary depending on charge size, and physical or biological factors. Airguns do not produce shock waves and the effects described for high explosives do not apply to them. Larson (1985) concluded from experiments with caged fish that mortality from high explosive shock waves only occurs when two criteria are met simultaneously: peak pressure is ≥ 2.75 x 105 Pa, and rise time and decay time is ≤ 1 ms. However, airguns do not meet these criteria and do not cause shock waves.

Impairment

When an individual experience a shift in their hearing threshold from permanent and irreversible damage caused by prolonged or repeated exposure to high sound levels, PTS occurs (Richardson *et al.* 1995). Scientifically measuring PTS is difficult and for ethical reasons not always possible, and thus in many cases TTS measurements / experiments are used to estimate conditions that may cause PTS (Henderson and Hamernik 1995). When an individual's hearing threshold is temporarily worsened during and immediately after an exposure event to a loud sound source, TTS occurs (Richardson *et al.* 1995). Temporary loss of hearing sensitivity (TTS) recovers after some period of time following the termination of the noise and results in temporary, but recoverable damage to the sensory cells of the inner ear involved in hearing (Smith *et al*. 2006). The extent (how many dB of hearing loss) and duration of the TTS may continue from minutes to days after the exposure (Hastings *et al*. 2005).

Thresholds

Impact thresholds were used to determine whether mortality/mortal injury, impairment or behavioural impacts from the discharge of the acoustic source were predicted. Impact thresholds for fauna groups were derived from scientific literature and published guidelines, including, but not limited to:

- Assessing the Impact of Marine Seismic Surveys on Southeast Australian Scallop and Lobster Fisheries. FRDC Project No 2012/008 (Day *et al*. 2016);
- EPBC Act Policy Statement 2.1 - Interaction Between Offshore Seismic Exploration and Whales (DEWHA 2008);
- Guidance for diver exposure to underwater sound in the frequency range from 500 to 2500 Hz (Parvin *et al*. 2002);
- Impact Statement for Marine Seismic Research Funded by the National Science Foundation (NSF 2011);
- Sound exposure guidelines for fishes and sea turtles: a technical report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI (Popper *et al*. 2014);
- Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (NOAA 2018); and
- Widely used marine seismic survey air gun operations negatively impact zooplankton (McCauley *et al.* 2017).

Impact thresholds used for the acoustic impact assessment are summarised in **Table 6-6**. Acoustic metrics presented in **Table 6-6** are as follows:

- dB PK
  - PK - Peak pressure level threshold
- SELss
  - per-pulse SEL - dB re 1 μPa2.s)
- SEL24h
  - 24 hour accumulation period for calculation SEL
- SELcum,
  - SELss+10log10(N)
    - for stationary piling driving and VSP activities, to apply it to transient seismic surveys is highly conservative. If the received SEL ss is approximately the same for all events, then the SEL cum can be estimated as SEL ss +10log 10 (N), where N is the number of impulsive events (Popper 2014).

Potential impacts from seismic source acoustic emissions on the various receptors, are described in **Sections 6.5.3** to **6.5.15**. The impact assessment for this aspect, which includes comparison of the impact thresholds in **Table 6-6** with the acoustic modelling results, is presented in **Section 6.5**.

Table 6-6 - Applied quantitative and semi-quantitative exposure criteria for assessing potential impacts

Receptor	Potential Impacts – Threshold Criteria				
	Mortality/Potential Mortal Injury	Impairment			Behavioural
		PTS	Recoverable Injury	TTS	
Plankton (eggs & larvae)	>210 dB SEL$_{cum}$[1] or >207 dB PK[1] 178 dB re 1μPa PK-PK[8]	NA	(N) Moderate[1] (I) Low (F) Low	(N) Moderate - tens of metres[1] (I) Low - hundreds of metres	(N) Moderate - tens of metres[1] (I) Low - hundreds of metres (F) Low – thousands of metres
Benthic invertebrates (crustaceans & molluscs)	ND	NA	202 dB PK-PK[2]	(F) Low – thousands of metres	(N) Moderate - tens of metres[1] (I) Low - hundreds of metres (F) Low – thousands of metres
Benthic invertebrates (sponges and corals)	ND	NA	226 PK[9]	(N) Moderate - tens of metres[1]	(N) Moderate - tens of metres[1] (I) Low - hundreds of metres (F) Low – thousands of metres
Fish including whale sharks (no swim bladder)	>219 dB SEL$_{cum}$[1] or >213 dB PK	ND	>216 dB SEL$_{cum}$[1] or >213 dB PK	>186 dB SEL$_{cum}$[1]	(N) High - tens of metres[1] (I) Moderate - hundreds of metres (F) Low - thousands of metres
Fish (swim bladder not involved in hearing)	>210 dB SEL$_{cum}$[1] or >207 dB PK[1]	ND	>203 SEL$_{cum}$[1] or >207 dB PK[1]	>186 dB SEL$_{cum}$[1]	(N) High - tens of metres[1] (I) Moderate - hundreds of metres (F) Low - thousands of metres
Fish (swim bladder involved in hearing)	>207 dB SEL$_{cum}$[1] or >207 dB PK[1]	ND	>203 SEL$_{cum}$[1] or >207 dB PK[1]	>186 dB SEL$_{cum}$[1]	(N) High - tens of metres[1] (I) High - tens of metres (F) Moderate - hundreds of metres
Elasmobranchs (sharks, rays and skates)	>219 dB SEL$_{cum}$[1] or >213 dB PK	ND	>216 dB SEL$_{cum}$[1] or >213 dB PK	>186 dB SEL$_{cum}$[1]	(N) High - tens of metres[1] (I) Moderate - hundreds of metres (F) Low - thousands of metres
Turtles	>210 dB SEL$_{cum}$[1] or >207 dB PK[1]	ND	(N) High[1] (I) Low (F) Low	(N) High[1] (I) Low (F) Low	>166 dB SPL[6]
Dugong (Sirenians)	NA	226 dB PK[4] 190 dB SEL24h[4]	ND	220 dB PK[4] 175 dB SEL24h[4]	160 dB SPL[5]
Low-Frequency (LF) cetaceans	NA	219 dB PK[3] 183 dB SEL24h	ND	213 dB PK[3] 168 dB SEL24h[3]	160 dB SPL[5]
Mid-Frequency (MF) cetaceans	NA	230 dB PK[3] 185 dB SEL24h[3]	ND	224 dB PK[3] 170 dB SEL24h[3]	160 dB SPL[5]
High-Frequency (HF) cetaceans	NA	202 dB PK[3] 155 dB SEL24h[3]	ND	196 dB PK[3] 140 dB SEL24h[3]	160 dB SPL[5]
Divers	NA	NA	NA	NA	145 dB SPL[7]

Notes:
NA – not applicable; ND – no data;
(N) – near distance from source; (I) Intermediate distance from source; (F) – far distance from source;
High, Moderate and Low - relative risk levels.

Threshold criteria:
1 – Popper *et al.* (2014), Table 7.4;
2 – Day *et al.* (2016);
3 – NMFS (2016) – Table 4;
4– NMFS (2016) – Table AE-1;
5 - NMFS (2013);
6 – NSF (2011);
7 - Parvin *et al.* (2002);
8 – McCauley *et al.* (2017);
9 – Heyward *et al*. (2018

6.5.2. Background to Acoustic Emissions (Seismic) and Acoustic Modelling

Marine seismic surveys use seismic source arrays to produce high intensity, low frequency impulsive sounds at regular intervals. The aim of a seismic survey is to direct the seismic sound energy downwards towards the sea floor, however some energy radiates at angles close to horizontal, potentially propagating sound energy over long distances (Laws and Hedgeland 2008). The rate at which the sound energy attenuates with distance from the source is dependent on the oceanography, bathymetry and seabed properties of the area (Urick 1983).

The prediction of impacts from the discharge of the acoustic source array presented in the following sections has been based on information sourced from a number of scientific literature publications. Underwater sound levels are typically reported as a number of dB with a reference level of 1 micro-Pascal (µPa). However, the dB number can represent multiple types of measurements, including zero-to-peak pressure (0-pk, or PK), peak-to-peak pressure (pk-pk), root-mean-square (rms) and sound pressure level (SPL; dB re 1 µPa). It is not uncommon to find reports and even peer-reviewed papers on the effects of underwater noise sources that fail to specify if the sound levels values refer to the pk-pk, 0-pk or SPL measure of the waveform amplitude, or whether it is measured or estimated for the source or the receiver.

Acoustic intensity is a more appropriate measure of sound exposure than SPL because the former takes into account the overall acoustic energy impinging on marine fauna per unit area. Sound Exposure Level (SEL) is the time-integrated squared sound pressure and is expressed as dB re 1 $\mu Pa^2.s$. Because SEL units take account of pulse duration, they provide the best way to compare source and/or received sound energies from activities such as seismic surveys. Often, it is not possible to determine if received levels quoted in the literature are SPL or SEL. Unless precise measurement types are reported, it can be impossible to directly compare results from two or more independent studies.

Site-Specific Acoustic Modelling

To understand the underwater acoustic noise that may be generated by the Factory 3D MSS, Shell Australia commissioned JASCO Applied Science (JASCO) to undertake a noise modelling study that predicted underwater sound levels associated with two potential seismic sources proposed for the survey (3,480 in^3 and 3,460 in^3) to determine the loudest configuration. "The source with the loudest far-field source level specifications is the 3,480 in^3 source, therefore, this was selected for consideration in the propagation modelling" (**Appendix D**; McPherson *et al*. 2019).

In order to achieve a high level of accuracy for the acoustic risk assessment, the JASCO airgun model was used to account for the spatial configuration of the sources in the array (refer **Appendix D**).

As described in McPherson *et al* (2019), JASCO's Airgun Array Source Model (AASM) produces a set of "notional" signatures for each array element based on the:

- Array layout;
- Volume, tow depth, and firing pressure of each airgun; and
- Interactions between different airguns in the array.

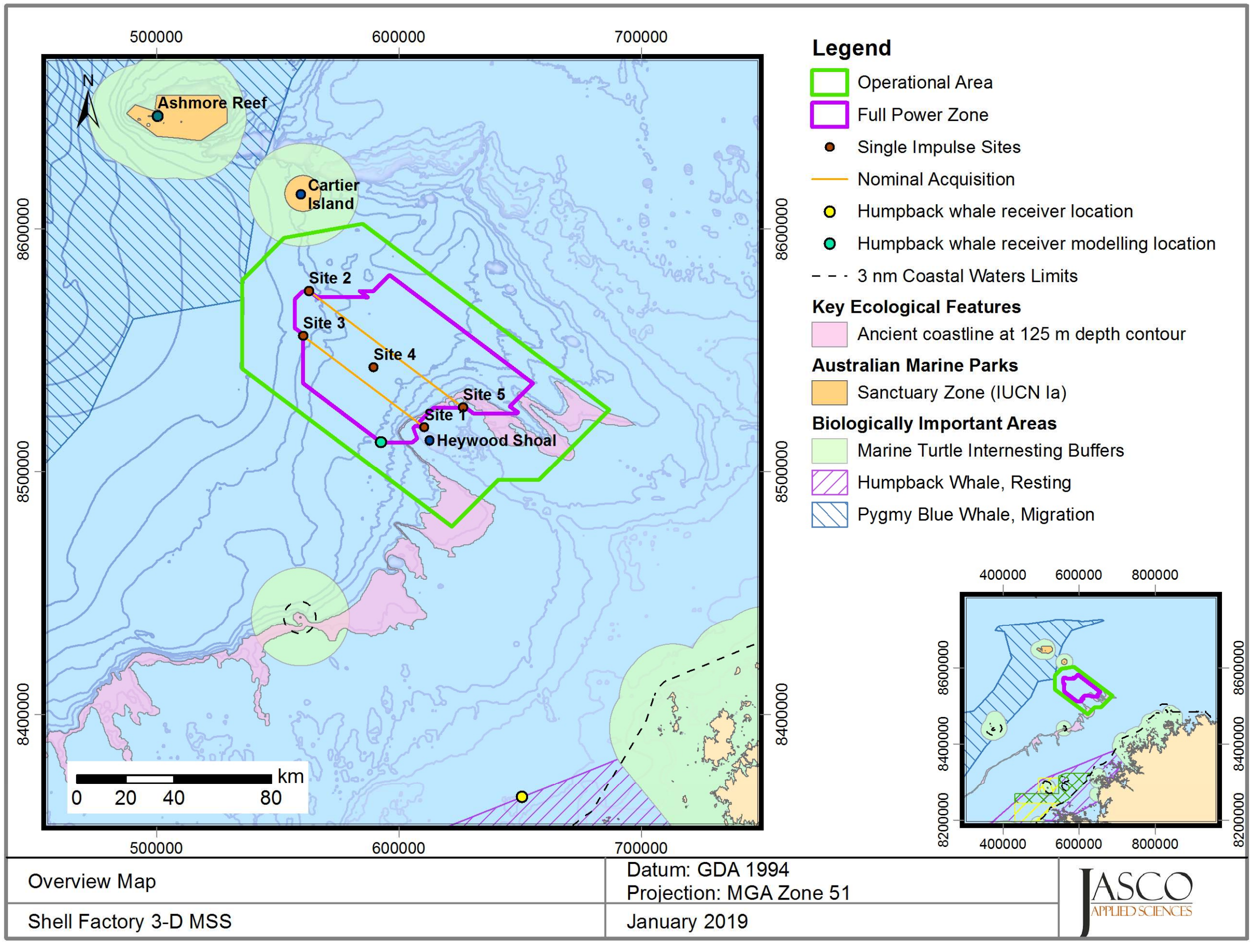
To increase accuracy, the modelling undertaken by JASCO also incorporates an analysis of seasonal sound speed profiles and accounts for site-specific bathymetric variations and local geoacoustic properties (McPherson *et al* 2019).

JASCO modelled the received sound fields associated with the 3,480 in^3 acoustic array volume at five site locations within the Factory FPZ (**Table 6-7**; **Figure 6-3**). Representative acoustic modelling sites were chosen to represent a range of environmental values and sensitivities within and adjacent to the FPZ and were based on the following criteria:

- Within the Factory 3D MSS FPZ;
- Closest proximity to sensitive habitats or protected areas (i.e. BIAs, AMP, KEFs, shoals, fisheries); and
- Shallow and deep-water depths represented.

Single impulse sound fields were also generated at fixed receiver locations relevant to the Kimberley humpback whale calving BIA, and at Ashmore Reef for relevance to potential diver exposure (**Table 6-8**). The source location for the humpback whale receiver was considered independently of other modelling scenarios and was chosen to be the closest point to the relevant receiver within the OA.

Figure 6-3 shows the location of the five acoustic modelling sites, the two humpback whale receiver and modelling locations, the diver receiver and modelling locations (Ashmore Reef and Site 2) and the key environmental features used to assist with selecting the modelling sites.



Source: modified from JASCO.

Note: Small green dots on Ashmore Reef, Cartier Island and Heywood Shoal are locations and not acoustic modelling sites.

Figure 6-3 - Location of Acoustic Modelling Sites

Table 6-7 –Location details of Factory 3D MSS acoustic modelling sites

Site	Site Name	Water depth (m)	Tow Direction (°)	Location Latitude (E)	Location Longitude (S)	Sensitivities	Distance to Sensitivity (~km)
1	Heywood Shoal South Shallow (HSS)	102	126.8	13° 24' 01.0465"	124° 01' 11.2809"	Heywood Shoal	1.8 km
						Whale shark migration BIA	Overlap
						Seabird foraging / breeding BIA	Overlap
						Humpback whale calving BIA	158 km
						KEF - Ancient Coastline at 125 m depth contour	4 km
						WA State Fishery - NDSF Area 2 Zone B	Overlap
						WA State Fishery - MMF Schedule 2 Area 1	Overlap
2	Cartier Island North Deep (CIN)	310.1	306.8	12° 53' 36.6888"	123° 34' 42.3622"	Seabird foraging / breeding BIA	Overlap
						Pygmy blue whale migration BIA	27 km
						Cartier Island AMP	33 km
						KEF - Continental Slope Demersal Fish Communities	Overlap
						KEF - Ashmore Reef and Cartier Island and surrounding Commonwealth waters	33 km
						WA State Fishery - NDSF Area 2 Zone C	Overlap
						WA State Fishery - MMF Schedule 2 Area 1	Overlap
						Commonwealth Fishery licence area - NWST	Overlap
3	Cartier Island South Deep (CIS)	315.4	126.8	13° 03' 37.7131"	123° 33' 23.2655"	Seabird foraging / breeding BIA	Overlap
						Pygmy blue whale migration BIA	30 km
						Continental Slope Demersal Fish Communities KEF	Overlap
						WA State Fishery - NDSF Area 2 Zone C	Overlap
						WA State Fishery - MMF Schedule 2 Area 1	Overlap
						Commonwealth Fishery licence area - NWST	Overlap
4	Mid-Point (MID)	223.4	126.8/306.8	13° 10' 37.5580"	123° 49' 30.3304"	WA State Fishery - NDSF Area 2 Zone C	Overlap
						WA State Fishery - MMF Schedule 2 Area 1	Overlap

Site	Site Name	Water depth (m)	Tow Direction (°)	Location		Sensitivities	Distance to Sensitivity (~km)
				Latitude (E)	Longitude (S)		
						Commonwealth Fishery licence area - NWST	Overlap
5	Heywood Shoal North Shallow (HSN)	107.6	306.8	13° 19' 28.9808"	124° 09' 59.2113"	Heywood Shoal	4 km
						Whale shark migration BIA	Overlap
						Seabird foraging / breeding BIA	Overlap
						Humpback whale calving BIA	157 km
						Ancient Coastline at 125 m depth contour KEF	1.9
						WA State Fishery - NDSF Area 2 Zone B	Overlap
						WA State Fishery - MMF Schedule 2 Area 1	Overlap

Table 6-8 – Factory 3D MSS Humpback whale and diver receiver locations and relevant modelling sites

Receiver Location	Location (MGA (GDA94), Zone 51)		Relevant Modelling Site (as shown in **Figure 6-3**)	Distance to (~km)
	Latitude(E)	Longitude (S)		
Camden Sound (humpback whale receiver location)	14° 46' 33.4502"	124° 23' 59.1400"	Humpback whale receiver modelling location	157.5
Ashmore Reef (diver receiver location)	12° 14' 32.8825"	123° 00' 16.9406"	Site 2	95.1

The underwater acoustic signatures of the two seismic sources (3,480 and 3,460 in^3) were modelled with JASCO's AASM (McPherson *et al*. 2019; **Appendix D**). Complementary underwater acoustic propagation models calculate sound levels at various distances using the modelled array signatures. Single-shot sound fields were predicted at each site (**Figure 6-3**). Accumulated sound exposure fields from a 24 hr operational scenario were computed for the survey lines closest to Heywood shoal (**Figure 6-4**).

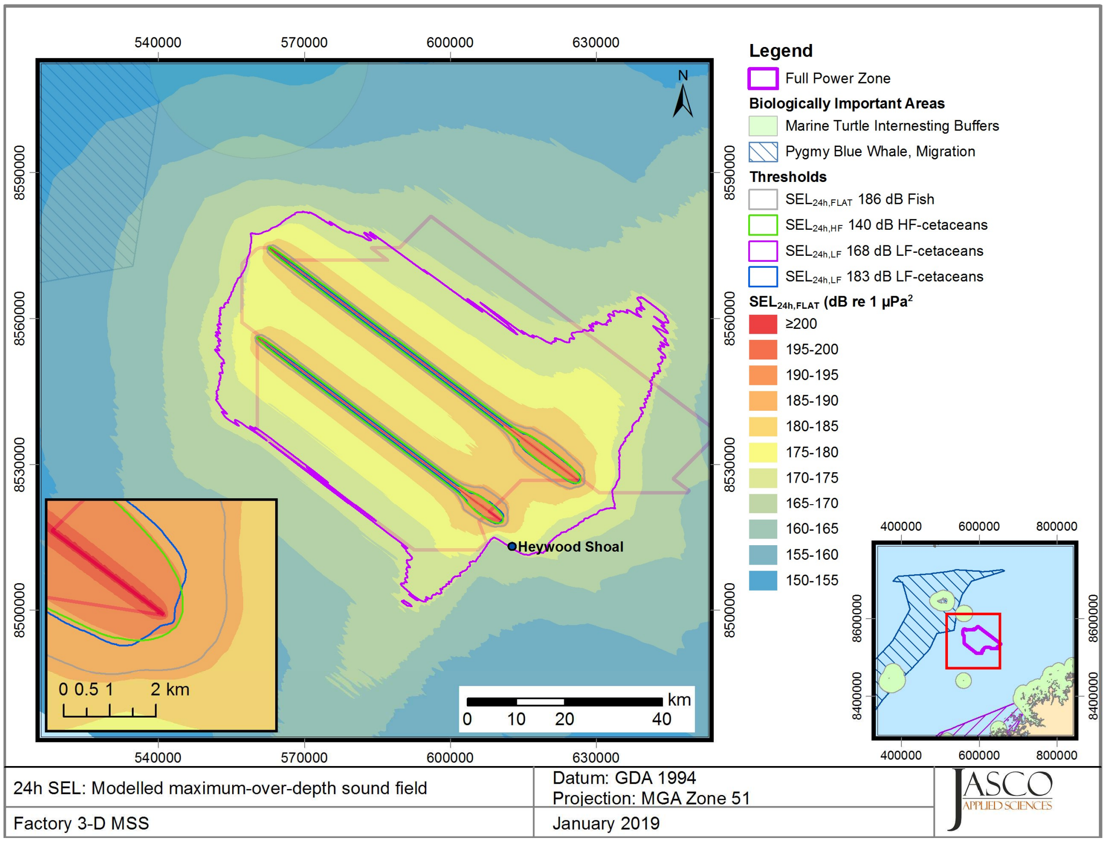


Figure 6-4 – Accumulated sound exposure fields from a 24 hr operational scenario

A single sound speed profile for July was considered in the modelling; this was identified as the seasonal period that was the most conducive to sound propagation, and as such it was selected to ensure a conservative estimation of distances to received sound level thresholds over the entire survey period (McPherson *et al.* 2019). The modelling methodology considered source directivity and range-dependent environmental properties at each site. The underwater acoustic modelling predicted the acoustic source levels, modelled the sound propagation and assessed distances to selected impact thresholds. Three sound propagation models were used to predict the acoustic field around the acoustic source array:

- Combined range-dependent parabolic equation and gaussian beam acoustic ray-trace model (MONM-BELLHOP, 10 Hz to 25 kHz).
- Full Waveform Range-dependent Acoustic Model (FWRAM, 10 Hz to 2 kHz).
- Wavenumber integration model (VSTACK, 5 Hz to 1 kHz).

Estimated underwater acoustic levels are presented as sound pressure levels (SPL, Lp), zero-to-peak pressure levels (PK, Lpk), peak-to-peak pressure levels (PK-PK; Lpk-pk), and either single-impulse (i.e., per-pulse) or accumulated sound exposure levels (SEL, LE) as appropriate for different noise effect criteria (**Appendix D**).

For each of the 5 sites, sound level contours were calculated using the modelled underwater sound fields sampled at (1) the sea floor or (2) as the maximum value over all depths. The predicted distances relative to the various sound thresholds were computed from these contours and are presented in **Table 6-9** and **Table 6-10**.

Two distances relative to the source are reported for each sound level:

- R_{max}, the maximum range to the given sound level over all azimuths; and
- $R_{95\%}$, the maximum range to the given sound level after the 5% farthest points were excluded.

It is important to understand that in some cases, a sound level contour might have small protrusions or irregular and remote fringes. In this case, the R_{max} can misrepresent the area exposed, and therefore $R_{95\%}$ is actually considered more representative. In other cases there may be bathymetric features which affect propagation that $R_{95\%}$ neglects to account for, and in this case R_{max} is a better representation of the region of effect. The difference between R_{max} and $R_{95\%}$ depends on source directivity and the non-uniformity of the acoustic environment (i.e. bathymetry). Shell Australia have adopted a conservative approach and have used the R_{max} distances for the Factory 3D MSS acoustic emissions impact assessment.

A reasonable approach for seismic surveys is to assume potentially impacted marine fauna stay in a fixed position whilst the seismic vessel approaches and passes, and most of the sound exposure accumulates when an individual is closest to the acoustic array (NMFS 2016). Therefore, an exclusion zone can be based on the distance away from the survey line at which an impact threshold is reached. In terms of acoustic impacts, the accumulated sound field was interpreted as the total sound energy that a potentially impacted individual at a given range and depth from the seismic source would experience if it did not move as the seismic source travelled past it.

For the Factory FPZ, the computed accumulated SEL scenario was based on all sound exposure events along a representative survey line which most closely approaches Heywood Shoal (approximately 1.8km; i.e. closest potential sensitive habitats for site-attached species such as the key commercially fished species of the NDSF).

Appendix D provides further details of JASCO's entire acoustic modelling methodology, including all model inputs, assumptions and environmental parameters (McPherson *et al*. 2017).

In-field Model Validation

Predictions from JASCO's AASM and propagation models (MONM, FWRAM and VSTACK) have been validated against experimental data from a number of underwater acoustic measurement programs conducted by JASCO globally, including the United States and Canadian Artic, Canadian and southern United States waters, Greenland, Russia and Australia (McPherson *et al*. 2019, **Appendix D**). In addition, JASCO has conducted measurement programs associated with a significant number of anthropogenic activities which have included internal validation of the modelling. Further details on JASCO's extensive field research and associated peer-reviewed publications are provided in **Appendix C** (McPherson *et al*. 2019).

Acoustic Modelling Results

The underwater sound fields for both arrays were modelled for water column speed profiles representative of July, which was selected to ensure precautionary estimates of distances to received sound level thresholds throughout an entire year (McPherson *et al.* 2019; **Appendix D**). The model produced estimates of the sound field generated during single airgun array shots at five sites and the 2 receiver locations across the survey area that represent different environmental conditions and to provide predictions of noise in the vicinity of selected BIAs (**Table 6-9**). The principal results for acoustic modelling are summarised in **Table 6-9** to Table 6-11. Analysis of these results for the impacted fauna are discussed in **Sections 6.5.3** to **6.5.14**.

The acoustic modelling study (McPherson *et al.* 2019; **Appendix D**) has examined maximum sound levels produced during full power operations. It is noted that the acoustic source may be operated from time-to-time at lower power levels, including during sort starts in the SSZ and brief maintenance testing of the source in the OA at less than 50% of the total array volume. Although the sound levels emitted during these discharges have not been modelled specifically, a single airgun may produce source levels in the order of 200 dB re 1 µPa (Jiménez-Arranz et al. 2017), increasing during ramp up and maintenance tests. In any case, the sound levels and impact radii produced by these lower power activities will be less than those produced during full power operations. In some case, thresholds for impacts such as mortality and potential mortal injury may not be exceeded at all.

Table 6-9 - Summary of distances to specific thresholds for Sites 1–5[6]

Acoustic Impact Criteria		Thresholds	Distance (SEL Rmax; SPL: Rmax; PK: Rmax; PK-PK: Rmax; km)				
			Site 1 - HSS ~102 m isobath	Site 2 - CIN ~310 m isobath	Site 3 - CIS ~315 m isobath	Site 4 - MID ~223 m isobath	Site 5 - HSN ~107 m isobath
ENTIRE WATER COLUMN							
Single shot threshold for cetaceans: EPBC Act Policy Statement 2.1. (DEWHA 2008). To assess the size of the low-power zone required under the Australian EPBC Act Policy Statement 2.1		Unweighted per-pulse SEL 160 dB re 1 µPa²·s	5.68	2.36	2.21	2.32	5.19
Marine mammal behaviour: U.S. National Marine Fisheries Service (NMFS) criterion (NMFS 2013).		SPL 160 dB re 1 µPa	9.73	8.00	7.94	7.69	10.06
Marine Mammal PTS NOAA Technical Guidance (NMFS 2018)	Low-frequency cetaceans	PK 219 dB re 1 µPa	0.02	0.02	n/a[7]	n/a	n/a
	Mid-frequency cetaceans	PK 230 dB re 1 µPa	<0.02	<0.02	n/a	n/a	n/a
	High-frequency cetaceans	PK 202 dB re 1 µPa	0.3	0.2	n/a	n/a	n/a
	Sirenians	PK 226 dB re 1 µPa	<0.02	<0.02	n/a	n/a	n/a
Marine Mammal TTS NOAA Technical Guidance (NMFS 2018)	Low-frequency cetaceans	PK 213 dB re 1 µPa	0.06	0.04	n/a	n/a	n/a
	Mid-frequency cetaceans	PK 224 dB re 1 µPa	<0.02	<0.02	n/a	n/a	n/a
	High-frequency cetaceans	PK 196 dB re 1 µPa	0.6	0.3	n/a	n/a	n/a
	Sirenians	PK 220 dB re 1 µPa	0.02	0.02	n/a	n/a	n/a
Turtle behaviour: U.S. National Marine Fisheries Service (NSF 2011).		SPL 166 re 1 µPa	7.32	3.17	3.17	3.53	7.09
Divers (Parvin 2005) Human health assessment threshold.		SPL 145 dB re 1 µPa	53.7	29.1	26.2	23.6	62.1
Plankton (McCauley et al 2017) Mortality threshold.		178 dB re 1µPa PK-PK	8.6	6.6	n/a	n/a	n/a
Fish, whale sharks, fish eggs and larvae, and turtles: Mortality and Potential mortal injury; Recoverable injury - to fish, whale sharks, fish eggs and larvae, and turtles: Sound Exposure guidelines for fish, Popper *et al.* (2014).		Fish (no swim bladder; also applies to sharks and whale sharks) injury: PK 213 dB re 1 µPa	0.06	0.04	n/a	n/a	n/a
		Fish (swim bladder involved in hearing, and not involved in hearing) injury: PK 207 dB re 1 µPa	0.2	0.1	n/a	n/a	n/a
		Turtles PK 207 dB re 1 µPa	0.2	0.1	n/a	n/a	n/a

[6] Results of the modelling study has been presented in terms of the noise criteria presented in **Table 6.11**, which have been chosen to include standard thresholds and thresholds suggested by the best available science, Source: modified from McPherson *et al.* 2019
[7] Not applicable – acoustic modelling for this particular threshold was not undertaken at sites with n/a

Acoustic Impact Criteria	Thresholds	Distance (SEL Rmax; SPL: Rmax; PK: Rmax; PK-PK: Rmax; km)				
		Site 1 - HSS ~102 m isobath	Site 2 - CIN ~310 m isobath	Site 3 - CIS ~315 m isobath	Site 4 - MID ~223 m isobath	Site 5 - HSN ~107 m isobath
	Fish eggs and larvae PK 207 dB re 1 µPa	0.2	0.1	n/a	n/a	n/a
SEAFLOOR						
Recoverable injury to sponges and corals: (Heyward *et al*. 2018)	Sponges and corals 226 dB re 1 µPa PK	-[8]	-	-	-	-
Recoverable injury to crustaceans: Payne *et al*. (2007)	Crustaceans 202 dB re 1 µPa PK-PK	0.637	0.430	0.434	0.523	0.634
Fish, whale sharks, fish eggs and larvae, and turtles: Mortality and Potential mortal injury; Recoverable injury Sound Exposure guidelines for fish, Popper *et al*. (2014).	Fish (no swim bladder; also applies to sharks and whale sharks) injury: PK 213 dB re 1 µPa	0.75	-	-	0.12	0.73
	Fish (swim bladder involved in hearing) injury, Turtles, Fish eggs and larvae PK 207 dB re 1 µPa	0.191	0.112	0.108	0.128	0.171

Source: modified from McPherson *et al*. (2019)

Table 6-10 - Summary of Humpback whale receiver location sound modelling

Receiver location	Distance (km)	Received SPL (Lp; dB re 1 µPa)	Received LF-weighted (Lp, LF; dB re 1 µPa)	Received SEL (LE; dB re 1 µPa²·s)
Camden Sound	157.5	113.1	112.7	104.1

Source: modified from McPherson *et al*. (2019)

[8] A "-" in the results the acoustic threshold was not exceeded at the site.

Table 6-11 - Summary of accumulated sound exposure fields from a 24-hr operational scenario

Acoustic Impact Criteria		Thresholds	Maximum-over-depth distances to SEL_{24h} (SEL Rmax; SPL: Rmax; PK: Rmax; PK-PK: Rmax; km)	
			R_{max} (km)	Area (km^2)
Marine Mammal PTS NOAA Technical Guidance (NMFS 2018)	Low-frequency cetaceans	SEL_{24h} 183 dB re 1 µPa	1.73	164.2
	Mid-frequency cetaceans	SEL_{24h} 185 dB re 1 µPa	-[9]	-
	High-frequency cetaceans	SEL_{24h} 155 dB re 1 µPa	-	-
	Sirenians	SEL_{24h} 190 dB re 1 µPa	-	-
Marine Mammal TTS NOAA Technical Guidance (NMFS 2018)	Low-frequency cetaceans	SEL_{24h} 168 dB re 1 µPa	38.0	4,198
	Mid-frequency cetaceans	SEL_{24h} 170 dB re 1 µPa	-	-
	High-frequency cetaceans	SEL_{24h} 140 dB re 1 µPa	1.66	219.7
	Sirenians	SEL_{24h} 175 dB re 1 µPa	-	-
Fish, sharks (inc. whale sharks), fish eggs and larvae, and turtles: Sound Exposure guidelines for fish, Popper *et al*. (2014).	Mortality and potential mortal injury	Fish (no swim bladder; also applies to sharks and whale sharks) injury:SEL_{24h} 219 dB re 1 µPa	0	0
		Fish (swim bladder not involved in hearing) injury: SEL_{24h} 210 dB re 1 µPa	0	0
		Turtles SEL_{24h} 210 dB re 1 µPa	0	0
		Fish eggs and larvae SEL_{24h} 210 dB re 1 µPa	0	0
		Fish (swim bladder involved in hearing) injury: SEL_{24h} 207 dB re 1 µPa	0.04	0.97
	Fish recoverable injury	Fish (no swim bladder; also applies to sharks and whale sharks) injury:SEL_{24h} 216 dB re 1 µPa	0	0
		Fish (swim bladder involved in hearing, and not involved in hearing) injury: SEL_{24h} 203 dB re 1 µPa	0.08	13.0
	Fish TTS	Fish (no swim bladder, swim bladder involved in hearing, and not involved in hearing) injury: SEL_{24h} 186 dB re 1 µPa	3.49	2.59

Source: modified from McPherson *et al*. (2019)

[9] - a DASH indicates the threshold was NOT reached -

6.5.3. Disturbance to Planktonic Organisms

Receptors

Plankton includes fish eggs and larvae and they are unable to swim against a current and cannot undertake evasive behaviours to avoid seismic arrays, they are mostly transported over large areas by currents and winds. Some forms of plankton are capable of independent movement and can swim vertically up and down in the water column to the rhythm of the sun (diel vertical migration; Berge *et al*. 2009).

For the Factory OA the following areas have been identified as potentially having increased plankton compared to surrounding waters, and are therefore considered planktonic receptors for potential acoustic emission impacts:

- Whale Shark migration BIA;
- Continental Slope Demersal Fish Communities KEF; and
- Heywood Shoal.

Other areas of potentially higher plankton concentrations in the wider region, outside of the OA, include surrounding reefs at Cartier Island and Ashmore Reef (Cartier Island is approximately 9 km from the OA), shoals such as Eugene McDermott Shoal (13 km from OA), Goeree Shoal (14 km from OA) and waters surrounding islands such as Browse Island (67 km from OA).

In addition to these areas of potentially increased plankton, the larvae of commercial fishing species are considered receptors; particularly demersal fish species which are targeted by the WA NDSF (**Section 4.3.3.1.4**) within the OA.

Receptor Sensitivity

Plankton are a diverse group of organisms defined by their pelagic habitat and inability to swim actively against a current. Some organisms form part of the plankton for only part of their life cycle, e.g. as eggs and larvae.

Larval fish species studied appear to have hearing frequency ranges similar to those of adults and similar acoustic startle thresholds (Popper *et al.* 2014). Swim bladders may develop during the larval stage and may render larvae susceptible to pressure-related injuries such as barotrauma. Effects of sound upon eggs, and larvae containing gas bubbles, is focused on barotrauma rather than hearing (Popper *et al*. 2014). Larval stages are often considered more sensitive to stressors than adult stages, but exposure to seismic sound reveals no differences in larval mortality or abundance for fish, crabs or scallops (Carroll *et al*. 2017).

<u>Impacts on plankton - spawning and fish stocks</u>

Commercial fish species targeted within the OA include both demersal species, such as Lutjanidae (snapper species), as well as pelagic species, such as Scombridae (mackerel species) and Carangidae (Trevallies and Jacks). Peak spawning periods for key target species in the WA commercial fisheries identified in Table 3-12 occur from September - May and therefore avoidance of all spawning periods is not achievable. It is also acknowledged that DPIRD consider fish stocks in the Kimberley area, particularly gold band snapper, to be fully allocated from a fishing sustainability perspective, therefore any additional risk could potentially impact long term sustainability.

As defined by DPIRD, (Table 3-12) demersal fish spawning periods are between 7-10 months. Demersal finish are broadcast spawners, are not limited by a geographical range, and spawn throughout their distribution range within the NWMR (rather than aggregating at specific locations; **Section 4.3.3.1.4**), which is a much larger area than the OA. Therefore, impacts on the demersal fishery stock are not likely to be significant at a population level.

Pelagic fish species spawning period occurs over a 5-month period and spawn around inshore reefs in the North Coast Bioregion, and therefore are not predicted to spawn within or in the vicinity of the OA.

Shark species spawning periods occur over a 4-month period and like demersal species, are not limited by a geographical range and spawn throughout their distribution range within the NWMR (rather than aggregating at specific locations; **Section 4.3.3.1.4**). Therefore, impacts on shark fishery stock are not likely to be significant at a population level.

Mortality / Mortal Injury

Studies of natural mortality of the larvae component of plankton show that natural losses are variable. Losses of pearl oyster larvae in the water column during the planktonic stage are extremely high, and <1% of the fertilised eggs actually survive the veliger stage (Southgate *et al.* 2008). It is during the pelagic phase that they are more likely to be impacted by seismic surveys. For a number of fish species, natural mortality of larvae is estimated at 5–15% per day.

Studies undertaken to understand the impacts to plankton from seismic surveys have found that acoustic emissions from seismic surveys cause plankton mortality. Recent studies undertaken by McCauley *et al.* (2017), conducted in temperate waters of south-east Tasmania, was the first large-scale field experiment on the impact of seismic activity on zooplankton. McCauley *et al.* (2017) provide three findings from the experiment to show that zooplankton were affected by the seismic source:

- the proportion of the mesozooplankton community that was dead increased two- to three-fold when compared to the controls;
- the abundance of zooplankton estimated by net samples declined by 64%; and
- the opening of a "hole" in the zooplankton backscatter observed via acoustics.

The study found that exposure to airgun noise (178 dB PK-PK) significantly decreased zooplankton abundance and increased the mortality rate from a natural level of 19% per day to 45% per day (on the day of exposure), and that these impacts were observed out to the maximum range assessed (1.2 km).

In western USA, trials of seismic air-gun emissions as a method to reduce the survival of non-native lake trout embryos produced high mortalities (of up to 100%), but only at close range (0.1 m). At distances of 2.7 m, mortalities did not differ from those of controls (Cox *et al.* 2012 as cited in NSW DPI 2014).

Excluding fish eggs, larvae and other minute planktonic organisms within a few metres of an airgun, McCauley (1994) concluded no planktonic organisms are likely to be affected significantly by acoustic array discharges. Sætre and Ona (1996) calculated that under the 'worst case' scenario, the number of larvae killed during a typical seismic survey was 0.45% of the population in the area surveyed. Consequently, the overall severity of seismic-induced mortality is so low compared to natural mortality that it can be considered to have an inconsequential impact on recruitment to fish stock populations.

Given the results of McCauley *et al* (2017) were inconsistent with previous studies, the International Association of Geophysical Contractors (IAGC) subsequently initiated an independent expert review of the paper by well-respected scientific institutions. The peer-review concluded that result of the study should be considered further, and that the data was not sufficient to support the conclusions of McCauley et al (2017).

The peer-review identified the following inconsistencies/ issues with the McCauley (2017) study:

- The sample size was inadequate;
- Water column movement data was insufficient to support the argument that there was a hole in the plankton field;
- Towed net and acoustic survey data disagree regarding zooplankton class size;
- The acoustic 'hole' indicating dead zooplankton may result from zooplankton which had swum to the bottom (10 m away based upon an observed dense acoustic scattering layer);
- Bottom sampling should have been conducted to address the issue of whether large zooplankton was present (i.e. killed or actively swum to the bottom);
- The wrong size nets were used and not towed correctly; and
- There is statistical error in the tow data.

The IAGC review has been shared with the authors of the McCauley et al. (2017) paper, and the authors have concurred with many of the shortcomings and evaluation identified by the independent reviewers (IAGC 2017). The IAGC (2017) review concluded that the results of McCauley *et al*. (2017) "patterns and trends, do not actually exist in the data, are of questionable scientific merit, and accordingly, must be subjected to more rigorous scientific study before being accepted as the "best available science" regarding the potential effects of seismic sound on zooplankton. Existing published studies demonstrating that any seismic effects on zooplankton occur only to tens of meters remain the best available science until the preliminary study by McCauley et al. (2017) can be properly replicated".

Furthermore, CSIRO (Richardson *et al*. 2017) performed a desktop study to critically review the methodologies and findings of the McCauley *et al.* (2017) study, and to simulate the large-scale impact of a seismic survey on zooplankton in the Northwest Shelf region, based on the mortality rate associated with airgun noise exposure reported by McCauley *et al.* (2017). The CSIRO study found that there was substantial impact of seismic activity on zooplankton populations on a local scale within or close to the survey area, however, on a regional scale the impacts were minimal and were not discernible over the entire Northwest Shelf Bioregion.

In terms of duration of plankton mortality / mortal injury impacts, the CSIRO study found that zooplankton biomass recovery time to pre-seismic levels within the survey area, and within 15 km of the survey area, was only three days after completion of the survey. Such a rapid recovery rate is due to fast growth rates of zooplankton, and the dispersal and mixing of zooplankton from both inside and outside of the impacted region (Richardson *et al.* 2017). The CSIRO study (Richardson *et al*. 2017) was based on a hypothetical 3D survey of 2,900 km^2 and over a 35-day period and is therefore applicable to the Factory 3D MSS impact assessment as the model was designed to predict impacts to plankton within the NWMR, and therefore the same region where the Factory 3D MSS will occur. Most importantly, the CSIRO study (Richardson *et al*. 2017) predicts zooplankton communities in the NWMR may start to recover before the completion of the survey.

The study also highlights which regions, water depths and seasons may have more impact on zooplankton populations. However, the study stresses that a detailed study of a particular region would be needed to quantify the spatial and temporal impacts in a particular region and season. Findings related to survey design are as follows:

- Surveys conducted in regions with dynamic ocean circulations are likely to have less net impact on zooplankton.
- Surveys conducted into or across prevailing currents would ensure zooplankton particles would be less likely to be impacted multiple times by a seismic source. Impact is less when the ocean currents carried zooplankton particles in the same direction as the seismic survey.
- Surveys conducted in regions off the shelf edge are less likely to have absolute impact, as zooplankton biomass is generally lower offshore.
- In seasons with lower zooplankton biomass is generally lower offshore (e.g. winter in temperate regions), there is likely to be less absolute impact, (although the same relative impact).
- Conducting the survey at night time instead of during the day would minimise impacts to zooplankton, as there are fewer zooplankton near the surface during the day. Due to vertical migration of zooplankton.

Whilst the studies described above (McCauley *et al.* 2017, Richardson *et al*. 2017, Larcombe *et al.* 2015, Southgate *et al.* 2008, Popper *et al.* in 2014, Cox *et al.* 2012, Sætre and Ona 1996) demonstrate that seismic acoustic emissions result in plankton mortality, the studies also show that the mortality is localised (restricted in extent) ranging from less than 2.7 m (Cox *et al.* 2012 as cited in NSW DPI 2014) to 1.2 km (McCauley *et al.* 2017).

Therefore, for completeness, the McCauley *et al* (2017) study has been considered in the assessment of potential impacts. However, the sound exposure guidelines for eggs/larvae mortality which have been established by the Working Group on the Effects of Sound on Fish and Turtles (Popper et al. 2014) and approved by the Accredited Standards Committee S3/SC 1 Animal Bioacoustics and accredited with the American National Standards Institute (ANSI) is the best available science to assess potential impacts on plankton communities

The Popper *et al.* (2014) threshold criteria indicate that for fish eggs and larvae, accumulated SEL levels >210 dB re 1 μPa^2·s or PK >207 dB re 1 μPa may incur mortality or potential mortal injury while individuals defined as "near" (within tens of metres) have a moderate risk of recoverable injury or TTS (**Table 6-6**). These predictions are based on work by Bolle *et al.* (2012) on pile driving signals, which have a faster rise time than seismic acoustic sources and therefore are more likely to cause injury.

Acoustic modelling sites potentially relevant to impacts on plankton and potential fish spawning locations (i.e. locations where fish eggs are released) are identified at Site 1, 2 and 4; **Figure 6-7**).

- Site 1, located at 102 m water depth within the Factory FPZ and is the closest point of approach (CPA) to Heywood Shoal and location of potential site-attached fish species.
- Site 2 located at 310 m water depth within the FPZ, is the CPA to Cartier Island reef system and also within the Continental Slope Demersal Fish Communities KEF where potential demersal fish spawning may take place.
- Site 4 located at 223 m water depth within the FPZ, is within the NWMR distribution range for commercially fished demersal and pelagic (shark) species.

Site 1 acoustic modelling predicted that the maximum horizontal distance from the 3,480 in^3 array to the injury threshold for fish eggs and larvae (Popper *et al.* 2014) was 200 m (**Table 6-9**). Site 2 acoustic modelling predicts the horizontal distance from the 3,480 in^3 array to the injury threshold for fish eggs and larvae is 100 m (Popper *et al*. 2014; **Table 6-9**). Therefore, the maximum range at which mortality or mortal injury may occur within the Factory FPZ is within a horizontal distance of less than 200 m from the source.

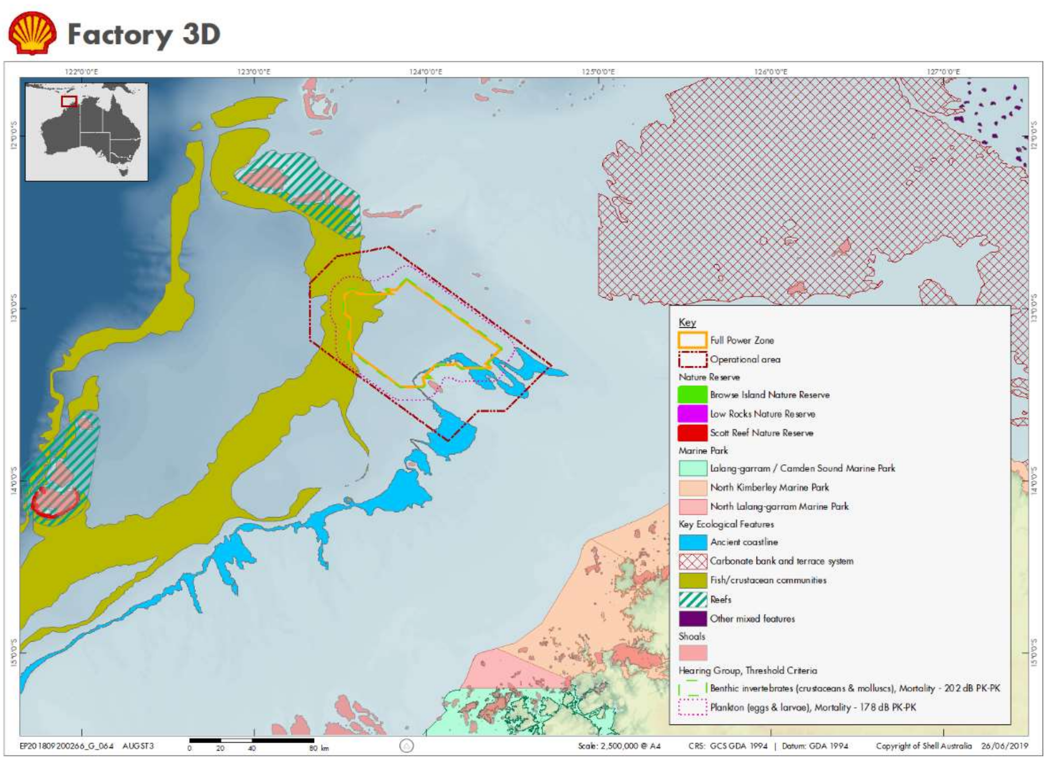


Figure 6-5 - Hearing Threshold Criteria for Invertebrates and Plankton and the Area from the FPZ where Thresholds are Exceeded

The modelling results are consistent with the findings of the studies described above, in that the results predict plankton mortality impacts will be localised. Therefore, mortality / mortal injury of plankton within the OA, including within areas of potentially higher plankton occurrence identified within the OA (whale shark migration BIA, Continental Slope Demersal Fish Communities KEF and Heywood Shoal) are expected to be localised. From the analysis of studies, mortality or mortal injury to plankton, including fish eggs and larvae, are expected to be short term based on estimated recovery times (three days). These potential impacts are not considered significant based on the following:

- Plankton (including fish eggs and larvae) are distributed over the entire water column within the survey area, they are not distributed evenly and exhibit substantial spatial patchiness and continually move with the currents;
- Zooplankton populations have a rapid recovery rate due to fast recruitment and growth rates, and dispersal and mixing of zooplankton from both inside and outside of the impacted area.
- 2017 CSIRO study identified that the time for the zooplankton biomass to recover from seismic levels inside the survey area, and within 15 km of the area, was only three days following the completion of the survey (Richardson *et al.* 2017).
- Any mortality or mortal injury impacts to fish eggs and larvae resulting from acoustic emissions are likely to be insignificant compared to natural mortality rates of fish eggs and larvae, which are very high (exceeding 450% per day in some species and commonly exceeding 10% per day; Sætre and Ona (1996).

Impairment / Behaviour

Popper *et al*. (2014) identifies there is a moderate risk of potential impairment (recoverable injury and TTS) or behavioural impact to fish eggs and larvae at locations near the source array (within tens of metres) and a low risk of impairment at intermediate distances (within hundreds of metres) of the source array. Therefore, potential impacts to plankton are not expected to be significant at the population level (**Table 6-6**).

Similarly, based on the application of the Popper *et al*. (2014) semi-quantitative exposure criteria (**Table 6-6**) there is a moderate risk of behavioural effects to larvae within tens of metres of the source. It is not clear what these behavioural impacts could be, but it is possible that zooplankton, including free-swimming larvae, in response to a stimulus such as underwater noise may move vertically or horizontally within the water column. These impacts are unlikely to be significant, especially as they will be constrained to a range of a few tens of metres from the source.

Overlap with EPBC Act Critical Marine Fauna Habitat and Sensitive periods of Activity

The Factory FPZ overlaps the whale shark foraging / migration BIA and this species is a plankton filter feeder.

Whale sharks transiting the survey area whilst on migration may opportunistically forage as they head north within the foraging / migration BIA along the 200 m isobath from March to November. For a 3,750 km^2 survey, the overall potential impact zone in terms of reduced plankton available for foraging is estimated to be 3,989 km^2 The whale shark foraging / migration BIA is ~218,990 km^2, therefore potential impacts from the survey may affect 1.8 % of plankton located within the total foraging area BIA.; however, reduction of plankton in this area will not occur simultaneously but will be restricted to an area around the seismic source and this reduction in plankton availability is expected to be short term (approximately three days) based on estimated recovery times from studies such as Richardson *et al*. 2017.

6.5.4. Disturbance to Benthic Invertebrates

Receptors

Benthic invertebrates occur in shallow water environments. Shallow water environments (i.e. water depth <50 m) within the OA occur at Heywood Shoal. There are no shallow water environments within the FPZ, and depths outside the Acoustic Source Exclusion Zones, where the acoustic source may be operated, are >70 m.

The following benthic invertebrate receptors have been identified as potentially occurring within the Factory OA:

- Crustaceans;
- Molluscs
- Invertebrates associated with the Ancient Coastline at 125 m KEF depth contour, including sponges and corals.

Although the OA overlaps the Commonwealth NWST Fishery, which targets scampi, stakeholder consultation and analysis of fishing data indicates that no fishing effort occurs within or close to the OA, therefore the Commonwealth NWST Fishery is not considered a receptor. There are no BIA or critical habitats for benthic invertebrates identified in the DoE National Conservation Values Atlas (DoE 2018az).

There are no BIA or critical habitats for benthic invertebrates identified in the DoE National Conservation Values Atlas (DoE 2018az).

Receptor Sensitivity

Many benthic invertebrates have a statocyst (an organ that assists the organism in maintaining balance and orientation in its immediate environment) and/or elaborate arrays of tactile 'hairs' that are sensitive to hydro-acoustic disturbances, however few marine invertebrates have sensory organs that can perceive sound pressure (such as a gas-filled bladder; Carroll *et al*. 2017 and McCauley 1994). To maintain their equilibrium and orientation, invertebrates use statocyst organs to direct their movements through the water and detect gravitational forces and linear accelerations. There is little information available on the functioning of these sensory organs, however, it has been suggested that marine invertebrates are sensitive to low-frequency sounds and this sensitivity is not directly linked to sound pressure but instead to particle motion detection (André *et al*. 2016, Roberts and Breithaupt 2016, Edmonds *et al*. 2016).

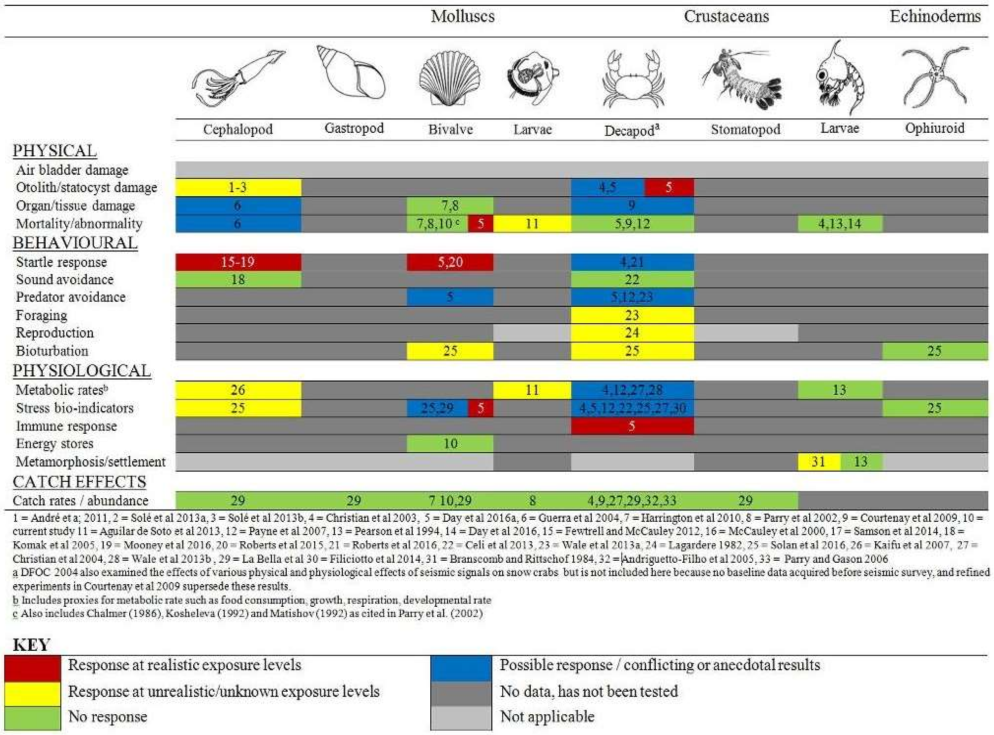
Decapod crustaceans have a variety of external and internal sensory receptors that are potentially responsive to sound and vibration. Many of these resemble vertebrate receptors that respond to hydrodynamic stimulation, particle motion and possibly pressure. However, the exoskeleton and body plan of aquatic decapods are more capable of responding to particle displacement components of an impinging sound field than pressure changes. Decapods also have limited acoustic sensitivity, and this is said to be related to their absence of gas-filled organs (e.g. swim bladders). However, sound detection in decapods is believed to occur through the extensive arrays of sensilla that sense mechanical disturbances in the surrounding water and sediment; known as the particle motion component of the sound field (Edmonds *et al*. 2016).

A review of the potential impacts of marine seismic surveys on fish and invertebrates (Carroll *et al*. 2017) summarises the impacts of low-frequency sound on marine invertebrates based on a literature review of 70 studies, which comprised a total of 68 species of fish and 35 species of invertebrates, including several studies that were not differentiated (e.g. bivalve larvae in Parry et al. 2002; demersal and pelagic fish in Dalen and Knutsen 1987 (Carroll *et al.* 2017).

Carroll *et al.* (2017) concluded:

"Our review has identified scientific evidence for high-intensity and low-frequency sound-induced physical trauma and other negative effects on some fish and invertebrates; however, the sound exposure scenarios in some cases are not realistic to those encountered by marine organisms during routine seismic operations. Indeed, there has been no evidence of reduced catch or abundance following seismic activities for invertebrates, and there is conflicting evidence for fish with catch observed to increase, decrease or remain the same."

The review (Carroll *et al*. 2017) concluded that there were no significant differences detected in any of these studies for marine invertebrates exposed to a seismic source, either between sites exposed and not exposed to the acoustic source (**Figure 6-6**).



Source: modified from Carroll *et al.* (2017).

Figure 6-6 – Summary of potential impacts of low-frequency sound on response of marine invertebrates

A critical evaluation of crustacean sensitivity to high amplitude underwater noise was undertaken by Edmonds *et al.* (2016) and sensitivity to underwater noise was shown by the Norway lobster and similar closely related crustacean species, including juvenile stages. Edmonds *et al*. (2016) concluded that current evidence supports physiological sensitivity to local, particle motion effects of sound production. Therefore, it is evident that a range of physiological response have been identified in some studies, however, received sound levels are typically at levels that would be received within a few hundred meters from the acoustic source or from repeated exposure at the same sound levels which is unrealistic in an actual seismic survey. Current stock assessment methodologies do not have the resolution to show statistically significant changes in distribution or abundance from seismic survey operations above that of natural variation (Edmonds *et al*. 2016 and Christian *et al*. 2003).

Many molluscs, including bivalves, possess statocysts (Carroll *et al*. 2017). Hawkins and Myrberg 1983; cited in McCauley 1994, hypothesised that statocyst organs may be receptive to the particle acceleration component of a sound wave, possibly in the far-field. (Franzen (1995) showed that tellinid bivalves (*Macoma balthica*) are sensitive to frequencies in the minimum range of 50-200 Hz, which corresponds to shear-wave vibrations that propagate along the sediment surface. A study on the ox-heart clam (*Glossus humanus*) demonstrated sensitivity to vibrations and hypothesised that the sensitivity was related to sensing breaking waves on the incoming tide and triggers the individual to move with the tide (Frings 1964; cited in McCauley and Kent 2008). *Donax variabilis*, a coquina clam, responds to pressure signals in the range of 20 Pa, or a sound pressure level of 140 dB re 1 µPa SPL_{rms} (rms; Ellers 1995). In at least one other bivalve species, response to sound has been evident by changes in aggregations; low frequency sound (30 to 130 Hz) has been demonstrated as an effective control measure for zebra mussel fouling (Donskoy and Ludyanskiy 1996) due to the mussel's sensitivity to low frequency sound.

<u>Other benthic invertebrates such as corals and sponges</u>

There are limited published studies on the impacts of noise on corals and sponges, and currently no peer-reviewed noise criteria or recognised thresholds which noise can be assessed.

A recent study by Heywood *et al.,* (2018) monitored corals such as scleractinian corals, (primarily plate corals) and soft corals in situ before, during and after a 3D seismic survey (Heyward et al. 2018). The study generated a maximum 24 h received sound exposure level (SEL24) of 204 dB re 1 µPa^2·s and received 0-to-peak pressure (PK) of 220 dB re 1 µPa at the coral monitoring sites. The study found there were no detectable impacts on scleractinian coral mortality, skeletal damage or visible signs of stress immediately after and up to four months following the marine seismic survey. Additionally, there was no evidence of a behavioural response, such as polyp withdrawal or flaccidity in soft corals such as *Lobophytum* spp.

<u>Crustaceans</u>

There have been a range of reviews of seismic/acoustic noise impacts to invertebrates, e.g. Carroll *et al*. (2017), Edmonds *et al*. (2016) and Salgado Kent *et al*. (2016). Specific studies of impacts of seismic noise to scampi species are limited, however, a number of studies have been undertaken on decapods with a range of effects to no effects identified, although none have identified impacts of increased mortality due to acoustic impacts. Crustaceans have been the most studied group in terms of the range of metrics investigated, such as catch rates and physical, behavioural, and physiological effects (Carroll *et al*. 2017).

<u>Mortality/Mortal Injury</u>

The review by Salgado Kent *et al*. (2016) supported a finding that there was no evidence in the current literature of direct mortality of crustaceans from seismic exposure.

As summarised by Carroll *et al*. (2017) *"Previous field-based studies on adult populations revealed no evidence of increased mortality due to airgun exposure in…..lobsters up to eight months after exposure (Payne et al. 2007; Day et al.,2016a). Similarly, there was no evidence of mortality-associated population effects such as reduced abundance or catch rates in …… reef-associated invertebrates four days after exposure (Wardle et al. 2001), snow crabs up to 12 days after exposure (Christian et al. 2003), shrimp two days after exposure (Andriguetto-Filho et al. 2005), or lobsters' weeks or years after exposure (Parry and Gason 2006)."*

A long-term study conducted on adult lobsters, Day *et al*. (2016) maintained them in modified lobster pots while a vessel with an acoustic source passed within close proximity to the individuals. Measurements from seabed sea noise loggers were used to build relationships of received levels (PK-PK and SEL) for the acoustic source with range and to use this relationship to estimate all fired air gun signal levels at each lobster pot. The estimated received per-pulse SEL ranged from 186-190 dB re 1 µPa^2·s, maximum accumulated SEL from 192–199 dB re 1 µPa2.s and PK-PK from 209-212 dB re 1 µPa. The results showed no evidence of lobster mortality for any experiment, as well as no evidence of impact to lobster embryos, which were described as resilient to the acoustic exposure. Therefore, mortality in direct response to seismic airgun exposure is unlikely.

No exposure criteria currently exist to enable an evaluation of potential mortality/potential mortal injury effects in crustaceans (**Table 6-6**). However, based on the research findings to date that have shown no evidence of crustacean mortality, it is predicted that mortality effects are likely to be confined to extremely close ranges (i.e. <10 m) from the source.Given the water depths where the acoustic source may be operated (>70 m) and absence of significant benthic communites from these areas, mortality / mortal injury of crustaceans from the Factory 3D MSS are not expected to occur.

<u>Impairment / Behaviour</u>

Edmonds *et al.* (2016) undertook a review and critical evaluation of crustacean sensitivity to loud impulsive, low frequency underwater noise typically produced by seismic surveys. The review identified that sensitivity to underwater noise is exhibited by the Norway lobster and closely related crustacean species, including juvenile stages. They concluded that current evidence supports physiological sensitivity to local, particle motion effects of sound production.

From 2013–2015, a long-term study evaluated the acoustic impacts from seismic exposure on southern rock lobsters (*Jasus edwardsii*) in Australia (Day *et al*. 2016a). The study found airgun exposure caused damaged statocysts in rock lobsters (Jasus edwardsii) up to a year later. However, no such effects were detected in snow crabs after exposure to 200 shots from a 40 in^3 acoustic source at levels of 201-207 dB re 1 µPa (PK) at distances of 2-15m and at 10 second intervals (Christian *et al*. 2003). Additionally, while Day *et al*. (2016a) also found that the rock lobster showed delayed time to right itself after exposure to airguns and a decrease in tail extension reflex after exposures to 209-212 dB re 1 µPa (PK-PK), no effects were observed in the American lobster (*Homarus americanus*) by Payne *et al*. (2007) at a PK-PK of 202 dB re 1 µPa. Reflex behaviours, sensory hairs and biochemistry levels indicated high levels of impairment and/or damage, all of which have the potential to compromise other behaviours and biological responses. These results should be interpreted with caution, especially as the lobsters were maintained in pots (confined) and prevented from swimming away and avoiding the acoustic source. Several other studies concluded that results from enclosed experiments are likely to be misinterpreted to natural populations and therefore require careful interpretation when determining realistic responses (Carroll *et al*. 2017).

In lieu of a suitable proxy, an understanding of level for pressure related metrics at which impacts were identified gives some mechanism for being able to understand the area of potential impact. As Payne *et al*. (2007) identified no effects on righting time in lobster at 202 dB re 1 µPa (PK-PK; **Figure 6-5**), and Day *et al*. (2016a) found effects at 209 dB re 1 µPa (PK-PK), the level of 202 dB re 1 µPa (PK-PK) has been applied in this assessment as a precautionary threshold proxy to determine potential impacts (**Table 6-6**). The modelling results for the Factory 3D MSS predicts recoverable injury impacts may occur within approximately 637 m (Site 1), 430 m (Site 2) and 634 m (Site 5; **Table 6-9**) from the array. Therefore, it is possible some individuals may incur a reduction in fitness. However, it is unlikely that this will occur to the majority of individuals within the FPZ, therefore, impacts to the benthic crustaceans population level due to reduced fitness is unlikely.

While sub-lethal impacts are likely to occur to individual crustaceans at close range to the seismic source, long-term acoustic impacts at the population level (and thus associated commercial fisheries) are unlikely to occur, based on the experimental results discussed above, the relatively small area of the OA compared to the wider region of comparable habitat (**Section 3.3**) and the deep-water marine environment of the surrounding region (**Section 3.2.5**).

Molluscs

Currently there is no information available concerning the distances over which bivalve molluscs may be able to detect either pressure or particle motion components of a sound wave, particularly for individuals suspended in mid-water.

Mortality/ Mortal Injury

Based on a number of previous papers, including a comprehensive literature review (Moriyasu *et al.* 2004), it is apparent that studies on the effects of underwater noise from seismic airguns on molluscs are very limited. A review of studies (Parry *et al*. 2002) suggested that molluscs are at risk of damage from seismic airgun noise only when they are closer than 1-2 m. However, previous studies have also suggested that most effects on invertebrates without gas-filled cavities are likely to be too subtle to be measured in the field (Parry and Gason 2006).

A study conducted by the Tasmanian Aquaculture and Fisheries Institute (TAFI) assessed the immediate impact of seismic surveys on adult commercial scallops (P*. fumatus*) in the Bass Strait in 2010 (Harrington *et al*. 2010). The TAFI study concluded that no short-term (<2 months) impacts on the survival or health of adult commercial scallops were detected after the seismic survey (Harrington *et al*. 2010). No change in the abundance of live scallops (or related change in dead scallop categories) or macroscopic gonad and meat condition after seismic surveying within either the control, impacted or semi-impacted strata was detected. There was also no observable change in the size frequency distribution of scallops in the impacted and semi-impacted strata following the survey.

In response to the lack of discernible results from the Harrington *et al*. 2010 study and concerns from fisheries groups that seismic operations negatively affect catch rates, the Gippsland Marine Environmental Monitoring (GMEM) project was developed (Przeslawski *et al*. 2016). This study aimed at modelling and measuring sound at various depths before and during a seismic survey in 2015 to quantify potential impacts of seismic surveys on scallops and other benthic organisms. Sound exposure was assessed using both field monitoring and desktop modelling. The underwater sound model predicted SELs of 170 dB re 1µPa^{2}·s within 250 m of the source and sound levels exceeding 150 dB re 1µPa^{2}·s out to 4 km from the source. However, the highest SEL measured by hydrophones during the survey was 146 dB re 1µPa^{2}·s at 51 m depth when the airguns were operating 1.4 km away. There was no evidence of increased scallop mortality, or effects on scallop shell size, adductor muscle diameter, gonad size, or gonad stage due to the seismic sound (Przeslawski *et al*. 2016). The GMEM study provided no clear evidence of adverse effects on scallops, fish, or commercial catch rates due to the 2015 seismic survey undertaken in the Gippsland Basin. Przeslawski *et al.* (2016) further concluded that the GMEN study provides a robust and evidence-based assessment of the potential effects of a seismic survey on some fish and scallops, however these results should be interpreted in the context of other studies such as Day *et al.* (2016a, 2016b), and should not be generalised to include other individuals due to the vast range of different physiology and sensory systems.

Day *et al* (2016b, 2017) has been conducting a long-term study on the acoustic impacts from seismic exposure on scallops (*P. fumatus*) in Australia. The experimental field research maintained the scallops in mesh enclosures while a vessel with the acoustic source passed close to the individuals. Seismic sound exposure did not cause mass mortality of scallops during the experiment; however, repeated exposure (i.e. more than one pass of the airgun) where maximum exposure levels were in the range of 181 to 188 dB re 1μPa^{2}·s SEL (191 to 213 dB re 1μPa PK-PK SPL) was considered to possibly increase the risk of mortality (Day *et al.* 2016a, 2016b). Day *et al* (2017) concluded that increased mortality has not been established whether it was due to the seismic source or experimental design, and that "*exposure to seismic surveys left scallops behaviourally and physiologically impacted and in a state such that any additional stress (e.g., dredging, warm water conditions, predation stress) could lead to further impairment or mortality".*

The JASCO noise modelling predicted exposure to 202 dB PK-PK (max PK-PK SPL in Day *et al*. 2016 that effects were identified at) was 637 m at Site 1, the shallowest site (102 m) and 434 m at Site 3 the deepest site. Based on this, it is possible that mortality of molluscs could occur up to 637 m from the source although it would be unclear whether the mortality would be as a direct result of exposure to seismic sound, or as a secondary impact due to mollusc being stressed from the sound level and then exposed to further environmental stresses. Therefore, it is possible some individuals may incur a reduction in fitness. However, it is unlikely that this will occur to the majority of individuals within the FPZ, therefore, impacts to the mollusc population level due to reduced fitness is unlikely.

<u>Impairment / Behaviour</u>
Studies on cephalopod molluscs such as caged squids (*Sepioteuthis australis*) subjected to an individual operating airgun showed behavioural changes and avoidance (McCauley *et al.* 2003; cited in Moriyasu *et al.* 2004 and Carroll *et al.* 2017 as McCauley *et al.* 2000a). They found an alarm response at 156-161 dB re1 μPa (SPL), and a strong startle response at 174 dB re 1 μPa involving ink ejection and rapid swimming. The caged squid were also the only animals to move to the sound shadowed area of the cage at the ocean surface. The authors suggested thresholds for affecting squid's behaviour are at 161-166 dB re 1 μPa (SPL).

The JASCO noise modelling predicted exposure to 161-166 dB re 1 μPa (SPL; in McCauley *et al*. 2016 that effects were identified at) was within a maximum distance of 9.73 km at Site 1, the shallowest site (102 m) and 7.94 km at Site 3 the deepest site. Based on this, it is possible that behavioural impacts of molluscs could occur up to 9.73 km. Therefore, it is possible some individuals behaviour may be affected. However, it is unlikely that this will occur to the majority of individuals within the FPZ, therefore, impacts to the mollusc population level due to reduced behavioural impacts is unlikely.

It is noted that a risk assessment of potential impacts of seismic survey impacts on marine finfish and invertebrates by DPIRD ranked seismic survey impacts on immobile invertebrates in water depths of 50 m as "Severe" and in 100 m as 'High' when an airgun array voume of 2,000 to 4,500 in^{3} is used (Webster et al. 2018), while impacts on mobile invertebrates were ranked as 'High' for 50 m water depth and 'Moderate' for 100 water depths. Only 0.1% of the FPZ is situated in water depth of 60 to 100 m (**Table 3-1**), the OA is largely expected to be relatively flat and comprise of mainly soft sediments (**Section 3.3**) and benthic surveys in the vicinity of the OA observed very low fauna abundance with some areas having little or no visible fauna (**Section 3.4.1**), therefore it is anticipated that impacts to invertebrates will be limited to a few individuals and no impacts on populations are expected.

<u>Ancient Coastline at 125 m Depth Contour KEF</u>
Benthic invertebrates, such as coral and sponges, are keystone features of the Ancient Coastline at 125 m Depth Contour KEF. Currently there is limited published literature on potential impacts of seismic noise on hard and soft corals, and subsequently there are no peer-reviewed criteria against which potential noise impacts to coral can be assessed.

Corals and sponges are only sensitive to noise in the nearfield (10-20 m) and therefore will not be sensitive to airgun emissions more than 1 km away. Woodside's Maxima Study on seismic noise on Scott Reef showed that corals required received levels of PK-PK exceeding 260 dB re 1 µPa SPL to induce injury and that exposure to SEL levels of 180, 187 and 200 dB re 1 $\mu Pa^2 \cdot s$ did not result in any detectable effect on plate corals (Woodside 2007).

Heywood *et al*. (2018) monitored scleractinian corals, in families Agaracidae and Acroporidae, and soft corals in situ before, during and after a 3D seismic survey and found no detectable impacts on scleractinian coral mortality, skeletal damage or visible signs of stress immediately after and up to four months following the 3D marine seismic survey.

The Jasco noise modelling predicted that the sound level threshold for sponges and corals, 226 dB re 1 µPa SPL (PK) will not be reached at any of the modelling sites. Therefore, impacts and risks to corals and sponges from the Factory 3D MSS are not predicted.

6.5.5. Disturbance to Fish

Receptors
Within the Factory OA the following types of fish have been identified:

- Site attached species;
- Demersal species, such as Lutjanidae(snapper species); and
- Pelagic fish species including commercial fish species such as Scombridae (mackerel species) and Carangidae (Trevallies and Jacks).

Only one WA State fishery targeting demersal species was identified during stakeholder consultation as actively fishing within the Factory OA, the NDSF. The following section discusses potential mortality, impairment and behavioural impacts to fishes from noise; potential changes in catch rates is discussed in Section (**Section 6.1.1**).

Receptor Sensitivity
Fishes like other vertebrates have two inner ears similar in structure and function to the inner ear of terrestrial vertebrates. The basic mechanism for transduction of sound into electrical signals is the sensory hair cell. Significantly, high intensity sounds are able to fatigue, damage or kill these cells resulting in temporary or permanent hearing loss. Fish however, unlike other tetrapods, are able to keep adding sensory hair cells throughout their lives. In addition, there is evidence (Popper and Hastings 2009) that damaged cells, as a result of exposure to sound that causes a shift in auditory thresholds, can be replaced.

The majority of fish species detect sounds from below 50 Hz up to 500-1,500 Hz. A smaller number of species can detect sounds to over 3 kHz, while a very few species can detect sounds to well over 100 kHz. When trying to understand whether or not an anthropogenic sound affects hearing it is important to consider whether the sound is within the hearing frequency range of a fish and loud enough to be detectable above thresholds. For this EP risk assessment, it is assumed that all fishes have hearing within the 0-200 Hz and therefore can 'hear' the seismic source.

The Working Group on the Effects of Sound on Fish and Turtles undertook a review of experimental findings of sound on fishes. In their American National Standards Institute (ANSI) accredited report (Popper *et al*. 2014) they presented sound exposure criteria for different levels of effects for different groups of species (**Table 6-6**), for three types of immediate effects:

- Mortality, including injury leading to death.
- Recoverable injury, including injuries unlikely to result in mortality, such as hair cell damage and minor haematoma.
- Temporary threshold shift (TTS).

Popper *et al.* (2014) classified fish into three groups based on their physiology:

- Fishes with swim bladders and hearing does not involve the swim bladder or other gas volumes;
- Fishes whose hearing does involve a swim bladder or other gas volume (e.g., snapper and emperor; and

- Fishes without a swim bladder and can descend down to the substrate when inactive (Popper *et al*. 2014, Carroll *et al*. 2017).

Masking and behavioural effects are assessed qualitatively, by assessing relative risk rather than by specific sound level thresholds.

Because the presence or absence of a swim bladder has a role in hearing, fish's susceptibility to injury from noise exposure varies depending on the species and the presence and possible role of a swim bladder in hearing. Therefore, different thresholds are proposed for fish without a swim bladder, fish with a swim bladder not used for hearing, and fish that use their swim bladders for hearing (**Table 6-6**). The fish receptors identified for this assessment such as syngnathids, some site-attached species and some demersal fish species are included in the category of fish having a swim bladder while mackerel do not.

Mortality / Potential Mortality

Recent studies by Popper *et al*. (2016) have found that fish exposed to a single-impulse of a maximum received level of either 231 dB re 1 µPa (PK) or 205 dB re 1 µPa2.s (SEL), remain alive after 7 days of exposure and that the probability of mortal injury did not differ between the exposed and the control (cited in McPherson *et al*. 2019).

To date no studies have demonstrated direct mortality of adult fish in response to airgun emissions, even when fired at close proximity (within 1–7 m; DFO 2004; Boeger *et al*. 2006 as cited in NSW DPI 2014; Popper *et al*. 2014). Carroll *et al* (2017) review concluded that there are few data on the physical effects (e.g. mortality, barotrauma) of seismic airguns on fish, and of these none have shown mortality. Hassel *et al*. 2004 (as cited in NSW DPI 2014) concluded that, although some fish deaths have been reported during cage experiments, the deaths were more likely caused by experimental artefacts of handling or confinement stress. For free-swimming fish that are able to move away from a seismic source as it approaches, the potential for lethal physical damage from airgun emissions is even further nullified. Pelagic fish are unlikely to be significantly affected by seismic sound exposure from the Factory 3D MSS.

Reef or bottom-dwelling fish that show greater site attachment may be less inclined to flee from a seismic sound source and as a consequence may experience greater effects. Despite this, Wardle *et al*. (2001, as cited in Popper and Hastings 2009) found that fish and invertebrates on a rocky reef showed only minor behavioural responses and no observed damage when exposed to a measured peak level of 210 dB re 1 µPa. In a tropical coral reef habitat exposed to a full commercial 3D seismic survey off WA, no significant changes in the diversity or abundance of the reef fish community were detected via underwater visual transect surveys (Miller and Cripps 2013). There was also no evidence of direct mortality or indirect mortality from sub-lethal effects among site attached species, such as pomacentrids that tend to hide within coral heads or reef crevices when startled rather than flee (NSW DPI 2014).

Diversity and abundance for fish species has been shown to be positively correlated with habitat complexity, with more complex habitats such as coral reefs, typically hosting higher species richness than simpler habitats such as bare sand or unconsolidated muddy sediments (Gratwicke and Speight 2005). Available information indicates there is limited habitat in waters deeper than 70 m that supports site-attached fish species. In fact, coral diversity reduces with increasing depth, and corals are uncommon at depths greater than 40 m (Waples and Hollander 2008). Similarly, seagrasses and macroalgae generally need light and so are limited to shallower waters to <20 m depth (DEC 2007a; URS 2010; CVX 2010). The majority of the benthos within the OA is deep water valley containing limited infauna. Based on the studies discussed above that showed no evidence of direct fish mortality, the lack of suitable habitat in the FPZ or the OA outside of the Acoustic Source Exclusion Zones, and therefore low numbers of site-attached fish expected to occur, mortality of site-attached fish within the OA from the Factory 3D MSS is considered unlikely.

Conditions that could result in fish being trapped (site-attached/territorial species) and unable to move more than a few metres from the noise source as the survey vessel(s) traverses the area include areas of reef or raised topographical features. There are no reef features or suitable habitats within the FPZ, the closest reef feature is Heywood Shoal, located ~ 1.8 km from the 60 m isobath (the identified shoal edge of Heywood shoal; Heyward *et al*. 2018). Within the OA, Heywood Shoal is the only location that can support site-attached fish species. Species and communities associated with the Heywood Shoal are variable and include pelagic fish species, site attached reef species, and benthic communities. These reef communities are

~1.8 km from the moving seismic source in the FPZ and will be subject to maximum received sound intensities at the shoal in the order of ~140 dB re 1µPa^{2}·s (SELss) and ~150 dB re 1µPa (SPL) during full power activities (McPherson *et al.* 2019; **Appendix D**). These are lower than the noise produced by snapping shrimp or bottlenose dolphins, and much lower than the numbers purported to induce mortality (207 dB re 1 µPa (PK) or 219 dB re 1µPa^{2}.s [SEL]). Based on these low levels and the anticipated minimal time the source will be near any particular location, mortality to site-attached fish located on Heywood Shoal is not predicted from either the single pulse or the 24hr SEL acoustic modelling; mortality or potential mortal injury is not predicted to occur beyond a maximum range of ~200m for even the most sensitive types of fish (**Table 6-11**).

The acoustic source may be operated at lower levels in water depths greater than 70m outside of the Acoustic Source Exclusion Zone around Heyward Shoal. Received sound levels from these lower power operations will not occur in areas of suitable habitat for site-attached fish (typically <50m water depth), which are also well beyond the maximum predicted ranges for potential mortality or mortal injury (based on the modelled full power discharges). Therefore, site-attached fishes are not expected to experience mortality or mortal injury.

Impairment

Other than physiological stress responses or hearing loss, no other physical damage to adult fish have been directly attributed to exposure to airgun discharges, even at close proximity (NSW DPI 2014).

The level and duration of exposure that causes TTS varies widely and can be affected by factors, such as repetition rate of the sound, pressure level, frequency, duration and health of the organisms. By definition, hearing recovers after TTS. The extent (how many dB of hearing loss) and duration of the TTS may continue from minutes to days after exposure.

McCauley *et al.* (2003) study on caged fish found no mortality and fishes continued to feed for the whole post exposure time. It is also important to note that sensory hair cells are continually added in fishes (Popper and Hoxter 1984; Lombarte and Popper 1994) and are also replaced when damaged (Lombarte *et al.* 1993; Smith *et al.* 2006; Schuck and Smith 2009). Therefore, any impacts to the hair cells of fish that could not avoid the seismic source would be temporary.

Based on the application of the exposure criteria for fish described by Popper *et al*. (2014) and the JASCO modelling outputs, for Sites 1, 2, 3, 4 and 5 predicted recoverable injury effects from the operation of the source array could occur out to horizontal distances of ~60 m (for fish without a swim bladder) or ~200 m (for fish with a swim bladder; **Table 6-9**).

Within the FPZ, the depth ranges of demersal species such as goldband snapper and red emperor are from 50-200 m and 10-180 m, respectively, which constitutes approximately 31.8 % of the FPZ. Given the absence of suitable habitat such as bank features, pinnacles and reefs, where large aggregations of demersal fish are likely to be found, and the high occurrence of unsuitable habitat type of deep holes and valleys (85%) within the FPZ, it is reasonable to conclude that the area is unlikely to include a high number of dense aggregations of site attached fish, or reef-associated demersal fish assemblages. Furthermore, demersal and pelagic fish species have the ability to move away from the moving source and as such impacts to fish within the FPZ at the population level are not predicted.

Heywood Shoal (~1.8 km from the FPZ) supports a variety of fish species (**Section 3.4.1.1**), the majority of them being shallow water and reliant upon suitable habitats such as reef, shoals, terrace, bank features (site-attached species; Heywood *et al*. 2017, 2017b), such as angelfish (Pomacanthidae), rabbitfishes (Siganidae), damselfishes (Pomacentridae) and surgeonfishes (Acanthuridae). Such species are restricted by habitat type, shallow water (~50m water depth) and, therefore, are located outside of the predicted maximum recoverable injury range of 80 m (SEL_{24h}) to ~200 m (PK).

Based on the JASCO modelling results, the potential for TTS to fish resulting from cumulative sound exposures (186 dB re 1µPa^{2}·s SEL_{24h}) may occur to a maximum range of ~3.5km. However, this distance is associated with broadside sound propagation in waters away from Heyward Shoal. Planned NW-SE survey lines are aligned perpendicular to Heywood Shoal and so cumulative sound exposures at the shoal are predominantly limited to sound exposures received from the closest discharges towards the end of an acquisition line. The JASCO modelling results demonstrate that sound propagation from the FPZ towards areas of Heywood Shoal closest to the FPZ will not result in received sound intensities that exceed the 186 dB re 1µPa^{2}·s (SEL_{24h}) threshold for TTS in fish.

It is noted that the acoustic source may be operated at lower power levels in closer proximity to the Heyward Shoal Acoustic Source Exclusion Zone, either during soft starts or potential maintenance tests. However, the potential for TTS effects in fish remains limited. During soft starts, the closest pulses of sound will be received from discharges of the single smallest air gun in the array, and the source will then move away from the shoal at a speed of approximately 4.5 knots during the line run-in; as the source is ramped up, increasing sound levels will be produced at increasing distance from the shoal. During maintenance tests, the acoustic source may be discharged several times at less than 50% of the total array volume. During both activities, the sound exposures will be less than those produced during full power activities. Therefore, TTS in site-attached fish at Heywood Shoal (primarily associated with habitat in less than 50 m water depth) is unlikely to occur. However, for the purposes of the assessment, it is conservatively assumed that some level of TTS may occur in some individuals in an area of Heyward Shoal located closest to the operating acoustic source. This repesents a very small proportion of the site-attached fish assemblages at Heyward Shoal, and the duration of exposure to sound that contributes to TTS effects will be short (in the order of minutes while the acoustic source is tested or moves away during the soft start). TTS is temporary and recovery is likely to occur within 24 hours (Popper et al. 2005; Popper 2018). The potential for such effects to have any significant implications on the fishes' fitness and survival is low and again limited to individuals.

Therefore, it is unlikely that significant impairment impacts will occur to fish, including site-attached fish at Heywood Shoal, and no impacts at the population level are predicted.

Behaviour

Behavioural responses to sounds are variable but include:

- Leaving the area of the noise source (avoidance; Streever *et al.* 2016).
- Startle/alarm response: changes in depth distribution (Pearson *et al.* 1994; Slotte *et al.* 2004; Woodside 2007a);
- Changes in swimming patterns (including change in swimming speed and direction): spatial changes in schooling behaviour (Slotte *et al.* 2004; Woodside 2007a); and
- Startle responses (Pearson *et al.* 1994; Wardle *et al.* 2001): changes in vertical distribution.

A strong 'startle' response has been observed for some fish at sound levels of 200 to 205 dB re 1 µPa, indicating that sounds at or above this level may cause fish to move away from the vessel. Sound levels of this intensity are likely to occur ~100 to 300 m from an acoustic array.

McCauley *et al.* (2003) also found that active avoidance may occur in some fish species at sound levels of ~161-168 dB re 1 µPa rms. These latter levels are more in line with results as indicated in a study by Woodside at Scott Reef (2007).

Low level behavioural effects:

- Avoidance at >140 dB re 1 µPa2.s (pelagic species and the more nomadic demersal species): a distance of >45 km from the acoustic source (**Appendix D**).
    - Startle/alarm at >160 dB re 1 µPa2.s (species with limited home ranges or site-attached and/or territorial strategies): a distance of >5.7 km from the acoustic source (**Appendix D**).
- High level behavioural effects:
    - Fright/flight at >180 dB re 1 µPa2.s (species with limited home ranges or site-attached and/or territorial strategies; Woodside 2007a): - a distance of >270 m from the acoustic source (**Appendix D**).

Behavioural effects are expected to be short-lived, with duration of effect less than or equal to the duration of exposure expected to vary between species and individuals and be dependent on the properties of received sound (DFO 2004). The ecological significance of such effects is expected to be low, except where they may influence reproductive activity. However, researchers have observed that once acoustic disturbances are removed, fish return to normal behaviour within about an hour (McCauley *et al.* 2000; Pearson *et al.* 1992; Wardle *et al.* 2001).

Considering that the distribution range of key species in the survey area, adequate spawning biomass levels, and that migratory routes are not restricted, impacts on fish populations is considered to be low. Available evidence suggests behavioural changes for some fish species are likely to be no more than a nuisance factor and within a few seconds they continue their previous activity. The temporary, short range displacement of pelagic or migratory fish populations may have insignificant repercussions at a population level (McCauley 1994); and for site-attached reef fish, spatial patterns of richness, abundance and diversity does not change after airgun noise emissions (Woodside 2007a; Miller and Cripps 2013).

It is noted that an assessment of impacts from seismic surveys on marine finfish and invertebrates by DPIRD ranked seismic survey impacts on demersal finfish in water depths of 50 to 100 m as 'High' when an airgun array voume of 2,000 to 4,500 in^3 is used (Webster et al. 2018). Impacts to pelagic finfish were ranked "Negligible". Only 0.1% of the FPZ is situated in water depth of 60 to 100 m (**Table 3-1**), the OA is largely expected to be relatively flat and comprise of mainly soft sediments (**Section 3.3**) and no fish aggregation areas have been identified within the FPZ, therefore it is anticipated that impacts to demersal fish will be limited to individual fish and no impacts on populations are expected.

Potential behavioural effects to site-attached fishes or spawning fishes at Heywood Shoal will be limited to short periods when the acoustic source is operating near the Heywood Shoal Acoustic Source Exclusion Zone (i.e. at the start or end of a limited number of acquisition lines). Therefore, the duration of each exposure will be in the order of minutes and normal behaviour is expected to resume soon after. Such short duration effects are not expected to result in long term or population-level impacts.

Conclusions
The seismic source, at any power level, will not be discharged in water depths <70 m, thus ensuring that sensitive environments and site-attached fish assemblages associated with Heywood Shoal are not adversely impacted as a result of vertical sound propagation. Implementation of the soft start mitigation strategies as recommended by the DoF (DoF 2013) ensures there will be no physiological impacts on mobile finfish species and fish communities and their habitats due to the avoidance nature of pelagic species and limited potential for impacts to site-attached species.

An assessment of potential control measures to reduce the impacts and risks to fish was undertaken and is summarised in **Appendix A**.

Overlap with EPBC Act Critical Marine Fauna Habitat and Sensitive periods of Activity
There are no BIA or critical habitats for fish identified in the DoE National Conservation Values Atlas (DoE 2018az), therefore no noise impacts are predicted.

6.5.6. Disturbance to Sharks and Rays

Receptors
Protected shark and ray species listed under the EPBC Act that are likely to transit through the OA are the white shark, whale shark shortfin mako, longfin mako, giant manta ray and reef manta ray (**Section 3.4.3.1.2**). The protected shark and ray species identified as potentially transiting through the OA are considered highly mobile with a wide-ranging distribution in deep offshore waters

Shark and ray species recorded at Heywood Shoal using BRUVs include whaler sharks and the great hammerhead shark (*Sphyrna mokarran*) as well as species restricted to shallow waters (less than 70 m) such as the tawny nurse shark (*Nebrius ferrugineus*), blue spotted stingray (*Dasyatis kuhlii*) and blotched fantail ray (*Taeniura meyeni*; Heyward et al 2012). Heywood Shoal is within the OA but outside the FPZ.

The Factory OA overlaps the whale shark migration BIA.

Receptor Sensitivity
Limited research has been undertaken on shark and ray responses to seismic surveys. Myrberg (2001) found that sharks differ from bony fish in that they have no accessory organs of hearing such as a swim bladder and therefore are unlikely to respond to acoustical pressure. The study also suggested that the lateral line system does not respond to normal acoustical stimuli and is unable to detect sound-induced water displacements beyond a few body lengths, even with large sound intensities (Myrberg 2001). Other studies indicate sharks are highly sensitive to sound between approximately 40 and 800 Hz, which does overlaps with seismic sound frequencies. Klimley and Myrberg (1979) found that a shark will suddenly turn and withdraw from a sound source of high intensity (more than 20 dB re 1 µPa above broadband ambient SPL) when approaching within 10 m of the sound source.

Elasmobranchs sense sound via the inner ear end organs and as they lack a swim bladder it is thought that they are only capable of detecting the particle motion component of acoustic stimuli, unlike the more highly sensitive teleosts which can also detect sound pressure (Myrberg 2001).

Mortality / Potential Mortality

There are no defined quantitative noise exposure criteria for mortality / potential mortal injury in sharks and rays.

Due to sharks and rays having no accessory organs of hearing such as a swim bladder it is highly unlikely that the underwater noise emissions from the acoustic array will cause any pathological effects (lethal and sub-lethal injuries), resulting in immediate and delayed mortality and physiological effects on shark species. Therefore, as a conservative and precautionary approach, the Popper *et al.* (2014) threshold criteria for fish with no swim bladder have been used to determine acceptable acoustic impacts to whale sharks from the discharge of the acoustic source (**Table 6-6**).

Acoustic modelling results predicts received sound levels are not likely to exceed the mortal injury impact threshold criterion i.e. 207 dB re 1 μPa SPL PK (Popper 2014) at distances >200 m (**Table 6-9**) from the acoustic source. It is possible that individual sharks and rays could be within 200 m of the vessel when the seismic survey is underway, which could result in the mortality / mortal injury of individual animals, impacts are considered highly unlikely due the highly mobile nature of sharks and rays, and the application of soft start procedures, which enables individual animals to avoid the approaching acoustic source.

Impairment

There are no defined quantitative noise exposure criteria for impairment in sharks. Therefore, as a conservative and precautionary approach, Popper *et al.* (2014) threshold criteria for fish with no swim bladder have been used to determine acceptable acoustic impacts to sharks and rays from the discharge of the acoustic source (**Table 6-6**), that is TTS onset >186 dB SEL_{cum} and recoverable injury 213 dB re 1μPa (PK) and >219 dB (SEL_{cum}). Using these threshold criteria, it is possible that impairment impacts could occur to individual sharks and rays within 200 m of the vessel when the seismic survey is underway, which could result in the impairment of individual animals, however impacts are considered highly unlikely due the highly mobile nature of sharks and rays which enables individual animals to avoid the approaching acoustic source. Impairment impacts are unlikely to be significant at a population level.

Impairment of sharks and rays associated with Heywood Shoal (including shallow water species) is not expected to occur due to the distance of Heywood Shoal from the FPZ (1.8 km) and the noise level predicted to reach the shoal (<150 dB re $1μPa^2·s$ (SEL)) which is less than noise levels produced by snapping shrimp or bottlenose dolphins.

Behaviour

Given their wide-ranging habitat and highly transient nature, likely impacts on shark and ray species are expected to be limited to short term behavioural responses such as avoidance of the vicinity (tens to hundreds of metres) of the operating acoustic array. These behavioural responses are unlikely to be significant at a population level, particularly as any sharks and rays in the area are likely to be transient.

Overlap with EPBC Act Critical Marine Fauna Habitat and Sensitive periods of Activity

Whale Shark BIA

Limited research has been conducted on shark responses to marine seismic surveys. Myrberg (2001) stated that sharks differ from bony fish in that they have no accessory organs of hearing such as a swim bladder and therefore are unlikely to respond to acoustical pressure.

The study also suggested that the lateral line system does not respond to normal acoustical stimuli and is unable to detect sound-induced water displacements beyond a few body lengths, even with large sound intensities (Myrberg 2001). Other reports indicate that sharks are highly sensitive to sound between approximately 40 and 800 Hz, which overlaps with seismic sound frequencies. Klimley and Myrberg (1979) established that an individual shark will suddenly turn and withdraw from a sound source of high intensity (more than 20 dB re 1μPa above broadband ambient SPL) when approaching within 10 m of the sound source.

Whale sharks are generally solitary outside of their aggregation periods, and therefore any disturbance is predicted to be slight behavioural impacts to individuals transiting the area. The available scientific evidence indicated that sharks will generally avoid seismic sources and the likely impacts on whale sharks are expected to be limited to short-term behavioural responses, possibly including avoidance of the operating acoustic array.

While the Whale Shark Recovery Plan (2005-2010; DEH 2005a) identified numerous possible threats to whale sharks, acoustic impacts were not identified as a specific threat. The recent publication from the Threatened Species Scientific Committee – Conservation Advice (TSSC-CA) for the whale shark did not identify any new information or impacts from seismic activities on whale sharks.

The OA overlaps the whale shark migration and foraging area. Subsequently individuals may be present at the time of seismic acquisition activities. However, given the low numbers of whale sharks and wide migration corridor (110 km at its narrowest point) the potential for significant impact is considered low. The area where the sound source levels are above the mortality, potential mortality injury and recoverable injury thresholds applicable to sharks and rays equate to ~3,750 km^2, this is ~0.4% of the total whale shark BIA migration area. Based on this analysis, and assuming impacts on individuals occurred, population level impacts are not expected due to the localised area of impact within the BIA.

As a conservative and precautionary approach, the threshold for fish with a swim bladder not involved in hearing (i.e. hearing generalists) have been implemented for whale sharks. The acoustic modelling results indicate that noise levels that may impact whale sharks (>213 dB re 1 µPa PK) will be limited to within 200 m of the acoustic source. It is conservatively expected that the potential impacts to whale sharks associated with acoustic noise will be the same as for other pelagic fish species, resulting in minor and temporary behavioural change (such as avoidance).

6.5.7. Disturbance to Sea Snakes

Receptors

The PMST reports identified 14 sea snake species as potentially occurring in the OA and an additional four species as potentially occurring in the wider EMBA. This including includes two species which are listed as threatened; the short-nosed sea snake and leaf-scaled sea snake.

During a survey of banks and shoals in 2011, the olive sea snake and the ornate reef sea snake were recorded at Heywood Shoal (which is within the OA but outside the FPZ), as well as 13 other individual sea snakes that were not identified (Heyward et al 2012).

In the wider region, known habitats for sea snakes are located at Cartier Island which is ~40 km from the FPZ.

Receptor Sensitivity

Snakes lack both an outer ear and a tympanic middle ear but have a connection between the middle ear bone to the jaw bones (Christensen *et al*. 2011). Scientific evidence demonstrated that snakes have dual auditory pathways to detect both airborne and ground-borne vibrations using the surface of their body and their inner ears (Young 2003), and their lower jaws may be stimulated by surface waves and vibrations (Christensen *et al*. 2011; Friedel *et al*. 2008). However, published snake audiograms measured hearing sensitivity to airborne sounds only (Christensen *et al*. 2011), although it seems plausible that sea snakes may use vibration detection for predator and prey interactions (Young 2003). Three characteristics suggest that sea snakes could be vulnerable to acoustic source impacts:

- Sealed nostrils and an air-filled lung extending the length of the body, plus slower swimming speeds than other marine vertebrates, might mean they are unable to avoid tissue damage at close range;
- Scale sensillae that allow sea snakes to detect the vibrations of their prey show peak sensitivity to low frequencies that overlap those produced by air guns. This may disrupt feeding (via acoustic masking) and provoke avoidance behaviour; and
- Translocation (a common response to air guns) is associated with high mortality in sea snakes; habitat displacement might have long term consequences for highly isolated populations.

A current research project – "Investigating the impact of seismic surveys on threatened sea snakes in Australia's North West Shelf" – is being undertaken at the School of Earth and Environmental Sciences, the University of Adelaide, supervised by Dr Kate Sanders.

Field experiments were trialled over 10 days in the Ningaloo Marine Park in August 2013. BRUVs equipped with underwater speakers, were deployed to assess impacts of airgun sound on sea snake behaviour. Due to technical difficulties in triggering reactions of wild sea snakes to underwater sound no further assessment was undertaken. It was noted that future studies will be needed to examine the behavioural and physiological effects of sounds, ideally using a real airgun source, on sea snakes.

Scanning electron microscopy and comparative phylogenetic analyses were used to provide evidence that the role of scale sensilla (touch receptors) of terrestrial elapid snakes may function as hydrodynamic receptors in sea snakes. Scale sensilla were more protruding (dome-shaped) in sea snakes than in their terrestrial counterparts, and high overall coverage of sensilla was found only in the sea snakes. High sensilla coverage appears to have evolved multiple times within sea snakes, so that the impacts of anthropogenic noise on sea snakes will likely vary among species.

One of the findings of the research and monitoring programme conducted at Scott Reef to study the effects of Woodside's Maxima 3D survey in 2007 on marine life was that the survey did not cause any observed physiological effects or mortality in marine fauna, including sea snakes (Woodside 2007a and 2007b). In the absence of observations of sea snakes exposed to air gun noise, either of captive individuals or in the field, a conservative and precautionary approach would presume that they will respond in a similar way to other marine reptiles (e.g. marine turtles), such as exhibiting behavioural change to an approaching sound source.

Mortality or mortal injury

Sea snakes are strongly reef-associated, have high rates of site fidelity, are mainly associated with shallow waters and maintain very small home ranges. Sea snakes at Heywood Shoal and Cartier Island are therefore not expected to travel into the FPZ, which is relatively flat, devoid of any hard substrate and deeper than 70 m water depth therefore does not provide sea snake habitat (Table 3-1). Suitable habitat is also unlikely to occur outside of the Heywood Shoal Acoustic Source Exclusion Zone.

Acoustic modelling results predicted that the maximum received sound levels at Heywood Shoal will be ~140-150 dB re 1μPa (SPL), and at Cartier Island are likely to be <130 dB re 1μPa (SPL) and <150-255 dB re 1μPa^2·s (SEL_{24h}); **Appendix D**). These levels are lower than mortality / potential mortal injury thresholds for marine reptiles (turtles) of >210 dB SEL_{cum} (**Table 6-6**), Therefore, no mortality / mortal injury impacts from the acoustic source are likely to occur at Heywood Shoal or Cartier Island (**Figure 6-7**). The survey activities will not result in anthropogenic disturbance in areas where the short-nosed or leaf-scaled sea snakes occur and will be consistent with the TSSC Conservation Advice (TSSC 2010).

The proposed survey activities will not have long-term implications at the population level.

Impairment / Behaviour

Using the Popper (2014) impact criteria for recoverable injury on other marine reptiles as a proxy, the impact range is defined as (F) thousands of metres due to the distance of the FPZ from Heywood Shoal (~1.8 km; **Table 6-6**). Therefore, potential impairment, recoverable injury impacts on seasnakes located at Heywood Shoal is low.

Using the acoustic impact criterion for other marine reptiles, such as marine turtle behavioural response to seismic sounds, for received sound levels that exceed 166 dB re 1 μPa (SPL; NMFS 2011), the maximum distance that behavioural impacts may occur are within 7.32 km from the source. Therefore behavioural impacts from the discharge of the acoustic array may occur to seasnakes located at Heywood Shoal (**Figure 6-7**).

Acoustic modelling results predict that the multiple pulse received sound levels in some areas of Heywood Shoal will be~140-150 dB re 1μPa (SPL) and ~186 dB re 1μPa^2·s (SEL_{24h}), therefore individual sea snakes at Heywood Shoal may display behavioural changes as the acoustic source is towed past Heywood Shoal. Due to the mobile nature of the seismic survey and the size of Heywood Shoal (approximately 32 km^2, of which the closest point is ~1.8 km from the FPZ), behavioural impacts are expected to be temporary and limited to individual sea snakes.

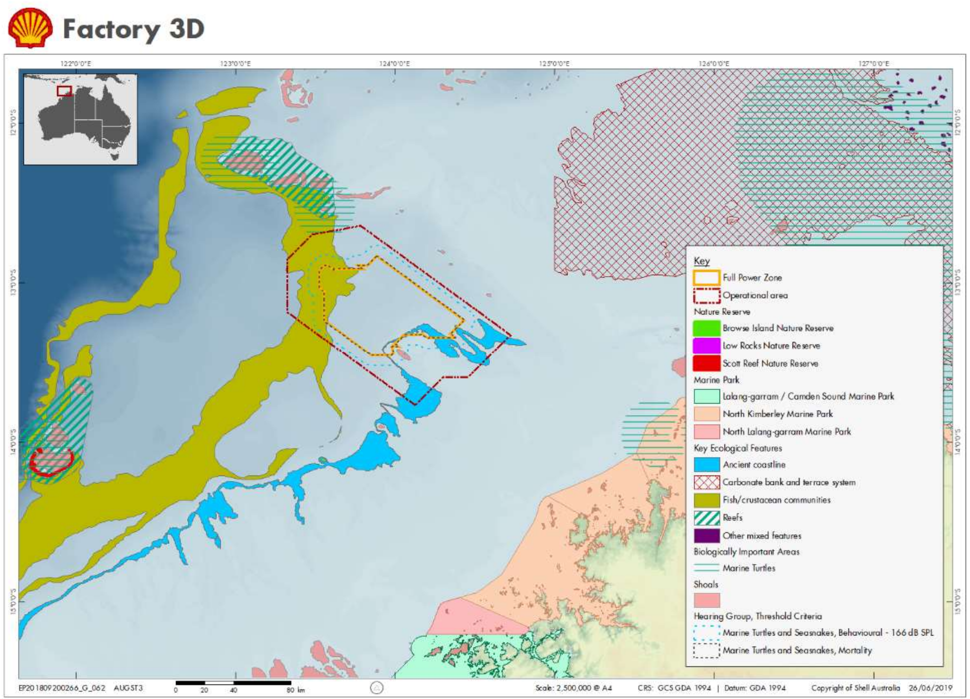


Figure 6-7 - Hearing Threshold Criteria for Marine Turtles and Sea Snakes and the Area from the FPZ where Thresholds are Exceeded

No impairment or behaviour impacts are expected at Cartier Island, due to modelling results predicting sound levels likely to be <130 dB re 1 µPa (**Appendix D**) and Cartier Island being located >20 km from anywhere where the acoustic source may be discharged.

The survey activities will not result in anthropogenic disturbance in areas where the short-nosed or leaf-scaled sea snakes occur and will be consistent with the TSSC Conservation Advice (TSSC 2010). The proposed survey activities will not have long-term impairment or behavioural implications at the population level.

Overlap with EPBC Critical Marine Fauna Habitat and Sensitive periods of Activity
There are no BIA or critical habitats identified for sea snakes in the DoE National Conservation Values Atlas (DoE 2018az).

6.5.8. Disturbance to Marine Turtles

Receptors
Green turtles and hawksbill turtles may be present within the OA during the survey. A green turtle internesting BIA at Cartier Island overlaps the Factory OA and is ~23 km from the FPZ. A hawksbill foraging BIA is located inside the reef at Cartier Island and is >20 km from where the acoustic source may be discharged and ~40 km from the FPZ. Additionally, Heywood Shoal (a shallow feature within the OA) may support foraging and internesting turtles (Commonwealth of Australia 2017a).

Receptor Sensitivity
There is limited information on marine turtle hearing. Migrating turtles may use various acoustic cues, and acoustic disturbances may potentially interfere with their navigational ability (McCauley 1994). The auditory sensitivity of marine turtles is centred in the 400–1,000 Hz range, with a rapid drop-off in noise perception on either side of this range (Richardson *et al.* 1995). This auditory range matches their weak vocalisation abilities, which are also in the low frequency range (100–700 Hz).

Electrophysiological responses, specifically auditory evoked potentials (AEPs), are the most widely accepted technique for measuring hearing in situations in which normal behavioural testing is impractical. AEP studies on hearing were conducted on various species and stages of life and indicated that the best hearing range for marine turtles is from 100–700 Hz, which overlaps with the frequency range of maximum energy in the horizontally propagating component of a seismic source (McCauley 1994).

Bartol *et al.* (1999 as cited in BOEM) found that juvenile loggerhead turtles detected sounds in the low frequency range of 250–1000 Hz, with the most sensitive hearing around 250 Hz. Another study on hatchling and juvenile loggerhead and juvenile green turtles (Bartol and Ketten 2006) found that hatchling loggerheads had the widest range of hearing frequency sensitivity (100–900 Hz), while larger juveniles responded to a narrower range (100–400 Hz). Hearing sensitivity of green turtles also varied with size, as smaller green turtles had a broader frequency range of hearing (100–800 Hz) than that detected in larger subjects (100–500 Hz). Piniak *et al.* (2012) found that leatherback turtle hatchlings detected sounds between 50 and 1,200 Hz, with maximum sensitivity between 100 and 400 Hz. Like other species of marine turtle, they had a relatively narrow, low-frequency range of hearing sensitivity.

Lavender *et al.* (2014) detected no significant differences in behaviour-derived auditory thresholds or AEP-derived auditory thresholds between post-hatchling and juvenile loggerhead turtles. As turtles are in different acoustic environments for each life history stage, individuals may have different hearing capacity throughout ontogeny. However, the measured hearing frequency range (50–1,100 Hz) and highest sensitivity (100–400 Hz) suggested that post-hatchling and juvenile loggerhead sea turtles are low-frequency hearing specialists, exhibiting little differences in threshold sensitivity and frequency bandwidth despite residence in acoustically-distinct environments throughout ontogeny. Consequently, the effects of seismic airgun noise emissions on hatchlings are anticipated to be similar to those of juveniles and adults.

Mortality / Potential Mortality

Popper *et al.* (2014) provided exposure guidelines for marine turtles exposed to seismic airgun noise, with an impact threshold criterion >207 dB PK or >210 dB SEL_{cum} for mortality and potential mortal injury to turtles (**Table 6-6**). There were no studies conducted on hearing loss or other effects on hearing in any turtle species. Therefore, Popper *et al.* (2014) extrapolated impact thresholds from fish, based on the rationale that the hearing range for turtles is more like that of fishes than of any marine mammal. There are no specific guideline values proposed by the Working Group for turtle behaviour disturbance due to the limitations described above (Popper *et al.* 2014).

Based on the noise modelling the received noise levels, turtle mortality or mortal injury may occur at a maximum distance of 191 m from the acoustic source and therefore impacts are not predicted within the nearest internesting BIA or at Heywood Shoal. The application of the Acoustic Source Exclusion Zones means that the source will not be discharged within 7.32 km of the Cartier Island turtle internesting BIA.

It is possible that individual marine turtles may transit through the OA at the time of survey, however, mortality impacts are considered unlikely due to marine turtles displaying behavioural responses to an approaching seismic array at received sound levels of SPL ~166 dB re 1 µPa and avoidance at around 175 dB re 1 µPa (McCauley *et al.* 2003; **Table 6-6**). Based on acoustic modelling for the Factory 3D MSS, behavioural impacts will occur at approximately 7.32 km from the source (see discussion on behavioural impacts below), which means it is highly unlikely that turtles will come within 191 m of the seismic source. No mortality / mortal injuries are expected as a result of the survey.

Impairment

There are no defined quantitative noise exposure criteria for impairment effects (PTS, recoverable injury and TTS) in turtles. Based on the application of the Popper *et al.* (2014) semi-quantitative exposure criteria (**Table 6-6**) there is a high risk of potential impairment (recoverable injury and TTS) effects to turtles within tens of metres of the array.

Based on these distances, the high-risk area for potential impairment (recoverable injury and TTS) to turtles will not occur within the nearest internesting BIA (>7km from where the source may be discharged) or at Heywood Shoal due to the Acoustic Source Exclusion Zones. There is a low risk of impairment to marine turtles from the acoustic source and impairment impacts at a population level are not considered credible.

Behaviour

There is no scientific evidence implying that turtles actively avoid or are attracted to close range (<500 m) encounters with operating acoustic arrays. However, Moein *et al.* (1994) tested the hearing sensitivity of caged loggerhead turtles altered after exposure to several hundred pulses within 30–65 m of a single airgun (**Figure 6-7**) pulse numbers and received sound levels not stated). Hearing was tested before, within a day and then two weeks after exposure. Approximately 50% of the exposed individuals indicated altered hearing sensitivity when tested within a day of their exposure, but none provided any sign of altered hearing two weeks later, compared to the pre-exposure tests. These results suggested that acoustic impacts were not significant, temporary and recoverable with two weeks.

However, other studies indicated that marine turtles began to show behavioural responses to an approaching seismic array at received sound levels of SPL ~166 dB re 1 µPa and avoidance at around 175 dB re 1 µPa (McCauley *et al.* 2003; **Table 6-6**). Also, Weir (2007) completed observations from on-board a seismic survey vessel during a 10-month 3D survey offshore from West Africa. She concluded that:

"..There was indication that turtles occurred closer to the source during guns-off than full-array, with double the sighting rate during guns-off in all distance bands within 1000 m of the array."

The reduction in number of turtles observed within 1,000 m during operation of a full acoustic array (Weir 2007) is therefore reasonably consistent with the observations of McCauley *et al.* (2003), which indicated a behavioural response threshold of ~166 dB re 1 µPa SPL. From airgun exposure tests on a caged green turtle and loggerhead turtle that were extrapolated to response levels for a typical acoustic array operating at full power in 100 m water depth, McCauley *et al.* (2003) concluded that turtles would, in general, show behavioural responses at 2 km and avoidance behaviour at 1 km from such operations.

Seismic surveys in shallow waters (<15 m) near nesting beaches may expose both mating turtles, internesting females and hatchlings to increased sound levels. Mating turtles and internesting females are not known to favour deeper waters (>15 m), and while the air gun discharges may be audible in the deeper water, it is unlikely the sound would be of sufficient intensity to cause a startle response in the individuals (Pendoley 1997). Similarly, it is unlikely that the noise associated with seismic discharges would override the biologically imprinted drive in turtle hatchlings to complete the initial 24-hour 'swim frenzy' that takes them out to sea as quickly as possible. Given the very high mortality rate in hatchlings, it is unlikely that the impacts from seismic source would be measurable (Pendoley 1997). The only area in the OA that is shallower than 70 m water depth is Heywood Shoal, which has plateaus in shallow water depths of 15 to 20 m (Section 3.4.1.1). However, Heywood Shoal does not rise to the sea surface and therefore does not provide any nesting beaches. The closest nesting beaches to the OA are located at Ashmore Reef and Cartier Island (52 km north-west and 9 km north of the OA respectively). A 20 km internesting buffer BIA and one nesting habitat critical area, both around Cartier Island, overlap the OA (**Figure 3-8**; **Figure 3-9**) however the BIA and habitat critical area are outside the predicted area of behavioural impacts (**Figure 6-7**) therefore no noise impacts on nesting, mating or internesting turtles are predicted to occur (see discussion below on EPBC Act Critical Marine Fauna Habitat).

Based on the limited data regarding noise levels that illicit a behavioural response in turtles, the lower level of 166 dB re 1 µPa level drawn from NSF (2011) is typically applied, both in Australia and by NMFS, as the threshold level at which behavioural disturbance could occur.

Based on the acoustic modelling received levels exceed the behavioural disturbance threshold within 7.32 km from the source. The turtle internesting BIA is located approximately 20km from the FPZ and SSZ, where the acoustic source will normally be operated. In addition, an Acoustic Source Exclusion Zone will apply 7.32 km from the edge of the green turtle internesting BIA (**Figure 2-2**). Therefore, no behavioural disturbance will occur to turtles within the identified green turtle internesting BIA . There may be some behavioural disturbance to isolated transient individuals within the OA.

Overlap with EPBC Act Critical Marine Fauna Habitat and Sensitive Periods of Activity

The OA overlaps the green turtle internesting buffer BIA at Cartier Island (DoE 2016c).

Based on the modelling the received levels for mortality or mortal injury or behavioural distance impacts to turtles is not reached within the closest internesting and foraging BIA. Individual turtles may traverse through the OA while a survey is being undertaken, however, impacts would be expected to be limited to behavioural disturbance such as moving further away from the survey.

The Recovery Plan for Marine Turtles in Australia (2017) identifies seismic noise as a threat to marine turtles with suggested controls of:

- Surveys planned to occur inside important internesting habitat should be scheduled outside the nesting season.
- Undertaking a soft start during surveys irrespective of location and time of year of the survey.

The acoustic modelling results at Site 2 predict that received sound levels at Cartier Island are likely to be <130 dB re 1 µPa (SPL) and therefore behavioural impacts within the green turtle internesting BIA and hawksbill turtle foraging BIA are not predicted (**Appendix D**).

Based on the scientific evidence, acoustic modelling results and proposed control measures, the survey activities are not expected to induce mortality, potential mortal injury nor long-term or permanent displacement of marine turtles. Any behavioural response or avoidance would be short-term and localised to a few individuals that may travel or rest directly under the source.

6.5.9. Disturbance to Seabirds

Receptors

The Factory OA overlaps the following seabird BIAs (NCVA 2018):

- Greater frigatebird – breeding and foraging;
- Red-footed booby – breeding and foraging;
- Wedge-tailed shearwater – breeding and foraging;
- White-tailed tropicbird – breeding and foraging; and
- Lesser frigatebird – breeding and foraging.

***Receptor* Sensitivity**

Bird species that plunge or dive for prey (such as tropicbirds and tern species) could potentially be exposed to underwater noise, if they dive near the seismic vessel when the acoustic source is in operation.

There is limited information available regarding the hearing sensitivity of seabirds and shorebirds whilst they are underwater. Studies to date have focused on observations of effects during seismic activity. Seabirds do not appear to be Stemp (1985 as cited in LGL 2012) conducted observations on the effects of seismic exploration on seabirds and did not observe any negative effects. Lacroix *et al.* (2003 as cited in LGL 2012) studied the effect of nearshore seismic surveys on moulting long-tailed ducks in the Beaufort Sea, Alaska, and failed to detect any negative effects. Furthermore, they noted that seismic activity did not appear to significantly change the diving intensity of the ducks.

Mortality / Mortal Injury / Impairment

Species such as the white-tailed tropicbird, lesser crested tern and the wedge-tailed shearwater forage by plunge-diving to depths. It's possible that during the course of normal feeding or escape behaviour some birds could be near enough to an acoustic source to be injured. However, no records of this circumstance or of bird mortality from seismic surveys could be found, a bird would have to be very close to an acoustic source to receive a discharge with sufficient energy to cause injury, and as such is very unlikely to occur. The approach of the vessel serves as a "ramp-up" in that the received noise levels at a fixed point along a line will gradually increase. As such, birds will be alerted to the approaching seismic vessel and have time to move away from the acoustic source. Birds may be affected slightly by seismic sounds from the proposed survey, but impacts are not expected to be significant and would be limited to individuals. Impacts to bird populations associated with the significant habitats of Cartier Island and Ashmore Reef from acoustic emissions resulting from the Factory 3D MSS are not anticipated due to the distance of the island and reef from the OA.

The EPBC Act Policy Statement 3.21 – *Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species* (COA 2015) does not identify any impacts and risks to shorebirds from offshore seismic activities.

Behaviour

Localised, temporary displacement

Seabirds may be physically displaced by vessels or because of increased noise at the sea surface only. However, as the directivity of the acoustic source is directed downwards towards the seabed and levels reduce with distance away from the source, the area of displacement is anticipated to be minimal and localised (within the vicinity of the vessel). Pelagic seabirds with BIA ranges within the OA cover very large areas when foraging, (over 100 km; e.g. terns, shearwaters and frigatebirds). Therefore, any displacement from the proposed survey activities would be limited to the immediate area close to the vessel and any impact is predicted to be temporary and no more than slight behavioural changes.

Modified prey abundance

Prey abundance is predicted to either increase or decrease from the discharge of the acoustic source. If a seismic activity disorients, injures, or kills prey species, or increases the availability of prey species to marine birds, a seismic survey may actually attract birds. Alternatively, if prey species exhibit avoidance of the acoustic source it is expected to be transitory and limited to a very small portion of a bird's potential foraging range. Acoustic impacts on prey species such as invertebrates and fish are outlined above in **Section 5.5.6.1.6** and **Section 5.5.6.1.5** and are expected to be limited to short-term behavioural displacement. Therefore, it's unlikely that seabird prey species will be significantly affected by seismic activities, particularly to a degree that affects the foraging success of birds and at a population level impact.

Disturbance to nesting birds

As nests are located on-shore, underwater noise from the acoustic source will not impact nesting birds. However, nesting birds could potentially be disturbed and response to either acoustic or visual stimuli if a project vessel approaches too close to a breeding colony. There is little potential for this during the proposed survey as the closest nesting site at Cartier Island, 20 km from the OA and 40 km from the FPZ.

Based on the impact assessment no long term or population impacts to seabirds are predicted.

6.5.10. Disturbance to Dugongs

Receptors

Dugongs are not identified as a receptor as there are no dugong BIA identified within the OA, the closest dugong BIA is located 80 km from the FPZ at Ashmore Reef.

Based on limited data regarding acoustic levels that may elicit a behavioural response in Sirenians, the level of 160 dB re 1 µPa (SPL; **Figure 6-9** below) has been applied as the threshold level at which behavioural disturbance could potentially occur (NMFS 2018, DEWHA 2008). The JASCO noise modelling identified the largest impact distance for the 160 dB re 1 µPa (SPL) threshold, was 10 km at site 5 (**Table 6-9**). Therefore, the dugongs within and adjacent to Ashmore Reef (80 km from the FPZ) are not predicted to be impacted by the discharge of the acoustic source.

6.5.11. Disturbance to Cetaceans

Receptors

Most cetacean species use sound to communicate (e.g. humpback whale calls) or perceive their environment (e.g. echolocation of prey). This reliance on underwater noise, and their high conservation value, makes cetaceans of concern when assessing potential impacts from underwater noise.

Within the Factory OA the following cetaceans have been identified:

- Blue whale
- Pygmy blue whale
- Humpback whale
- Sei whale
- Fin whale
- Bryde's whale
- Killer whale
- Sperm whale
- Spotted Bottlenose dolphin

- Australian Snubfin dolphin

The Factory OA slightly overlaps the pygmy blue whale migration BIA (OA overlaps 0.02% of the total migration BIA). The Factory FPZ does not overlap any BIA for any cetaceans and the closest cetacean BIA to the FPZ are as follows:

- 22 km from the pygmy blue whale migration BIA;
- 143 km from the Australian snubfin dolphin foraging BIA; and
- 157 km from humpback whale calving BIA.

No resting, breeding or foraging BIA are identified within the OA and as such any cetaceans encountered are likely to be transiting through the OA.

Odontocetes – toothed whales

Receptor Sensitivity

Odontocetes (i.e. toothed whales) includes both medium frequency (MF) and high frequency (HF) species. Toothed whales produce a wide range of whistles, clicks, pulsed sounds and echolocation clicks. The frequency range of toothed whale sounds excluding echo location clicks are mostly <20 kHz with most of the energy typically around 10 kHz, however some calls may be as low as 100 to 900 Hz. Sound levels of these calls range from 100 to 180 dB re 1 µPa (SPL; Richardson *et al.* 1995). The sounds produced (other than echolocation clicks) are very complex in many species and used for communication between members of a pod in socialising and coordinating feeding activities.

Hearing capability of larger toothed whales is largely unknown. Generally, they have more sensitive hearing in the lower frequencies than the smaller toothed whales, for example, killer whales most sensitive hearing range extends to as low as 18 kHz (Szynmanski *et al*. 1999). Considering the auditory weighting from NMFS (2016) applicable for the majority of odontocetes in Australian waters, mid-frequency cetaceans, they have low sensitivity to low frequency sounds, such as seismic sources, which have the majority of energy below 500 Hz. Therefore, it is highly unlikely that mid-frequency cetaceans, which includes sperm, beaked and killer whales, and bottlenose and common dolphins, will experience either PTS or TTS from a seismic survey.

Mortality / Potential Mortality

There are no defined noise exposure criteria for mortality and potential mortal injury impacts in either MF or HF cetaceans. These effects are extremely unlikely to occur as received sound levels of sufficient magnitude to cause mortality/potential mortal injury may only occur at extremely close range (i.e. <10 m) to an operating airgun array. This scenario is extremely unlikely to occur given the control and mitigation measures that are routinely implemented for marine seismic surveys in Australian waters, in compliance with EPBC Policy Statement 2.1 (i.e. use of MFOs; observation, low-power and shutdown zones; soft starts etc.).

Impairment

There are two categories of auditory threshold shifts or hearing loss; PTS and TTS. PTS occurs when an individual experiences a shift in their hearing threshold caused by prolonged or repeated exposure to high sound levels and resulting in permanent and irreversible damage (Richardson *et al.* 1995). TTS occurs when an individual's hearing threshold is temporarily increased during and immediately after an exposure event to a loud sound source (Richardson *et al.* 1995). It is quite difficult and not always possible to accurately measure PTS, and as such TTS measurements over time are used to predict likely occurrences of PTS. This process is described in the recent National Marine Fisheries Service (NMFS) technical guidance (NMFS 2016), which summates the most recent scientific literature on the impacts of sound on marine mammal hearing.

Table 6-6 describes the functional marine mammal hearing groups based on hearing sensitivity and provides the NMFS threshold levels for PTS onset for low-frequency (LF) cetaceans (i.e. baleen whales), mid-frequency (MF) cetaceans (e.g. dolphins, toothed whales) and high-frequency (HF) cetaceans (e.g. true porpoises, pygmy and dwarf sperm whales) for impulsive sources of noise such as seismic airgun arrays (NMFS 2016).

Acoustic modelling was not conducted to assess the accumulated SEL footprints related to PTS for mid-frequency cetaceans. It is considered that the potential adverse effects such as PTS on toothed whales would only occur if the whale is within close range (i.e. less than a few hundred metres). Therefore, the potential for TTS in odontocetes is extremely low, as it is estimated that it would require the individual to be <200 m from the acoustic array (**Appendix D**).

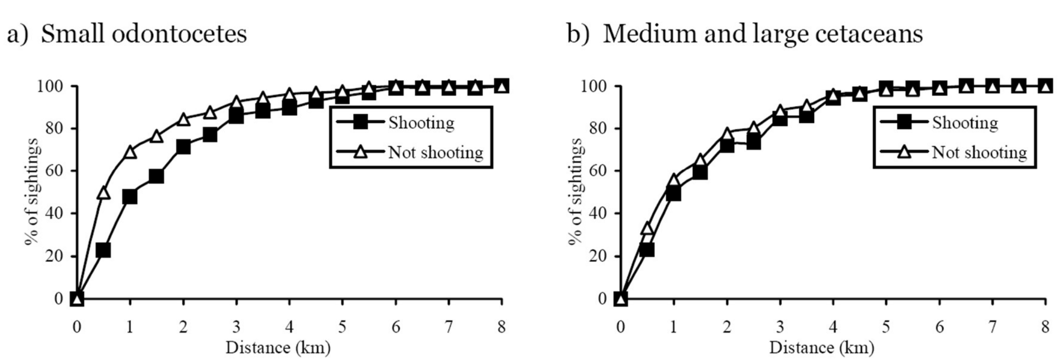
Impairment effects on both large MF and HF cetaceans are unlikely to occur given the mitigation procedures and control measures that are routinely implemented for marine seismic surveys in Australian waters, in compliance with EPBC Policy Statement 2.1 (i.e. use of MFOs; observation, low-power and shutdown zones; soft starts etc.).

<u>Behavioural</u>
As marine mammals differ in their response type and strength, and conspecifics who are exposed to the same sound react differently, behavioural responses to underwater sound are difficult to determine (Nowacek *et al.* 2004, Gomez *et al.* 2016, and Southall *et al.* 2016). An individual's response to a stimulus is influenced by the context in which the individual receives the stimulus and how relevant the individual perceives the stimulus to be. There are a number of biological and environmental factors that can affect an individual's response—their behavioural state (e.g., foraging, travelling or socialising), reproductive state (e.g., female with or without calf, or single male), age (juvenile, sub-adult, adult), and motivational state (e.g., hunger, fear of predation, courtship) at the time of exposure as well as perceived proximity, motion, and biological meaning of the sound and nature of the sound source.

There is little systematic data on the behavioural response of toothed whales to seismic surveys. Richardson *et al.* (1995) reported that sperm whales appeared to react by moving away from surveys and ceasing to call even at great distances from a survey. However, in a 2003 study supported by the US Minerals Management Service (Jochens and Biggs 2003), two controlled exposure experiments were carried out (including one with three simultaneously tagged whales) to monitor the response of sperm whales to seismic source. The whales were exposed to a maximum received level of 148 dB re 1 µPa. There was no indication that the whales showed horizontal avoidance of the seismic vessel nor was there any detected change in feeding rates of the tagged sperm whales.

The Bureau of Ocean Energy Management (BOEM - Barkaszi *et al.* 2012) report indicated that defined species groups (all cetaceans, baleen whales, delphinids, and sperm whales) were sighted at significantly greater distances from acoustic sources during fullpower than during periods of silence, illustrating a level of spatial avoidance to the acoustic sources.

Odontocetes have poor hearing in the low frequency range of acoustic array noise (10 to 300 Hz; NMFS 2016) and seismic operators sometimes report dolphins and other small toothed whales near operating acoustic arrays. However, there is a component of seismic pulses in the higher frequency spectrum and in general most toothed whales do show some limited avoidance of operating seismic vessels. Goold (1996) studied the effects of 3D seismic surveys on common dolphins (*Delphinus delphis*) in the Irish Sea. The results indicated a local displacement of dolphins around the seismic operation. This observation is consistent with data compiled by Stone (2003) from marine mammal observers aboard seismic vessels in the North Sea that shows small toothed whale species tend to move away from operating airguns (**Figure 6-8**).



Source: Stone (2003).

Figure 6-8 - Proportion of marine mammal sightings occurring within specified distances of the airguns during seismic surveys

Overlap EPBC with Critical Marine Fauna Habitat and Sensitive periods of Activity

The proposed OA does not overlap any odontocetes BIA or migratory paths, therefore it is unlikely that large numbers of cetaceans will be present in the area during acquisition, and any individuals within the OA would be limited to transiting individuals. The closest Australian snubfin dolphin BIA is >143 km from the OA and at this distance noise levels are expected to be <120-130 dB re 1 μPa^2·s SEL and therefore below the levels said to elicit TTS or PTS impairment.

Mysticetes – baleen whales

Receptor Sensitivity

Baleen whales are predominantly low frequency (LF) species. Studies of baleen hearing structures suggests that their hearing is best adapted for low frequency sound (Mooney *et al.* 2012). Baleen whales produce a rich and complex range of underwater sounds ranging from about 12 Hz to 8 kHz, but with the most common frequencies below 1 kHz (McCauley 1994).

Mortality/potential mortal injury

There are no defined noise exposure criteria for mortality and potential mortal injury impacts in LF cetaceans. These effects are extremely unlikely to occur as received sound levels of sufficient magnitude to cause mortality/potential mortal injury may only occur at extremely close range (i.e. <10 m) to an operating airgun array. This scenario is extremely unlikely to occur given the control and mitigation measures that are routinely implemented for marine seismic surveys in Australian waters, in compliance with EPBC Policy Statement 2.1 (i.e. use of MFOs; observation, low-power and shutdown zones; soft starts etc.).

Impairment

TTS has not been observed for a baleen whale, however their low-frequency hearing capability suggested that these species may be sensitive to low-frequency seismic sources. To reduce potential acoustic exposure to sound levels that may trigger TTS in baleen whales, the EPBC Act Policy Statement 2.1 adopted an energy measure threshold of an un-weighted 160 dB re 1 μPa^2·s SEL for a single seismic 'shot' at 1 km. This threshold assumed that a baleen whale is susceptible to TTS if exposed to a weighted SEL of 183 dB re 1 μPa^2·s SEL (Southall *et al.* 2007) but applied in an unweighted fashion. The policy statement concluded that a baleen whale could be exposed to 33 minutes of 160 dB re 1 μPa^2·s shots every 10 s before levels sufficient to cause TTS would be reached. This threshold determined whale exclusion zones, within which seismic sources operate at lower acoustic power output or shut-down completely to prevent significant exposure to sound levels that could induce TTS.

If SELs from air-gun impulses fall below this threshold, the policy concluded that seismic sources may operate with a reduced 1 km exclusion zone; while if SELs are above this threshold, the seismic sources will not operate within a 2 km exclusion zone from the acoustic source. Acoustic modelling predicted that the EPBC Act Policy Statement 2.1 threshold level would be not be exceeded at 5.68 km (Site 1), 2.36 km (Site 2) 2.21 km (Site 3), 2.32 km (Site 4), 5.19 km (Site 5);**Table 6-9**; **Table 6-11**).

Physical damage to the auditory system of cetaceans may occur at accumulated SEL >183 dB re 1 μPa^2·s (SEL_{24h}) or PK levels >219 dB re 1 μPa (SPL; **Table 6-9**; **Table 6-11**; NOAA 2016). Acoustic modelling was conducted to assess the accumulated SEL footprints related to PTS and TTS for low-frequency cetaceans. The predicted PTS SEL_{24H} for LF would be exceeded within 1.73 km from the acoustic source, and therefore less than the lower power zone distance of 2 km (**Table 6-11**). Therefore, with the precaution zones implemented as per EPBC Act Policy Statement 2.1 (**Appendix A: Requirements and Comittments**), mysticetes will not be exposed to underwater sound levels likely to cause PTS.

The distance to the low-frequency NMFS PK threshold from the acoustic source for PTS is predicted to be 20 m and TTS is predicted to be <20 m (**Table 6-9**). Therefore, the combination of implementing a 2 km low-power zone and a 500-m shut-down zone will ensure that baleen whales are not exposed to peak pressure levels which could induce PTS or TTS.

The following precaution zones will therefore be implemented throughout survey:

- Observation zone: 3 km horizontal radius from the acoustic source

- Low power zone: 2 km horizontal radius from the acoustic source
- Shut-down zone: 500 m horizontal radius from the acoustic source.

Behavioural

Underwater noise associated with acoustic source arrays used during seismic surveys can cause behavioural changes in whales (McCauley 1994). Behavioural responses to airgun noise include swimming away from the source of the noise, rapid swimming on the surface and breaching (McCauley *et al.* 2003). The noise level at which responses are elicited varies between species and between individuals within a species (Richardson *et al.* 1995). Stone (2003) suggested that different groups of cetaceans adopt different strategies for responding to acoustic disturbance from seismic surveys, with baleen and killer whales displaying localised avoidance, pilot whales showing few effects and sperm whales showing no observed effects. Blackwell *et al.* (1995) noted that:

"Bowhead whale calling rates initially increased alongside seismic sound exposures, but call rates levelled off and peaked as seismic levels increased and then began to decrease when the cumulative SEL 1-min values increased above 118 dB re 1 μPa^2.s, until they are silent when cumulative SEL 10-min values were above ~160 dB re 1 μPa^2.s (Blackwell et al. 2015)."

McCauley *et al.* (2003) carried out a comprehensive study and monitored the effects of seismic survey noise on humpback whales in the Exmouth Gulf region of WA and concluded:

- Only localised avoidance was seen by migrating whales during the seismic operation, indicating that the 'risk factor' associated with the seismic survey was confined to a comparatively short period and small range displacement;
- Coupled with the fact that humpback whales were seen to be actively utilising the 'sound shadow' near the surface, then it was unlikely that individuals were at any physiological risk unless at very short range from a large acoustic array, perhaps of the order of a few hundred metres; and
- Upper levels of noise at 1.5 km from the CMST seismic survey array were in the order of 182 dB re 1 μPa, which was still well below the source levels of the highest components of humpback whale song (192 dB re 1 μPa).

It is also known that baleen whales avoid operating seismic vessels, and the distance over which avoidance occurs seems to be highly variable between species and even within species. It is considered that avoidance behaviour represents only a minor effect on either the individual or the species unless avoidance results in displacement of whales from areas of biological importance such as nursery, resting or feeding areas, important period for the species. McCauley *et al.* (2003) found that migrating humpback whales showed a general avoidance of an operating seismic source at 157 to 164 dB re 1 μPa (SPL).

Research from the analysis of the BRAHSS data found similar results, where significant responses were observed within 3 km of an operating source and received levels were greater than 140 dB re 1 μPa^2 s (SEL; Dunlop *et al*. 2017). However, it is important to note the desktop research of data collected states that these limits *"do not represent a threshold of response, but that responses were more likely to occur within these bounds than outside of them*". Responses were highly variable – some groups did not respond, some groups responded outside this (Dunlop *et al*. 2017).

The National Marine Fisheries Service (NMFS) in the U.S. use a threshold 160 dB re 1 μPa (SPL **Figure 6-9**) for potential behavioural disturbance to marine mammals (NMFS 2013). From the modelling for the survey this noise threshold level could be expected to occur within 7.7-10 km of the acoustic source (**Appendix D**). Avoidance, however, is not directly related to sound level thresholds but also influenced by the state of the individuals (e.g. their reproductive, health, and foraging condition) and the context of exposure.

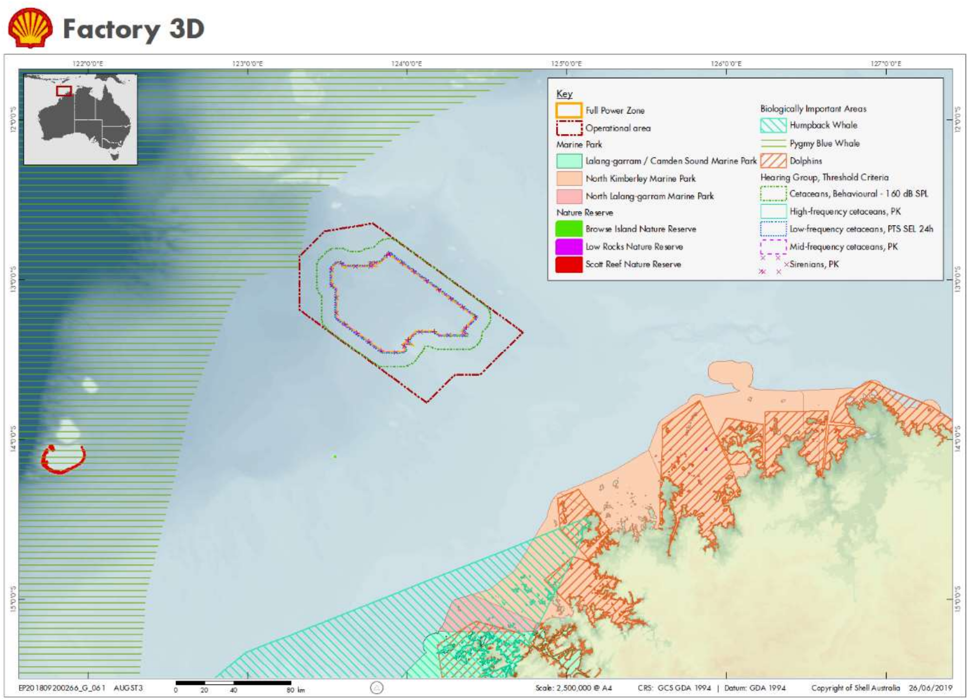


Figure 6-9 – Hearing Threshold Criteria for Marine Mammals and the Area from the FPZ where Thresholds are Exceeded

<u>Overlap with EPBC Act Critical Marine Fauna Habitat and Sensitive periods of Activity</u>

<u>Pygmy blue whales</u>

The OA only overlaps 0.02% (1.8 km^2) of the pygmy blue whale migration area, which is over 100 km wide in most locations and is therefore not considered a narrow or restricted corridor, nor is it considered a critical habitat (feeding, breeding, calving, resting aggregation, narrow/restricted migratory pathway). In fact, where the polygon does overlap the BIA, the BIA is over 120 km wide and migrating whales will be transient and able to move around and away from the survey vessel and acoustic source. Although the timing of the survey may overlap with the pygmy blue whale migratory period, the FPZ does not overlap the migration BIA and is >22 km from the boundary of the BIA. The OA overlaps no other recognised cetacean BIA.

Given the well-known progression of migration (**Figure 3-12** to **Figure 3-14**), migrating pygmy blue whales are expected to pass to the west of the OA on their northern migration from March to August (no acquisition will occur within March), and on their southbound migration from October to December (no acquisition will occur within October). However due to the maximum water depths over the OA and FPZ (max depths 455 m and 374 m, respectively), it is very unlikely that significant numbers of pygmy blue whales will be encountered during the survey and any individuals that are encountered will be transient.

The predicted TTS SEL_{24H} for LF is predicted to be exceeded within 38 km from the acoustic source, however, the SEL_{24h} scenario assumes an unrealistic scenario, that being the whale is consistently exposed to the acoustic threshold in a fixed position for a 24-hour period. As such the corresponding SEL_{24h} radii for low-frequency cetaceans were larger than those for peak pressure criteria, but they represent an unlikely worst-case scenario (McPherson *et al.* 2019). "More realistically, marine mammals (and fish) would not stay in the same location or at the same range for 24 hours. Therefore, a reported radius for SEL_{24h} criteria does not mean that marine fauna travelling within this radius of the source will be injured, but rather that an animal could be exposed to the sound level associated with injury (either PTS or TTS) if it remained in that range for 24 hours (McPherson et al. 2019)."

As pygmy blue whales will be migrating, any whales likely to be encountered will be transiting through the survey area at speeds of between 5-33 km/hr (no breeding foraging, calving BIA are identified) or exhibit a behavioural response and move away from the acoustic source and as such, accumulated SEL will not be attained as they would not occur within the area exceeding TTS SEL_{24H} for LF conservatively longer than 16 hours[10] typically for more than around 15 hours (Department of Sustainability and the Environment, Action Statement 242[11]). It is anticipated that any whales that may experience TTS will fully recover after the sound exposure ceases (NMFS 2018). Therefore, the SEL_{24h} is a highly conservative metric for this assessment.

Received sound levels below those said to cause behavioural disturbance, SPL's <160 dB re 1 µPa (SPL; NMFS 2013) are considered acceptable for potentially migrating pygmy blue whales. Based on acoustic modelling results at Site 2 (**Table 6-9**) received sound levels are not likely to exceed the behavioural impact threshold criterion at distances >8 km from the acoustic source. Sound levels are predicted not to exceed ~120-130 dB re 1 µPa (SPL) within the migration BIA, and therefore these levels are not likely to adversely impact migrating pygmy blue whales.

The modelled SEL_{24h} for PTS is 1.73 km, and therefore a proposed mitigation powerdown zone of 2 km will ensure no PTS impacts to pygmy blue whales occur, therefore marine mammals will not be exposed to cumulative sound levels which exceed the PTS (SEL_{24h}) threshold.

The geological formations of the seabed and below including the formation of nearby Heywood Shoal are such that it is optimal to configure acquisition sail lines in a northwest/southeast direction throughout the OA. As such, the survey vessel will be undertaking line turns in the northwest and southeast ends of the OA where there is overlap with the pygmy blue whale BIA. Line turns will be undertaken in a racetrack progression and are generally considered to cover 5-10 km at either end of the FPZ so as to safely navigate whilst towing 8,100 m of streamers. Further, during line turns, the acoustic source array will either be shut down or in low power mode during soft starts. In other words, the full fold seismic acquisition area does not extend as far in a south/north direction as the OA and therefore seismic acquisition will not occur in the portion of the OA which overlaps the BIA. The seismic survey is proposed to commence in November 2019 and there is likely to be an overlap with the pygmy blue whale southern migration in November and December, however seismic array emissions will be transient as the sail lines fall perpendicular to the BIA and are at the very end of the sail lines where the line turns will occur (i.e. the acoustic source array will either be shut down or in low power mode during soft starts).

EPBC Policy Statement 2.1 and Matters of National and Environmental Significance

EPBC Policy Statement 2.1 and Matters of National and Environmental SignificanceEPBC Policy Statement 2.1 and Matters of National and Environmental Significance

There are a number of key points relating to the Department of Environment EPBC Policy Statement 2.1 which Shell has taken into account when evaluating the cost of avoiding the BIA against the potential environmental benefit:

- Biologically important habitats are defined in the Policy Statement as: *"breeding, calving, or resting areas, or confined migratory routes or feeding areas."* The pygmy blue whale migration BIA is over 120 km wide where it overlaps with the OA, which is not considered a confined migratory route. Therefore, the pygmy blue whale BIA cannot be viewed as a biologically important habitat under the definition provided. On this basis, there should not be a requirement for *"explicit justification for why the proposed survey should take place…"*
- The Policy Statement includes the following (pg. 2):
  "This Policy Statement is not intended to prevent all behavioural changes, which might occur in response to detectable, but non-traumatic sound levels. In fact, it is

[10] Based on the assumption that a whale might travel as slow as 5km/hr migrating and it needs to travel 80km to move outside the area exceeding TTS SEL_{24H} for LF.

[11] https://www.environment.vic.gov.au/__data/assets/pdf_file/0014/32315/Blue_Whale_Balaenoptera_musculus.pdf

likely that whales in the vicinity of seismic surveying will avoid the immediate area due to an aversive response to the sound. This aversion is relied upon as a form of mitigation to prevent whales from approaching or being approached closely enough to cause acoustic injury from intense or **prolonged sound exposure. At the scale of a seismic survey, such temporary displacements are unlikely to result in any real biological cost to the animals unless the interaction occurs during critical behaviours (e.g. breeding, feeding and resting), or in important areas such as narrow migratory corridors.** In these biologically important habitats (**Figure 3-14**), where the displacement of whales may have a more significant or biologically relevant effect, the proponent is encouraged to conduct the survey at different times of year to avoid overlap with the presence of whales."

Shell assessed whether the activity could result in significant impacts on pygmy blue whales (listed as Endangered and Migratory under the EPBC Act) using the Department of Environment's Matters of National Environmental Significance (NES) guidelines (DoE 2013). The DoE NES guidelines (DoE 2013) list the significant impact criteria for Endangered and Migratory species as:

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- *lead to a long-term decrease in the size of a population*
- *reduce the area of occupancy of the species*
- *fragment an existing population into two or more populations*
- *adversely affect habitat critical to the survival of a species*
- *disrupt the breeding cycle of a population*
- *modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*
- *result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat*
- *introduce disease that may cause the species to decline, or*
- *interfere with the recovery of the species.*

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- *substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species*
- *result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or*
- *seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.*

There is no "real chance or possibility" that the Factory 3D MSS activity will result in any significant impact outcomes for pygmy blue whales, based on the significant impact criteria for Endangered or Migratory species identified above, particularly with the application of the mitigation measures that are proposed for the Factory 3D MSS activity.

- The Conservation Management Plan for the Blue Whale; A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999 (DoE 2015) clearly defines the habitat critical to the survival of blue whales as follows (see **Figure 3-13**):

"It is not currently possible to define habitat critical to the survival of blue whales. Due to our limited knowledge about the distribution and abundance of these subspecies, little is currently known about the location and characteristics of these habitats. ***To date, the best information relates to biologically important areas where foraging occurs.*** *These foraging areas can be considered important to the survival of blue whales as they*

seasonally support highly productive ecosystem processes on which significant aggregations of whales rely."

Recognised foraging areas for the pygmy blue whale off the WA coastline are located in the Perth Canyon and possible foraging areas are located off Northwest Cape at Exmouth and at Scott Reef (DoE 2015). There are no pygmy blue whale foraging areas in the NWMR. Therefore, the pygmy blue whale BIA is not a "biologically important habitat" and there is no justification for avoidance of the BIA during either peak or non-peak migration periods. As a conservative and precautionary approach Shell will apply selected Part B Additional Management Procedures throughout the duration of the Factory 3D MSS survey. The NWMR Marine Bioregional Plan also states that BIA information has been identified for three cetacean species in the NWMR; the humpback whale, the Indo-pacific humpback dolphin and the Australian snubfin dolphin. The pygmy blue whale was not identified as having a critical habitat in the NWMR in this report (DSEWPaC 2012). Given the lack of critical habitat within the OA and FPZ, there is no "real chance or possibility" that the Factory 3D MSS activity will result in any significant impact outcomes to pygmy blue whales in a critical habitat.

From the results of the satellite telemetry and acoustic loggers, pygmy blue whales have also been recorded outside of the BIA and the evidence indicates that the migratory path is more elastic in nature and may have multiple routes. Such elasticity is likely to be prey driven, or oceanic conditions driven, and also been observed in other whale species such as the eastern North Pacific blue whales Double *et al.*, (2014).

Pygmy blue whales migrate through an area that also contains the majority of Australia's gas resource, and production and development is ongoing. Unless anthropogenic noise causes population level consequences (growth changes, mortality or reproduction success) it is unlikely to cause population level consequences). Unless, anthropogenic noise is responsible for the abandonment / avoidance by a number of cetacean species during a sensitive and essential life cycle period within habitat essential for breeding, foraging, nursing, calving (i.e. critical habitat; Double *et al.* 2014).

Therefore, there is no substantial environmental benefit from avoiding the pygmy blue whale BIA, as a temporary displacement based on a 10 km radius from the source, (where received noise levels will exceed 160 dB re 1μP (SPL) around an operating seismic survey vessel is unlikely to "result in any real biological cost" to pygmy blue whales. It should also be noted that the OA overlaps the inshore shallow edge of the pygmy blue whale BIA (~1.8 km) and any avoidance behaviour is likely to result in whales passing slightly further offshore within the broad area of the BIA.

<u>Humpback whales</u>

There are no humpback whale BIA overlapping the OA or FPZ and the closest humpback whale BIA is >157 km from the FPZ.

Single impulse sound fields were sampled at fixed receiver locations relevant to the Kimberley humpback whale resting and calving BIA. Acoustic modelling predicted that noise levels at the boundary of the BIA, 157 km from the acoustic source would not exceed 113 dB re 1 μPa (SPL), 112 dB re 1 μPa (SPL LF-weighted) and 104 dB re 1 $\mu Pa^2 \cdot s$ (SEL), and therefore behavioural impacts to humpback whales within the Kimberley calving BIA are not predicted (**Table 6-10**).

6.5.12. Disturbance to Divers

Recreational diving is common along the mainland coast and inshore islands of WA and is generally restricted to water depths less than 40 m, which is the prescribed depth limit for recreational divers (World Recreational Scuba Training Council). Charter boat operators do not offer bluewater diving tours (i.e. depths >40 m) and the maximum dive depths of 40 m is limited to exceptionally experienced divers. Recreational diving is therefore usually conducted in shallow waters of 40 m or less, which is the depth limit that standard recreational dive certification allows (www.padi.com).

The OA and FPZ do not overlap recreational diving areas (i.e. <40m). The closest diving area is located at Ashmore Reef and is >95 km from the FPZ.

The International Marine Contractors Association (IMCA) reports strongly suggest that the 10 km distance recommended by the Diving Medical Advisory Committee (DMAC) as being an appropriate distance for the initiation of a joint risk assessment between seismic and diving operators is inadequate.

A workgroup comprising of IMCA, the International Association of Oil & Gas Producers, DMAC and seismic surveying representatives has been formed to consider the safe diving distance from seismic survey operations. The guidance has now been drafted, which will recommend:

- Where diving and seismic activity are scheduled to occur within a distance of 60 km, all parties should be made aware of the planned activity. As a minimum, this should include clients/operators, diving and seismic contractors.
- Where seismic survey/diving SIMOPS are proposed within a distance of 30 km, a joint risk assessment should be undertaken. The risk assessment should consider ramp-up trials as well as other risk control measures.
- If the risk assessment generates a requirement for a ramp-up trial, the starting point for the trial will also need to be determined by the risk assessment.
- Should any member of the diving team in the water suddenly experience discomfort, the seismic source should be turned off immediately if a request is made to do so.

Interaction with divers[12] includes a variety of different types of diving activities, including (but not limited to) commercial, recreational, scientific, and fisheries (e.g. pearl oyster divers). Divers exposed to high levels of underwater sound can suffer from dizziness, hearing damage or other injuries to sensitive organs, depending on the frequency and intensity of the sound. The human auditory system is significantly less sensitive underwater than in air and is further degraded if diving equipment obstructs the ears or face (such as, diving with a hood or full facemask). Underwater auditory threshold curves indicate that the human auditory system is most sensitive to waterborne sound at frequencies between 400 Hz to 1 kHz (Parvin *et al.* as cited in Anthony *et al.* 2009), and these frequencies have the greatest potential for damage. In general, within this frequency band, underwater hearing is 35-40 dB less sensitive than in air. Within the literature (all as cited in Ainslie 2008), there is some variation in acceptable SPLs for divers:

- NATO military divers: 177 dB re 1 µPa (31.5-2,500 Hz);
- NATO recreational divers: 154 dB re 1 µPa (600–2,500 Hz);
- Ainslie *et al.* (2008): 160 SPL (up to 4,000 Hz)
- Parvin *et al.* (2005): 145 dB re 1 µPa (100–500 Hz).

Two of the thresholds above apply to frequency levels higher than the Factory 3D MSS and therefore are not relevant to the proposed acoustic source, which has the majority of sound energy <500 Hz. Furthermore, Parvin *et al.* developed a weighting scale to enable the allowable level of noise underwater to be assessed and directly compared to air levels. While both the thresholds for NATO military divers and DMAC commercial diver guidelines are relevant to the proposed frequency levels, the DMAC guidelines developed Safe Diving Distance from Seismic Surveying Operations for commercial dive operations, particularly if divers have the potential to come closer than 10 km of a seismic survey. To ensure that no acoustic impacts will occur to recreational divers, the proposed survey activities will be consistent with the DMAC guidelines.

Shell Australia will adhere to the most precautionary and conservative diver acoustic impact threshold and guideline, this being Parvin (2005) guideline (Reported in Ainslie *et.* al. 2008) of an acceptable level being SPL <145 dB re 1 µPa (**Figure 6-10**). From the acoustic modelling, a diver would need to be <23 km away from the source for received levels to exceed >145 dB re 1 µPa (SPL). Single impulse sound fields were sampled at fixed receiver locations relevant to the closest recreational dive site at Ashmore Reef (>95 km from the proposed OA), at which point received levels are predicted to be <110 dB re 1 µPa (SPL). Impacts to divers at Ashmore Reef are therefore not predicted (McPherson *et al.* 2019; **Appendix D**).

[12] All types of diving activities e.g. commercial, recreational, and scientific etc.

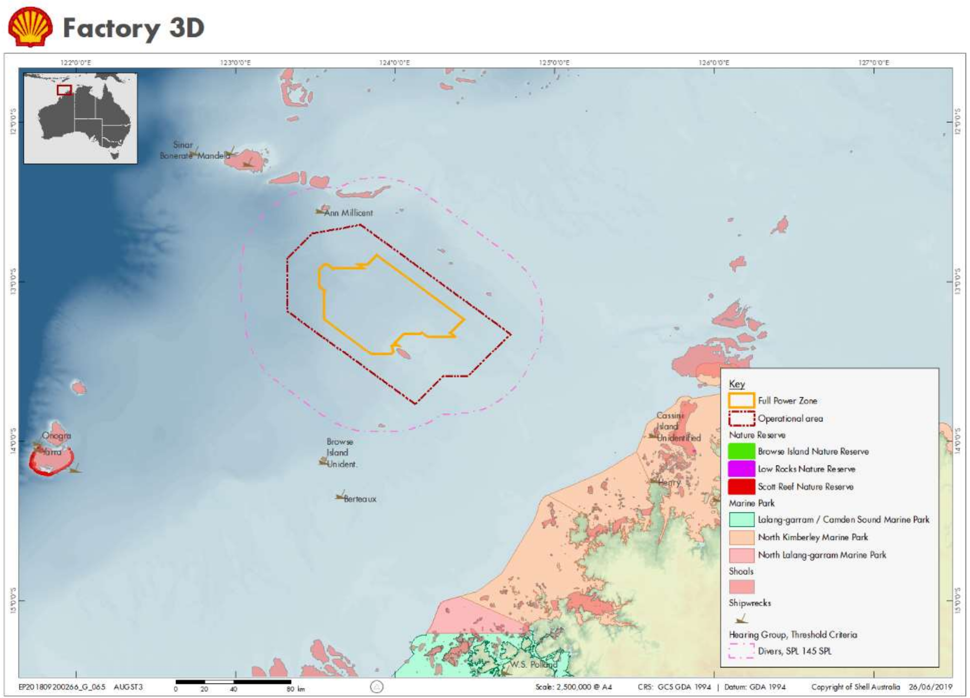


Figure 6-10 - Hearing Threshold Criteria for Divers and the Area from the FPZ where Thresholds are Exceeded

However, as a precautionary approach, stakeholder consultation with AMSA and promulgation of the Notice to Mariners will be undertaken, including the use of a support / chase vessel (see **Section 10**).

6.5.13. Disturbance to Traditional Fisheries

Survey activities will not overlap with or exclude fishers from fishing areas known to be used by Indonesian traditional fishers within the MOU 74BOX at Scott or Seringapatam Reef.

Ashmore Reef and Carter Island AMP boundaries are located >80 km and 34 km, respectively from the FPZ. Acoustic modelling results predicted that from Site 2 received sound levels will be <110 dB re 1 µPa (SPL) at Ashmore Reef and <120-130 dB re 1 µPa (SPL) at Cartier Island AMP boundaries; **Appendix D**). Additionally, single impulse sound levels of this amplitude will not result in accumulated SEL from the seismic survey at these locations to approach the acoustic impact threshold for TTS onset in fish (186 dB re 1 µPa^2.s), therefore, acoustic impacts are not expected to impact target fish species and thus Indonesian traditional fisheries catch.

Furthermore, the estimated received sound levels within the reef are not likely to exceed acoustic impact thresholds for divers [i.e. 145 dB re 1 µPa (SPL)], as the predicted levels outside the reef are <110 dB re 1 µPa (SPL) at Ashmore Reef and 120-130 dB re 1 µPa (SPL) at Cartier Island and therefore no acoustic impacts are expected to Indonesian traditional fishers that may be diving within the reef. If Indonesian traditional fishers are diving / fishing within the sheltered lagoons of the reefs, the received sound levels inside the reef will be much lower than the received sound levels predicted for the outside edge of the reef. Additionally, Shell will implement the use of the support / chase vessel to manage the proximity of the seismic vessel to any traditional fishing vessels that may be transiting the OA.

6.5.14. Disturbance to Heritage and Conservation Values

6.5.14.1.1. Ashmore Reef Ramsar Wetland

The closest Ramsar wetland is ~75 km (Ashmore Reef) from the FPZ. The closest acoustic modelling site to Ashmore Reef within the FPZ is Site 2. Site 2 predicts received sound levels at the boundary of the Ramsar wetland will be <120-130 dB re 1 µPa (SPL), and 150-155 SEL_{24h}.

Based on the distance between the OA and the Ashmore Reef Ramsar wetland, acoustic modelling predicts received sound levels will not exceed 130 dB re 1 µPa (SPL), and therefore will not reach injurious thresholds, or trigger behavioural impacts on the marine fauna of the Ramsar wetland. Therefore, acoustic impacts from the activity are not predicted to impact the Ashmore Reef Ramsar wetland.

6.5.14.1.2. Ancient coastline at 125 m depth contour KEF

The FPZ overlaps 0.77% of the Ancient coastline KEF, impacts to benthic invertebrates at this feature have not been predicted (see **Section 6.5.3**)

6.5.14.1.3. Demersal fish communities

FPZ overlaps 1.51% of the Demersal fish communities KEF%. Impacts to demersal fish species that may be found within this feature has been discussed in detail in **Section 6.5.4** above.

6.5.14.1.4. Australian Marine Parks –Cartier Island and Ashmore Reef

Ashmore and Carter Island AMP boundaries are located ~75 km and 34 km, respectively from the FPZ. In addition, the Acoustic Source Exclusion Zone surrounding Cartier Island excludes any operation of the acoustic source within 7.32km of the green turtle internesting BIA at Cartier Island and approximately 20km from the Cartier Island AMP.

Shell commissioned JASCO to undertake an additional study (Lucke and McPherson 2019) to assess the received sound levels at Cartier Island AMP, a Sanctuary Zone (IUCN category Ia). Expanding upon the assessment already undertaken by JASCO (McPherson *et al.* 2019), the received sound levels emitted by the Factory 3D MSS during full power discharges were calculated for three sampling locations positioned at the boundary of the green turtle inter-nesting BIA, Cartier Island MP and Cartier Island reef. An additional hypothetical modelling transect was considered to provide the required information for the assessment, as shown in **Figure 6-11**. This transect from the nearest impulse site from McPherson *et al*. (2019), Site 2 intersected with both the boundary of the green turtle BIA and Cartier Island AMP and ends in 10 m of water near Cartier Island. The three locations identified in **Table 6-12** are the locations at which the received seismic impulses were assessed:

- the boundary of the green turtle inter-nesting BIA around Cartier Island,
- the boundary of the Cartier Island Marine Park, and
- the 10 m contour on Cartier Island reef.

In summary, the acoustic modelling predicted no impacts to the conservation values and management principles for each AMP zone, the sound levels generated by the survey activities are within acceptable levels for each AMP.

The Acoustic Source Exclusion Zone surrounding the Cartier Island AMP also means that no impacts are expected to the conservation values of the AMP during low power discharges beyond the FPZ (e.g. during soft starts or maintenance).

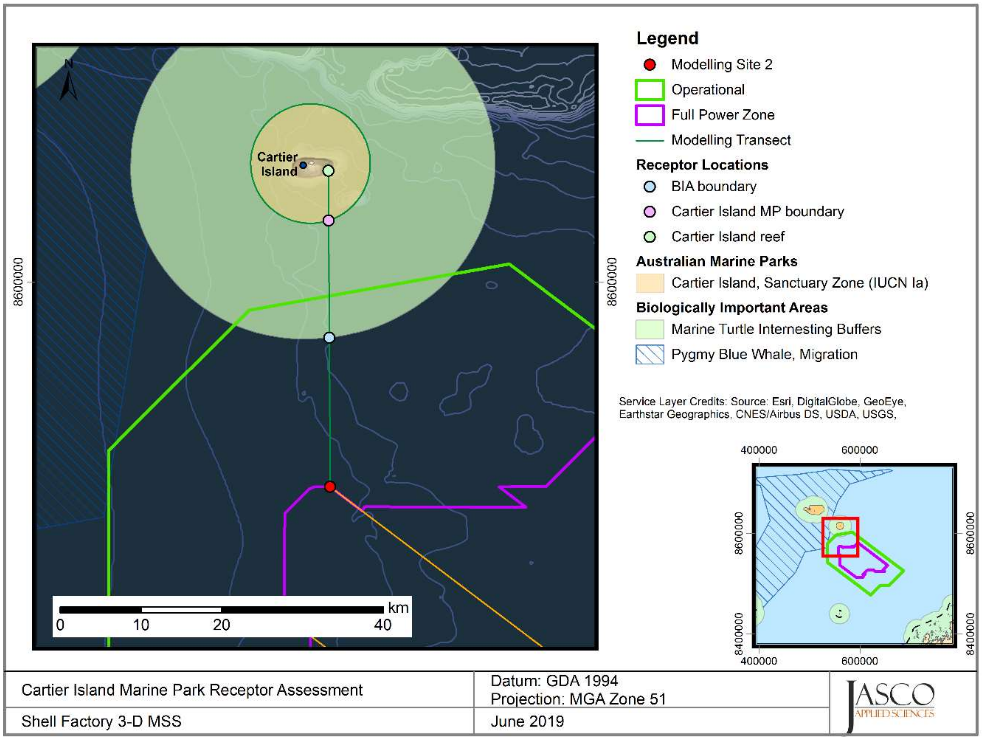


Figure 6-11 - Modelling transect and features associated with assessment of Cartier Island receptors (Lucke and McPherson 2019).

Table 6-12 - Received Levels at Receiver Locations

Receiver	Range (km)	Depth (m)	SPL (L_p; dB re 1 µPa)	Per-pulse SEL (L_E; dB re 1 µPa²·s)	PK-PK (L_{PK-PK}; dB re 1 µPa)	PK (L_{PK}; dB re 1 µPa)
BIA Boundary	18.52	10	127.9	122.7	146.3	141.2
	18.52	250	135.0	129.1	151.4	146.7
Cartier Island MP Boundary	33.08	10	118.1	112.8	134.8	129.1
	33.08	225	122.7	116.4	135.8	129.9
Cartier Island Reef	39.24	10	122.2	114.6	145.4	140.6

The closest acoustic modelling site within the FPZ is Site 2. Site 2 predicts received sound levels at the boundary of the Cartier Island AMP will be 122.2 dB re 1 µPa (SPL; **Table 6-12**; **Appendix D**). Noise levels at the boundary of the Ashmore Reef AMP are predicted to be within 120-130 dB re 1 µPa (SPL).

For this study, in the absence of auditory information, comparative data was used that provided indicative results, for the full assessment see **Appendix D.**

To assist with the assessment of audibility and behavioural disturbance at the green turtle BIA and Cartier Island MP, the audiograms of green turtles, cod and catfish (representing teleost fish) are presented along with the 1/3-octave-band levels at the three receiver locations in **Figure 6-12** and **Figure 6-13**, respectively.

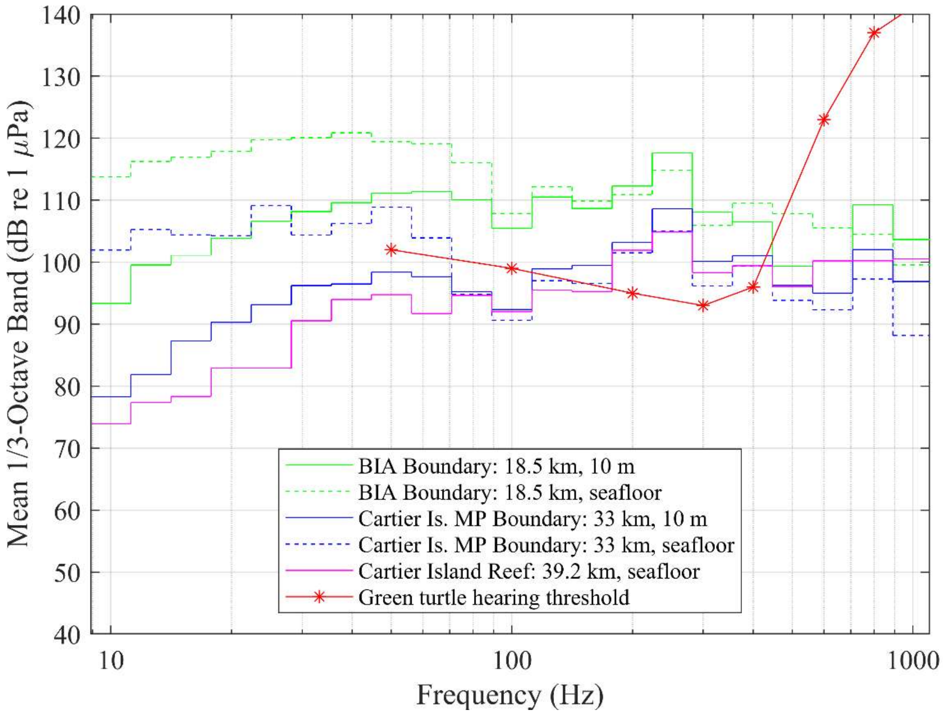


Figure 6-12 - Green turtle hearing threshold, and 1/3 octave band levels at receiver locations.

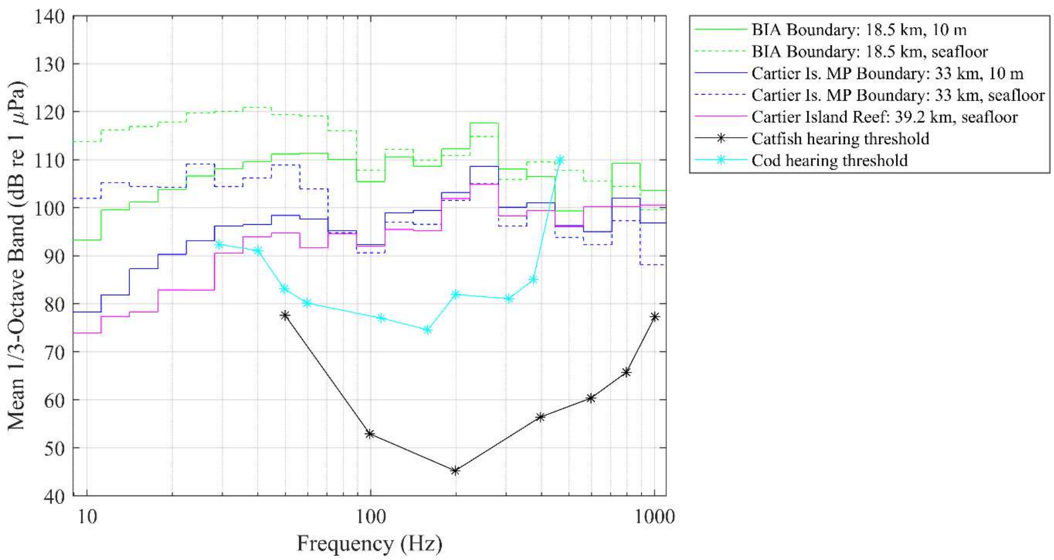


Figure 6-13 - Fish hearing thresholds, and 1/3 octave band levels at receiver locations.

Marine Turtles

The ear of marine turtles is functionally designed to detect sound pressure. Their hearing sensitivity, however, is relatively poor (i.e., they are insensitive to sound), and their frequency range of auditory perception is limited to frequencies <1 kHz.

The modelling results indicate that green turtles will be able to perceive (i.e., 'hear') the seismic airgun impulses up to approximately 600 Hz. Sensation levels reach 25 dB above their hearing threshold at their frequency of best hearing at the BIA boundary; at the Cartier Island MP boundary and reef these levels are reduced by ~10 dB and the frequency band over which sea turtles will be able to hear the impulses is limited to the range of their best hearing sensitivity. To put these levels into perspective using humans as an analogy, the SPL of a normal human conversation is ~60 dB re 20 µPa, while a sound level of 20–30 dB re 20 µPa is considered to describe a very quiet environment.

The behavioural study conducted by McCauley et al. (2000) made use of caged marine turtles. While studying caged animals is generally useful for determining the physical impacts of noise, behavioural effects are difficult to interpret. Any observed response of caged marine turtles to noise is unlikely to be truly representative of responses in open water as the effects of noise on marine turtle behaviour will be compounded by the effects of captivity on behaviour. Information gathered on non-captive individuals would provide more accurate information regarding behavioural responses in open ocean environments. Nevertheless, in the absence of any robust scientific information allowing to determine the onset level of behavioural disturbance, the onset level for behavioural responses of 166 dB re 1 µPa (SPL) provides at least an indication of such a threshold. This value exceeds the threshold of best hearing green turtles by >70 dB. The estimated exceedance of the marine turtles' hearing threshold by the seismic airgun impulses, however, is much lower at all three receiver locations and would therefore be unlikely to cause behavioural disturbance.

Behavioural reactions are highly context specific (Ellison *et al*. 2012), and, moreover, processes such as behavioural sensitisation and habituation can change the onset threshold for reactions.

Sea Snakes

Sea turtle data were suggested as proxy information to assess the potential audibility of seismic airgun impulses based on a loose taxonomical relationship between these taxa; as discussed, the resulting exceedance of hearing thresholds of green turtles indicates that the animals would be able to detect the signals. The ears of sea snakes, however, are functionally designed to detect vibration as supported by experimental data for terrestrial snakes (Christensen *et al.* 2012). This renders any conclusions derived from sound pressure thresholds in a proxy species extremely uncertain. Given the close evolutionary relationship between different taxonomic groups (families) of snakes it is probable that the range of frequencies terrestrial snakes are sensitive to is likely close to the hearing range of sea snakes (species of concern: short-nosed or leaf-scaled sea snakes). The absolute sensitivities, however, may differ due to the physical properties of the two media (air vs water) and cannot be extrapolated from the study on terrestrial animals.

While particle motion is a strong component of signals in the acoustic near field of a sound source it decays quickly over distance. At distances as large as those considered in this study (>10 km) it is unlikely that short-nosed or leaf-scaled sea snakes would be detectable above natural levels. However, the available information regarding the particle motion component of seismic airgun impulses at long distances is limited which, consequently, limits the scientific robustness of this assessment.

Fish

Elasmobranchs

Elasmobranchs, lacking a swim bladder, are insensitive to sound pressure and have been shown to be sensitive to particle motion. Similar to sea snakes, the particle motion levels induced by the seismic airgun impulses can be expected to be at or below ambient levels at the three receiver locations. In the absence of detailed quantitative information regarding the particle motion signature of seismic airgun impulses at these long distances, however, there is insufficient data for assessing the detectability of seismic airgun impulses or the likelihood for behavioural disturbance at the three impulse positions for these species.

Teleost fish

The hearing sensitivity of mackerel, goldband snapper, and blue spotted emperor, representing the fish species of importance to fisheries in the OA, is unknown. These species have either no swim bladder (mackerel); or a swim bladder that is not connected to the ears, such as snapper species and other site attached species such as surgeon fish (*Acanthuridae*), butterfly fish (*Chaetodontidae*), or parrot fish (*Scaridae*).

None of the fish species of interest in this study is expected to have an auditory sensitivity comparable to the hardhead catfish. This is because the catfish is the only pressure sensitive fish so it has an extended hearing frequency range (up to about 4 kHz) compared to the other fish (~1 kHz), and the catfish is expected to be more vulnerable to loud sounds due to the pressure sensitivity via that swim bladder.

Fish species lacking a swim bladder, such as mackerel, are considered insensitive to sound (Popper et al. 2014), comparable to shark and sea snakes. They are unlikely to be able to detect seismic airgun impulses within the borders of the Marine Park around Cartier Island or impulse points farther away. Their sensitivity to particle motion is unknown and cannot be extrapolated from the particle motion detection curves for flatfish (plaice, *Pleuronectes platessa* and dab, *Limanda*; see **Figure 6-14**; **Figure 6-15**) due to their difference in life style (pelagic versus bottom living) as this may be related to substantial differences in sensitivity to vibratory stimuli.

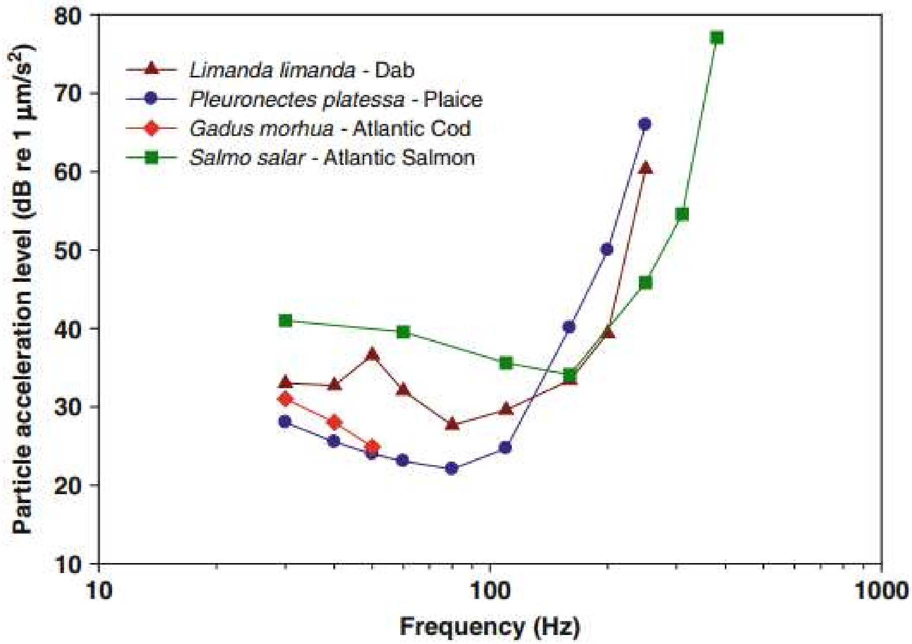


Figure 6-14 - Particle motion behavioural audiograms for four fish species that are particle motion-sensitive, or where sensitivity to particle motion is dominant at the frequencies plotted.

Atlantic salmon (Salmo salar; Hawkins and Johnstone 1978); plaice (Pleuronectes platessa; Chapman and Sand 1974); dab (Limanda limanda; Chapman and Sand 1974); Atlantic cod (Gadus morhua; Chapman and Hawkins 1973). Source: Popper et al. (2014).

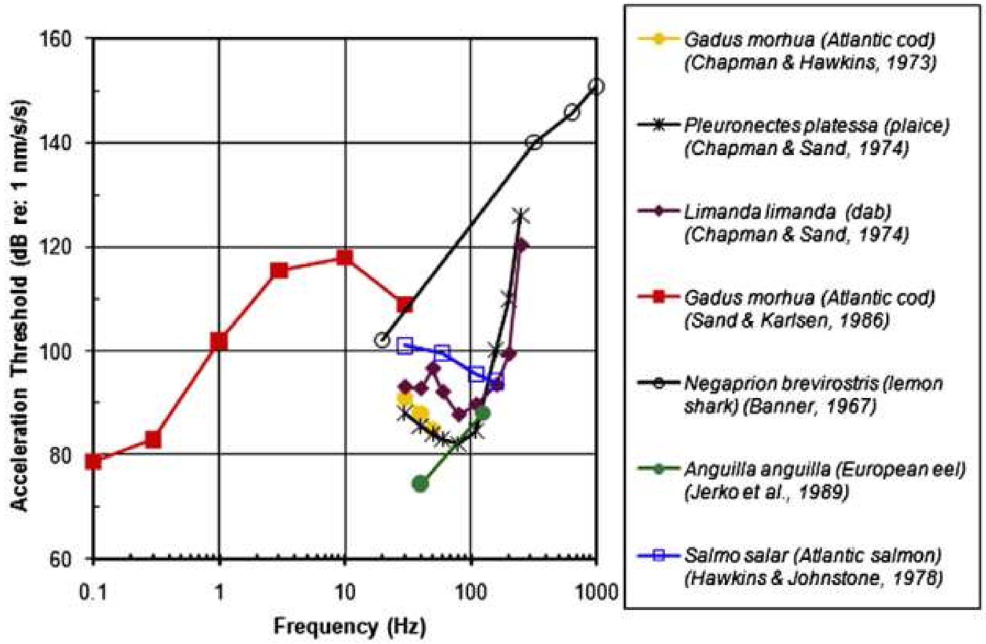


Figure 6-15 - Particle acceleration audiograms for those fish species that have been shown to be motion sensitive at the frequencies indicated, extracted from Popper and Fay (2011).

Atlantic cod has a swim bladder that is not connected to their ears; due to this anatomical and (postulated) functional similarity with this species is used as proxy for assessing the audibility and behavioural disturbance of snapper species. The received levels at all three receiver locations indicate that snapper are likely to be able to hear the seismic airgun impulses; the received sound levels, however, are low and when compared to the behavioural results by McCauley *et al*. (2000) they indicate that the number of startle responses will increase only slightly due to the seismic airgun impulses compared to an undisturbed situation (ratio difference <0.1, i.e., less than 10% increase in responses). The data presented by McCauley *et al*. (2000) were collected on different species compared the key receptor fish species in this study, and inter-specific differences are likely, although the study included a number of fish likely to be within the Cartier Island AMP. Moreover, as discussed for the sea turtles, fish behavioural reactions may also vary, as they are highly context specific and behavioural sensitisation and habituation must be accounted for.

Summary

Based on results from hearing studies on green turtles it is likely that these animals can hear the seismic source impulses from within the OA or FPZ (considering controls are implemented) at low sensation levels at all three impulse locations; behavioural disturbance is unlikely, but robust scientific information to inform this aspect is lacking.

Sea snakes are unlikely to hear the signals as their ears are functionally not designed to be sensitive to sound pressure. Based on experimental information on terrestrial snakes and anatomical considerations, these animals are assumed to be sensitive to vibration. The particle motion level generated at the three assessed locations by the seismic airgun impulses cannot be quantified but is expected to be at or below natural background levels which makes the vibratory perception of the signals or any behavioural reaction by sea snakes unlikely.

All fish species are thought to be sensitive to the particle motion component of acoustic signals, but their sensitivity to sound pressure seems to be functionally correlated to the presence and absence of gas-filled chambers such as the swim bladder. Sharks and mackerel lack swim bladder and can be assumed to be insensitive to sound and behavioural reactions of these species in response to seismic airgun impulses are unlikely. Their sensitivity to particle motion caused by the MSS impulses cannot be assessed due to the lack of detailed quantitative information regarding the particle motion signature of seismic airgun impulses at long distances. Goldband snapper and blue spotted emperor are likely able to hear the MSS impulses at relatively low levels and only a small increase in startle responses of these species should be expected.

Based on the distance between the FPZ and OA to Ashmore Reef and Cartier Island AMP, acoustic modelling predicts received sound levels will not exceed 122.2 dB re 1 µPa (SPL) or 130 dB re 1 µPa (SPL), respectively or <150-155 SEL24h and therefore will not reach injurious thresholds or trigger behavioural impacts on the marine fauna of the AMPs. Therefore, acoustic impacts from the activity is not predicted to impact species of high conservation value located at the Ashmore Reef or Cartier Island AMP.

6.5.15. Cumulative Impacts and Concurrent Seismic Surveys

Shell has carried out a review of the previous seismic surveys which have intersected the proposed survey area and the broader NDSF over the previous 10 years. The results of this review are presented below (**Figure 6-16**). It has been approximately 4 years since the last survey overlapping with this area, and there have been only 4 surveys covering any portion of the OA in the last 10 years. Therefore, Shell considers that 4 years in between surveys is considered a highly conservative and a precautionary approach and more than enough time to allow recovery, particularly for site-attached fish or other sedentary species such as marine turtles.

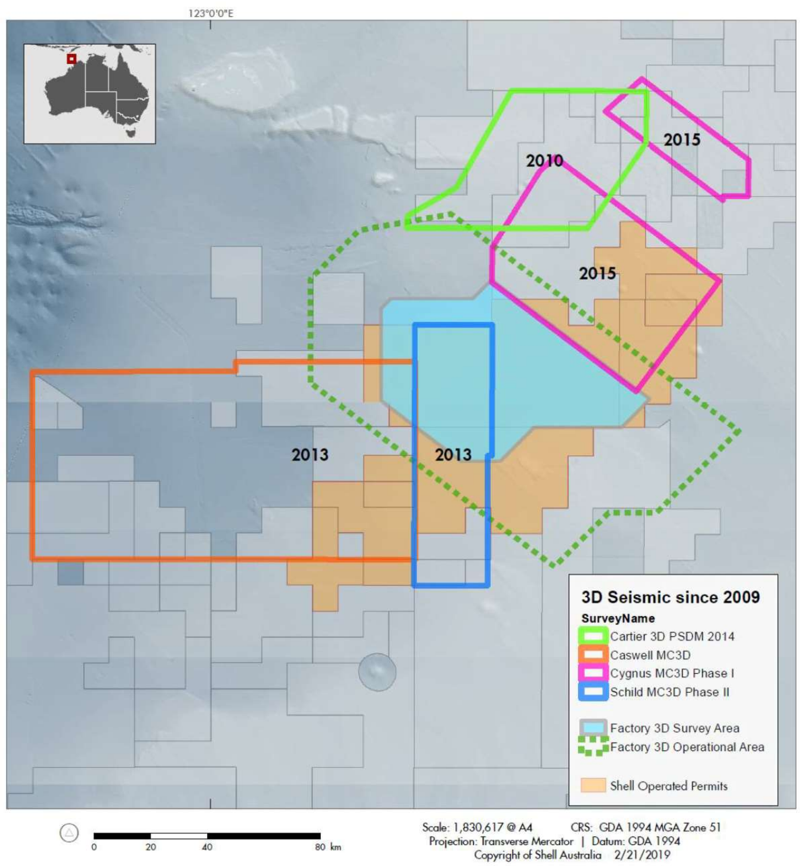


Figure 6-16 -Previous Surveys within and Adjacent to the Factory 3D MSS

For seismic surveys that occur at the same time the Bureau of Ocean Energy Management (BOEM 2014) recommends a 40 km geographic separation distance (based on worst case scenarios) between the sources of simultaneous seismic surveys to minimise the impacts to marine life by providing a ‘corridor’ between operating vessels. Survey vessels will be constantly moving while acquiring data, meaning that, if seismic surveys occur simultaneously, the two vessels will only temporarily (i.e. minutes or hours at most) be within a relatively close distance of one another such that a larger area is impacted by elevated noise levels.

The seismic vessel shall be travelling at ~4.5 kn and the seismic array will be discharged approximately every 6-7 seconds. Subsequently, the direct application of cumulative criteria developed for pile driving (shot fired every 1.2 seconds and static) to a seismic array is not necessarily appropriate since the received level of each discharge a fish may receive would be a different SEL (single strike). As such, the figures outlined in the Popper *et al.* (2014) paper are highly conservative.

In order to understand cumulative impacts, JASCO undertook acoustic modelling of the accumulated SEL over 24 hours of seismic operation which considered a realistic acquisition pattern within the FPZ.

It should be noted that these ranges are calculated on the assumption that the individual remains static throughout the 24-hour period. However, the actual dose an individual receives will be dependent on the path the individual takes relative to the operating survey; and in the case of a fleeing individual, the ranges will be typically much lower. Site-attached fish at the reefs surrounding Cartier Island (40 km away from the FPZ) will not receive sound levels likely to cause mortality or mortal injury impacts.

The maximum impact range for the Factory 3D MSS survey, based on the application of the SEL_{24h}, is 38 km for TTS for LF cetaceans. Based on acoustic modelling predictions received sound levels will be reduced to <183 SEL_{24h} at horizontal distances >1.73 km away from the sound source and to <168 SEL_{24h} at horizontal distances >40 km from the sound source.

Therefore, implementation the recommended 40 km separation distance from simultaneous surveys will be implemented. In the event that the timing of any proposed seismic survey coincides with another survey in the area, the survey vessel will ensure a minimum distance of 40 km is maintained between them during full seismic acquisition to:

- minimise potential cumulative impacts on marine fauna; and
- minimise noise interference that may affect seismic data quality.

Seismic Surveys within Same Time Period

Based on consultation undertaken with the permit holders in the area of the Factory 3D MSS and multi-client seismic operators with Environment Plans being assessed by NOPSEMA (see **Section 10**), no seismic surveys were identified as likely to be acquired during or close to the same time period as the Factory 3D MSS, within the survey area or in adjacent waters.

This section does not assess cumulative impacts from seismic surveys within the area that occur after the Factory EP validity as that should be the responsibility of that titleholder as part of their cumulative impact assessment.

6.5.16. Impact Assessment

Table 6-13 - Risk Assessment for Discharge of the acoustic source array.

Environmental Aspect	Environmental Value/Sensitivity				Evaluation – Planned		
	Physical Environment	Threatened species and ecological communities	Ecosystems, communities and habitats	Socio-economic and cultural environment	Magnitude	Sensitivity	Residual Impact
Discharge of the acoustic source array.	-	-	X	X	Minor	Medium	Minor
Potential Impact							
Physical such as mortality or mortal injury – plankton					Slight	Low	Slight
Physical such as mortality or mortal injury - invertebrates					Minor	Low	Minor
Physiological – benthic invertebrates					Minor	Low	Minor
Physical such as mortality or mortal injury – fish					Minor	Medium	Minor
Physiological impacts – fish TTS					Minor	Medium	Minor
Behavioural impacts – fish					Minor	Medium	Minor
Physical such as mortality or mortal injury – sharks					Slight	Medium	Slight
Physical such as mortality or mortal injury – sea snakes					Minor	Medium	Minor
Physical such as mortality or mortal injury – turtles					Minor	Low	Minor
Behavioural impacts – turtles					Minor	Low	Minor
Behavioural impacts – dugongs					Minor	Medium	Minor
Physical impacts – cetaceans TTS					Minor	Low	Minor
Behavioural impacts – cetaceans					Minor	Medium	Minor
Physical impacts – divers					No effect	Medium	No effect
Physical impacts – traditional fishermen					No effect	Medium	No effect
Requirements, Control Measures, Environmental Performance Standards and ALARP Assessment							
For details of the requirements that apply to the activity, adopted control measures, environmental performance standards and ALARP assessments applicable to this event, please refer to Appendix A.							
Demonstration of Acceptability							

Value or Sensitivity	**Feature**	**Set acceptable levels of impact**	**Predicted impacts**
Benthic Communities	Heywood Shoal Eugene McDermott Shoal Goeree Shoal Vulcan Shoal Barracouta Shoals Echuca Shoal.	No unrecoverable or long-term effects on fish, benthic or coral assemblages from impacts and risk associated with the activity	Predicted noise levels from the seismic source array modelling indicates PTS will not occur at any of the shoals in the Factory EMBA. TTS from which fish are expected to recover, may credibly occur at the nearest shoal (Heywood Shoal). No unrecoverable impacts are predicted.
Commercial, Recreational and Traditional Fisheries	Social and economic features of each fishery within the ensonified area of the survey	No effect to the sustainability of the fish population and the sustainability of the fisheries in the Gascoyne and North	Yes, the sustainability of the economic features of the area are mainly comprised of the NDSF currently. An important part of the ongoing sustainability of this fishery is

		Coast fishing marine bioregions.	the recruitment of the key species which make up the fishery. Impacts to plankton from key fish species like the red emperor and goldband snapper are predicted to be short term based on estimated recovery times (3-5 days). The fish status report, states oil and gas development activity presents a low risk status in the north coast bioregion. On this basis, the ongoing sustainability of the fishery is maintained with the presence of the Factory 3D seismic survey occurring.
Listed Threatened and Migratory Species	Fish and Invertebrates	•No fish/invertebrate mortality or PTS effects •Non-peak spawning effects are short-term, localised, and recoverable	Yes impacts are at an acceptable level due to no mortality or PTS is predicted on site-attached fish. Demersal and pelagic species are likely to exhibit avoidance behaviours and avoid the short-term seismic source array. TTS, from which fish are expected to recover, may occur.
	Marine Reptiles, Birds and Sharks and Rays	•Effects limited to behavioural disturbance of a small number of individuals. •No local population impacts on breeding, migration or foraging. •No population level effects.	Yes impacts are at an acceptable level due to no mortality or PTS is predicted on birds or marine turtles. Sharks, birds and turtles are likely to exhibit avoidance behaviours and avoid the short-term seismic source array. TTS, from which sharks are expected to recover, may occur.
	Marine Mammals	•No displacement of foraging, aggregating, calving/breeding, or migrating cetaceans from identified BIA's •No alteration to critical habitat •No injury to any marine mammal	Yes, impacts are at an acceptable level due to no foraging, aggregation, calving or breeding BIA for cetaceans located within the EMBA. Predicted noise levels from the seismic source array will not credibly exceed impact thresholds within the pygmy blue whale migration BIA, as this impact distance is based on a stationary animal. No critical habitats for marine mammals are within the EMBA. PTS impact thresholds for marine mammals will not be exceeded with the proposed mitigation procedures in place. Cumulative 24-hr PTS and TTS thresholds for low frequency cetaceans may be exceeded, however it is not credible, it is very unlikely that a low frequency cetacean would

			remain in the area long enough to result in PTS or TTS injury.
Key Ecological Features	Ancient Coastline at 125 m Depth Contour KEF	No increase in status of the regional pressures as a direct result of the planned activity.	All regional pressures 'of concern' have been considered and the activity will not increase the pressure on the values of each of the KEFs considered. Noise Pollution - vessels and seismic exploration noise pressures on these KEFs is identified as being of 'Less concern'.
	Continental Slope Demersal Fish Communities KEF		
	Ashmore Reef and Cartier Island and Surrounding Commonwealth Waters		
	Carbonate Bank and Terrace System of the Sahul Shelf		
	Seringapatam Reef and Commonwealth waters in the Scott Reef Complex		
Australian Marine Parks **(by IUCN Category)** **Including Offshore Reefs and Islands**	1a	No disturbance to the habitats, ecosystems, and native species of the AMP.	Predicted noise levels from the seismic source array will not credibly reach injurious thresholds or trigger behavioural impacts on the marine fauna of the AMP around Cartier Island. Therefore no impacts are predicted to the to the high conservation value species of the Cartier Island and Ashmore Reef AMP is predicted.
Principles of ESD	The impacts from the discharge of the acoustic source during the Factory 3D MSS are consistent with the principles of ESD based on: • The socio-economic values/sensitivities within the OA are not expected to be significantly impacted; • The health, diversity and productivity of the environment is not expected to decrease; and • Decision-making integrated both long-term and short-term economic, environmental, social and equitable considerations (e.g. reducing impacts from acoustic noise on marine fauna). • No threats of serious or irreversible environmental damage were identified. • The principle of inter-generational equity is maintained for the benefit of future generations. • The conservation of biological diversity and ecological integrity were fundamental considerations in decision making and development of control measures. • The approved control measures considered improved valuation, pricing and/or incentive mechanisms.		

Summary of Acceptability

The residual impact on values and sensitivities associated with the acoustic emissions (seismic) of acquisition vessel during the survey is minor given the application of the controls outlined in Appendix A and the following points:

- The minimal impacts posed by the acoustic emissions (seismic) from the acquisition vessel;
- Regulatory requirements are incorporated;
- The Factory 3D MSS is consistent with Shell policy, standards and culture;
- Good practice developed from Shell's global vessel operations, industry guidelines and practical mitigations to reduce the risk associated with the survey have been undertaken; and
- Stakeholder concerns have been considered and incorporated into this EP (Appendix A).

The predicted levels of residual impact have been assessed against the defined levels of acceptability, and overall the residual impacts associated with acoustic emissions associated with

the acquisition vessel are considered acceptable. No activity will be undertaken during the months of March and October. The residual level of impact and risk is considered acceptable.

6.6. Acoustic Emissions (Non-seismic)

6.6.1. Acoustic Emissions during Project Vessel and / or Aircraft Operations

6.6.1.1. Environmental Aspects Arising from the Activity

Project vessels will generate underwater noise above ambient levels. This noise may result in impacts and risks to environmental receptors. Vessel noise varies with the size, speed, engine type of the vessel and the activities being undertaken. Smaller, faster vessels typically produce higher-frequency sound at lower source levels than large, relatively slow-moving ships. Support vessels typically produce sound levels around 160-180 dB re 1 µPa at 1 m during transit and these levels drop with reduced speed. As a ship's speed increases, broad band noise such as propeller cavitation and hull vibration noise become dominant over machinery related tones (National Research Council (NRC) 2003).

Project vessels may use DP for holding station while present within the OA. When vessels use DP, emitted noise frequencies increase considerably with the use of thrusters to maintain position. McCauley (1998) measured noise from AHTs 'holding station' with an estimated source volume of 182 dB re 1 µPa at 1 m, with levels decreasing by around 34 dB within 50 m. During the activity the seismic vessel, as well as two support vessels (one supply vessel and one chase vessel) will occur within the OA at a time.

Project vessel sound emissions are generally dominated by low frequencies below 1 kHz and sound levels are significantly lower than seismic source noise level discussed in **Section 6.5**.

6.6.1.2. Impact Assessment

Vessels

Underwater noise generated by the presence of the survey vessel may result in incidental changes in behaviour of marine fauna (primarily cetaceans, whale sharks and marine turtles), such as disturbance, avoidance or attraction. However, these impacts are likely to be localised and temporary. The recommended root mean square (rms) SPL threshold (Southall *et al.* 2007) that could result in possible avoidance is 120 dB re 1µPa at 1 m. The recommended rms SPL threshold (Southall *et al.* 2007) that could result in physical injury is not expected to be exceeded by non-pulse noise sources vessel noise.

Furthermore, underwater noise from the survey vessel is transient, the vessel will be moving across large areas rather than concentrating activities in a small area, and the type of noise is no different to that emitted by the commercial shipping traffic and fishing vessels operating in these areas. Given the slow operating speed (generally less than 4-5 knots), and the low numbers of marine fauna anticipated to be in the area at the time of the survey, the probability of significant impacts from disturbance to marine fauna is assessed to be low.

Research assessing behavioural responses of whale sharks to the presence of tourism vessels within the Ningaloo Marine Park found that, although whale sharks were observed changing direction more frequently in the presence of tourism vessels, individuals were also observed to maintain neutral behaviours including surface swimming, resurfacing and no reaction to the presence of tourism vessels and/or tourists swimming within 250 m of the shark (Raudino et al. 2016). It is likely that noise from these vessels would be one of the key causes of observed impacts. Given these vessels specifically target and approach whale sharks, it's reasonable to assume behavioural responses from whale sharks to project vessels would be less directed and restricted to general avoidance of the OA.

Helicopters

The intensity of sound travelling from a source in the air (e.g. helicopter) to a receiver underwater depends on source altitude and lateral distance, receiver depth, water depth, and other variables. Richardson *et al.* (1995) reports figures for a Bell 214 helicopter (stated to be one of the noisiest) being audible in air for four minutes before it passed over underwater hydrophones, but detectable underwater for only 38 seconds at 3 m depth and 11 seconds at 18 m depth. The maximum received level was 109 dB re 1uPa.

Table 6-14 – Risk Assessment for Noise Emissions from Project Vessels and Helicopters

<table>
<tr><th rowspan="2">Environmental Aspect</th><th colspan="4">Environmental Value/Sensitivity</th><th colspan="3">Evaluation – Planned</th></tr>
<tr><th>Physical Environment</th><th>Threatened species and ecological communities</th><th>Ecosystems, communities and habitats</th><th>Socio-economic and cultural environment</th><th>Magnitude</th><th>Sensitivity</th><th>Residual Impact</th></tr>
<tr><td>Noise emissions from project vessels and helicopters</td><td>-</td><td>X</td><td>-</td><td>-</td><td>Slight</td><td>Medium</td><td>Slight</td></tr>
<tr><th colspan="8">Requirements, Control Measures, Environmental Performance Standards and ALARP Assessment</th></tr>
<tr><td colspan="8">For details of the requirements that apply to the activity, adopted control measures, environmental performance standards and ALARP assessments applicable to this event, please refer to Appendix A.</td></tr>
<tr><th colspan="8">Demonstration of Acceptability</th></tr>
<tr><td>Principles of ESD</td><td colspan="7">The risks and impacts from underwater noise associated with the Factory 3D MSS are consistent with the principles of ESD based on:
• The environmental values/sensitivities within the OA are not expected to be significantly impacted; and
• Significant impacts on the health, diversity, productivity and ecological integrity of the environment are not expected to occur.</td></tr>
<tr><th colspan="8">Summary of Acceptability</th></tr>
<tr><td colspan="8">The residual impact on marine fauna of conservation significance associated with noise emissions from the Factory 3D MSS is slight given the application of the controls outlined above and the following points:
• The minimal behavioural impacts posed by noise emissions from the Factory 3D MSS;
• Regulatory requirements and Shell standards are incorporated;
• The activity is consistent with Shell policy, standards and culture;
• Good practice developed from Shell's global vessel operations, industry guidelines and practical mitigations to reduce the risk associated with noise emissions from project vessels have been undertaken; and
• No stakeholder concerns have been raised in regard to vessel and helicopter noise emissions.
The potential impacts of discharges are not considered to pose any risk to the values of any receptors identified in Section 5. The residual impact is considered acceptable.</td></tr>
</table>

7. Unplanned Events

7.1. Invasive Marine Species

7.1.1. Unplanned Biofouling of Vessel Hull, Other Niches and Immersible Equipment

7.1.1.1. Environmental Aspects Arising from the Activity

There are three primary mechanisms causing the inadvertent introduction and spread of invasive marine species (IMS) are hull fouling, biofouling of in-water survey equipment and ballast water exchange. Most of these introductions are confined to coastal waters with a significantly greater occurrence in temperate waters than tropical waters.

Vessel cruising speeds during transit are typically held around 10 knots to avoid high fuel consumption. These slow voyaging speeds permit retainment of fouling growth that typically requires higher cruising speeds for efficient control. Support vessel hulls are typically surveyed twice during a 3 to 5-year maintenance cycle that includes dry-docking and replacement antifouling. Some operators follow a 30-month dry-docking and antifouling renewal interval to avoid excessive drag and fuel consumption from heavy bio-fouling. All vessels with an overseas 'last port of call' will obtain all required quarantine clearances prior to entering Australian waters.

Support vessels carry comparatively little ballast water for trimming purposes compared to other merchant ships. Significantly, the largest volumes of ballast water are typically carried by support vessels on 'light' return voyages from the offshore location back to a supply base and so do not represent a significant risk for the introduction of marine pests. Nonetheless, as per Australian Quarantine Inspection Service (AQIS) Ballast Water Management requirements, all vessels with an overseas 'last port of call' will be required to undertake exchange of high-risk ballast outside Australia's territorial sea prior to arrival.

When conducting project activities with the exception of emergency and spill response, vessels will remain within the OA. When responding to a spill, under specific circumstances, vessels may be required to enter the Cartier Island Marine Park. Any vessel responding to an oil spill will still be required to meet ballast and quarantine requirements.

7.1.1.2. Impact Assessment

IMS are marine plants or animals that have been introduced into a region beyond their natural range and can survive, reproduce and establish populations. All known and potential marine pests listed by Australian agencies are nuisance foulers, predators, invasive seaweeds or noxious dinoflagellates that inhabit harbours, embayment's, estuaries, shorelines and/or shallow coastal waters less than 200 m deep (Hayes *et al*. 2004, Barry *et al*. 2006).

The published 'Proposed Australian Biofouling Management Requirements' reports that there are approximately 450 marine species of non-indigenous or unknown origins in Australia (Hewitt 2011; cited in DAFF 2011). It also states that studies show that up to 69 per cent of these are associated with biofouling (Hewitt *et al*. 2010, 2004, 1999; cited in DAFF 2011). It predicts that 3 to 4 new non-indigenous marine species (NIMS) continue to establish in Australian waters each year (Hewitt 2011; cited in DAFF 2011a).

The water depth within the OA ranges from approximately 20-650 m, with the most shallow and susceptible area to establishment of IMS being in proximity to Heywood Shoal. Outside this area, the OA is characteristic of an open ocean environment which provides minimal larval retention times or suitable habitat for coastal adapted exotic species. Hence, the likelihood of the introduction of exotic or introduced marine species is remote, with a slightly higher risk in the area of Heywood Shoal. The impact of potentially introducing IMS within the OA is considered to be minor.

Cartier Island is used by Green Turtles for nesting, and is surrounded by a fringing reef. The shallower waters adjacent to the island would be more susceptible to invasive marine species. However, Cartier Island lies 9 km outside the operational area, and would only be visited by project vessels in the unlikely event of a spill which extends to the island. Any responding vessels will still be required to adhere to ballast and quarantine requirements, and the likelihood of introducing IMS to Cartier Island is considered to be negligible.

Table 7-1 – Risk Assessment for Physical Presence of Project Vessels – Invasive Marine Species

Environmental Aspect	Environmental Value/Sensitivity				Evaluation – Unplanned		
	Physical Environment	Threatened species and ecological communities	Ecosystems, communities and habitats	Socio-economic and cultural environment	Significance	Likelihood	Residual Impact
Introduction of IMS	-	X	-	-	Minor	Remote	Minor

Requirements, Control Measures, Environmental Performance Standards and ALARP Assessment
For details of the requirements that apply to the activity, adopted control measures, environmental performance standards and ALARP assessments applicable to this event, please refer to Appendix A.

Demonstration of Acceptability	
Principles of ESD	The risks and impacts from introduction of IMS are consistent with the principles of ESD based on: • The environmental values/sensitivities within the OA are not expected to be significantly impacted; and • Significant impacts on the health, diversity, productivity and ecological integrity of the environment are not expected to occur.

Summary of Acceptability
The residual risk associated with the introduction of IMS for the survey is minor given the application of the controls outlined above and the following points: • Regulatory requirements are incorporated; • The survey is consistent with Shell policy, standards and culture; • Good practice developed from Shell’s global vessel operations, industry guidelines and practical mitigations to reduce the risk associated with IMS will be implemented; and • Stakeholder concerns have been considered and the following controls have been proposed to mitigate the exposed risks: - Visual vessel checks will be conducted on all the vessels being used for the survey. - All potential impacts to the ecology of the area have been identified in this EP and proactive control measure to manage the impact have been proposed. The potential risk of IMS are not considered to pose any risk to the values of any receptors identified in section 5. The residual risk is considered acceptable.

7.2. Unplanned Seabed Disturbance

7.2.1. Emergency Anchoring of Project Vessels and Equipment Dragging or Loss

7.2.1.1. Environmental Aspects Arising from the Activity

The Factory 3D MSS is a typical 3D survey using methods and procedures similar to others conducted in Australian waters. No unique or unusual equipment or operations are proposed.

7.2.1.2. Impact Assessment

Anchoring of project vessels and equipment dragging within the OA may impact the seafloor and associated benthic communities and disturb sediments causing localised temporary turbidity increased. The significance of the impact would depend on the sensitivity of the seafloor habitat being affected. Heywood Shoal lies on the 50-60 m isobath (Heyward et al. 2018) and overlaps the OA. It comprises sand, rubble and generally low-relief consolidated reef supporting corals, invertebrates, fish and algae (**Section 3.4.1.1.1**). Emergency anchoring on-top of the shoal has the potential to cause slight impacts to the seabed and benthic habitats associated with this feature. The potential impacts to the seabed and benthic communities from emergency anchoring are expected to be localised smothering and temporary disturbance of sediments and increased turbidity.

No anchoring will occur within the OA, or the Cartier Island MP. Furthermore, the vessel will not transit through the Cartier Island Marine Park (MP) with the seismic equipment deployed.

Aside from Heywood Shoal, the seabed within the OA is expected to be relatively flat with mainly soft sediments, devoid of any significant seabed features and with little, if any, available hard substrate (**Section 3.4.1**). Seabed features such as pockmarks, sand waves and megaripples are likely to occur based on surveys undertaken near the OA (**Section 3.4.1**).

Table 7-2 – Risk Assessment for Emergency Anchoring of Project Vessels

Environmental Aspect	Environmental Value/Sensitivity				Evaluation – Unplanned		
	Physical Environment	Threatened species and ecological communities	Ecosystems, communities and habitats	Socio-economic and cultural environment	Significance	Likelihood	Residual Impact
Seabed disturbance from emergency anchoring	X	-	X	-	Slight	Remote	Slight
Requirements, Control Measures, Environmental Performance Standards and ALARP Assessment							
For details of the requirements that apply to the activity, adopted control measures, environmental performance standards and ALARP assessments applicable to this event, please refer to Appendix A.							
Demonstration of Acceptability							
Principles of ESD	The impacts from the potential anchoring during the survey are consistent with the principles of ESD based on: • The socio-economic values/sensitivities within the OA are not expected to be significantly impacted; • Significant impacts on the health, diversity, productivity and ecological integrity of the environment are not expected to occur.						
Summary of Acceptability							
The residual risk is associated with unplanned emergency anchoring of project vessels for the Factory 3D MSS is minor given the application of the controls outlined above and the following points: • Regulatory requirements are incorporated; • The survey is consistent with Shell policy, standards and culture;							

- Good practice developed from Shell's global vessel operations, industry guidelines and practical mitigations to reduce the risk associated with the physical presence of the project vessels have been undertaken; and
- Stakeholder concerns have been considered. As stated above, no seismic acquisition will occur within 5 km of the Shoals close to OA. Also, no operation of full acoustic source will be conducted in water depths shallower than 70 m to minimise the impact in shallow areas such as Heywood Shoal.
- As is standard practice, soft start procedures will be implemented, as identified in the WA Fisheries Publication No, 112, 2013 Guidance statement on undertaking seismic surveys in WA waters.

The potential risk and impacts of anchoring are not considered to pose any risk to the values of any receptors identified in section 5. The residual risk is considered acceptable.

7.3. Unplanned loss of hazardous or non-hazardous materials

7.3.1. Unplanned Loss of Solid Waste (hazardous/non-hazardous) or Dropped Objects and Equipment

7.3.1.1. Environmental Aspects Arising from the Activity

Project vessels will generate non-hazardous and hazardous waste during daily operations. The volumes of solid waste generated during the survey are likely to be small. Non-hazardous waste from the project vessels (such as packaging, bottles and cans, electrical/electronic waste, paper and cardboard, scrap metal, wood) will be collected, stored and transferred to shore for disposal. Hazardous waste (including waste chemicals/oil, empty chemical containers, batteries and medical waste) will be appropriately stored and transferred onshore for disposal at an approved licensed facility as per the HSSE and SP Control Framework, waste requirements. No solid wastes will be disposed of at sea. All wastes will be stored and transported back to shore for correct management according to the vessel Garbage Management Plan.

Various equipment, including small items such as tools and Personal Protective Equipment, will be needed by personnel to undertake daily work tasks and maintenance on project vessels. There is the potential for equipment and improperly stored waste to be accidently dropped or blown overboard from vessels during the survey.

Seismic survey equipment, for example streamers, hydrophone, airguns, tail buoys, have the potential to be lost as a result of breakage or from snagging. Depending on the equipment lost, this could have impacts to marine fauna due to entanglement or ingestion or disturbance to the seabed.

7.3.1.2. Impact Assessment

Loss of solid waste or equipment overboard may reduce water quality, with subsequent impacts on nearby environmental sensitivities. Benthic habitats may be temporarily polluted or smothered by dropped solid waste or equipment if the item is heavy enough to sink to the seabed. As described in **Section 3.4.1.1**, there is only one receptor within the OA which comprises significant benthic habitat, Heywood Shoal. Impacts to the benthic habitat at Heywood Shoal or in other areas of the OA from dropped waste or equipment are possible, however, impacts are expected to be highly localised.

Marine fauna within the OA (including species of conservation significance such as whales, whale sharks, marine turtles and seabird as described in **Section 4**, may become entangled or ingest discarded waste. Pollution is a key threat to threatened and migratory marine mammals, marine turtles, birds and sharks in Australia (Commonwealth of Australia 2017a; DEH 2005a; DEWHA 2008b; DEWHA 2009a; DEWHA 2009b; DoE 2014c; DoE 2014d; DoE 2015c; DoE 2015c; DoE 2015e; DoE 2015l; DoE 2015m; DoE 2016a; DoE 2016b; DoE 2016c; DoE 2016d; DoE 2016e; DSEWPaC 2011a; DSEWPaC 2013b). Whale sharks are surface filter feeders, and the OA occurs within the migration BIA. However large numbers of whale sharks are not expected to transit the area due to their solitary nature. The OA overlaps the green turtle internesting buffer BIA and foraging/breeding BIAs for five species of seabirds. Significant impacts to any marine fauna including marine turtles are considered unlikely as they are limited to individual fauna that may encounter dropped items.

Table 7-3 – Risk Assessment for Unplanned Loss of Solid Waste (hazardous/non-hazardous) or Dropped Objects and Survey Equipment Overboard

	Environmental Value/Sensitivity				Evaluation – Unplanned		
Environmental Aspect	Physical Environment	Threatened species and ecological communities	Ecosystems, communities and habitats	Socio-economic and cultural environment	Significance	Likelihood	Residual Impact
Unplanned loss of solid waste (hazardous/non-	X	X	-	-	Slight	Unlikely	Minor

hazardous) or dropped objects overboard							
Unplanned loss of survey equipment from breakage or shark bite: Includes the acoustic array and the SeaSPY Marine Magnetometer system (or equivalent) tow fish.	X	X	-	-	Slight	Unlikely	Minor

Requirements, Control Measures, Environmental Performance Standards and ALARP Assessment

For details of the requirements that apply to the activity, adopted control measures, environmental performance standards and ALARP assessments applicable to this event, please refer to Appendix A.

Demonstration of Acceptability

Principles of ESD	The risks and impacts from accidental loss of solid waste or equipment to the marine environment are consistent with the principles of ESD based on: • The environmental values/sensitivities within the OA are not expected to be significantly impacted; and • Significant impacts on the health, diversity, productivity and ecological integrity of the environment are not expected to occur.

Summary of Acceptability

The residual risk associated with accidental loss of solid waste or equipment to the marine environment is minor given the application of the controls outlined above and the following points:

- Regulatory requirements are incorporated including compliance with relevant DAFWA and DAWR requirements;
- The survey is consistent with Shell policy, standards and culture;
- Good practice developed from Shell's global vessel operations, industry guidelines and practical mitigations to reduce the risk associated with the accidental loss of solid waste or equipment overboard will be implemented; and
- No stakeholder concerns have been raised.

The potential risks and impacts of equipment loss are not considered to pose any risk to the values of any receptors identified in section 5. The residual risk is considered acceptable.

7.3.2. Unplanned Discharge of Chemicals or Hazardous Liquid Waste Activity

7.3.2.1. Environmental Aspects Arising from the Activity

Project vessels will have a range of chemicals and hydrocarbons stored in small quantities (e.g. cleaning products, hydraulic fluid, etc.). Accidental spills of these chemicals may occur, potentially leading to unintentional discharge to the marine environment (i.e. small spills and leaks). Smalls spills may occur during the survey when the chemical is in use, or from leaks in chemical/waste storage areas and/or equipment.

Hazardous wastes and chemicals generated/produced by the activity may include:

- Water treatment chemicals;
- Cleaning agents (e.g. degreasers for maintenance, electric contact cleaner, solvents);
- Adhesives/sealants (e.g. small quantities of isocyanates used in superglues, threadlock);
- Refrigerants;
- Hydraulic fluids;
- Paint and thinners; and
- Other liquid additives/chemicals.

7.3.2.2. Impact Assessment

Hydrocarbon-based or chemical spills may result in localised impacts on water quality and toxicity effects on marine fauna, with a potential to impact conservation significant species which may be passing through the immediate vicinity of the spill location. Pollution and chemical discharge are key threats to threatened and migratory marine mammals, marine turtles, birds and sharks in Australia (Commonwealth of Australia 2017a; DEH 2005a; DEWHA 2008b; DEWHA 2009a; DEWHA 2009b; DoE 2014c; DoE 2014d; DoE 2015c; DoE 2015c; DoE 2015e; DoE 2015l; DoE 2015m; DoE 2016a; DoE 2016b; DoE 2016c; DoE 2016d; DoE 2016e; DSEWPaC 2011a; DSEWPaC 2013b). Specific effects on individual receptors would depend upon the type and volume of chemical released. Spills are expected to rapidly disperse and dilute within the marine environment most likely causing impacts which are restricted to minor decreases in water quality. Impacts to Heywood Shoal are unlikely given the depth of the shoal, 50-60 m (Heyward *et al*. 2018).

Depending on the volume released, the impact of hazardous wastes/chemicals to the marine environment at the location from incorrect disposal/spill is considered negligible to minor. Given the controls in place to manage this risk, smaller spills are more likely than those that may cause minor impacts. Impacts are expected to be restricted to the OA and will disperse and rapidly dilute, given the open offshore location of the OA.

Table 7-4 – Risk Assessment for Unplanned Discharge of Chemicals or Hazardous Liquid Waste

	Environmental Value/Sensitivity				Evaluation – Unplanned		
Environmental Aspect	Physical Environment	Threatened species and ecological communities	Ecosystems, communities and habitats	Socio-economic and cultural environment	Significance	Likelihood	Residual Impact
Unplanned discharge of chemicals or hazardous liquid waste	X	X	-	-	Slight	Unlikely	Minor
Requirements, Control Measures, Environmental Performance Standards and ALARP Assessment							
For details of the requirements that apply to the activity, adopted control measures, environmental performance standards and ALARP assessments applicable to this event, please refer to Appendix A.							

Demonstration of Acceptability	
Principles of ESD	The impacts from an unplanned discharge of chemicals or hazardous liquid waste during the survey are consistent with the principles of ESD based on: • The environmental values/sensitivities within the OA are not expected to be significantly impacted.
Summary of Acceptability	
The residual risk associated with unplanned chemical and/or hazardous liquid waste discharges to the marine environment during the Factory 3D MSS is minor given the application of the controls outlined above and the following points: • Regulatory requirements are incorporated; • The survey is consistent with Shell policy, standards and culture; • Good practice developed from Shell's global vessel operations, industry guidelines and practical mitigations to reduce the risk associated with the unplanned discharge of chemicals or hazardous liquid waste will be implemented; and • No stakeholder concerns have been raised. The potential impacts of discharges are not considered to pose any risk to the values of any receptors identified in section 5. The residual risk is considered acceptable.	

7.4. Unplanned Collision Between Vessels / Towed Array and Marine Species

7.4.1. Unplanned Injury/Mortality of Conservation Significant Fauna

7.4.1.1. Environmental Aspects Arising from the Activity

Project vessels within the OA pose a potential collision risk to whales, whale sharks and turtles that may frequent transit the area. Marine seismic surveys involve the use of two or more vessels travelling at slow speed (~4.5 knots) along defined survey lines. The survey may coincide with the northern migration of whale sharks, southern migration of the pygmy blue whale and nesting periods for green and hawksbill turtles.

Receptors

- The OA overlaps 1.5% of the whale shark migration BIA, whale sharks may travel through the OA during the survey, but they are not expected to occur in significant numbers, the area is not an identified aggregation area.
- The OA slightly overlaps 0.02% of the pygmy blue whale migration BIA.
- The OA overlaps 0.6% of the green turtle internesting buffer BIA.
- The closest potential aggregation area for humpback whales is >157 km from the OA.

Other fauna such as birds, fish and sea snakes are likely to avoid vessels operating in the area and are considered low risk of a potential vessel strike.

7.4.1.2. Impact Assessment

Vessel collisions are key threats to threatened and migratory marine mammals, marine turtles and whale sharks in Australia (Commonwealth of Australia 2017a; DEH 2005a; DEWHA 2009a; DoE 2015c; DoE 2015d; DoE 2015l).

The impact from vessels with marine fauna can be as minimal as behavioural changes by the marine fauna to severe impacts such as mortality resulting from vessel strikes. Vessel collisions contribute to the mortality of marine fauna, notably turtles (Lutcavage *et al*. 1997; Hazel and Gyuris 2006; Hazel *et al*. 2007) and large cetaceans (Knowlton and Kraus 2001; Laist *et al*. 2001; Jensen and Silber 2003). Stranding records for Queensland indicate that 14% of dead marine turtles had been struck by vessels (Hazel and Gyuris 2006). These records are largely from populated areas of the state and comprise an unknown proportion of the total mortality. A report on vessel strikes in Queensland (DoE 2007) has indicated that "both commercial and recreational boats have been responsible for striking marine animals. Recreational vessels, however, account for 96.9% and commercial vessels only 0.001%." A recent review of vessel whale strike data identified up to 109 potential strikes in Australian waters from 1840 to 2015 (Peel *et al*. 2016). Records of cetacean deaths as a result of vessel collisions in Australian waters occurred in the Bass Strait in 1992 (WDCS 2006), and is attributed to container ships and fast ferries.

The NCVA identified the pygmy blue whale migration path on the continental shelf edge over depths of 500-1,000 m (McCauley *et al* 2010), and therefore located in water depths deeper than the majority of the OA. Migrating individuals are not expected to transit the OA in large numbers.

The OA overlaps the whale shark migrating BIA, individuals may be encountered, however given the distance from the OA to the Ningaloo Reef high density foraging BIA (>1,000 km) individuals are likely to have a wide dispersion on migration and therefore reducing the likelihood that large numbers of whale sharks encounters within the OA.

The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017) identified marine turtle mortality from a vessel strike as an issue in Queensland waters. However, turtles are more vulnerable to vessel strike in areas of high urban population where incidents of pleasure crafts are much higher than expected within the Factory OA. WA turtle populations are not highlighted as the most affected by vessel strikes, this is likely to be related to low density of communities along the Kimberley coastline.

Vessels will be moving at slow speeds in the OA, reducing the likelihood of a collision between project vessels and marine fauna, and, should a collision occur, that it would result in serious injury.

Table 7-5 – Risk Assessment for Unplanned Injury/Mortality of Conservation Significant Fauna

Environmental Aspect	Environmental Value/Sensitivity				Evaluation – Unplanned		
	Physical Environment	Threatened species and ecological communities	Ecosystems, communities and habitats	Socio-economic and cultural environment	Significance	Likelihood	Residual Impact
Accidental collision between vessels and threatened species	-	X	-	-	Slight	Remote	Slight
Requirements, Control Measures, Environmental Performance Standards and ALARP Assessment							
For details of the requirements that apply to the activity, adopted control measures, environmental performance standards and ALARP assessments applicable to this event, please refer to Appendix A.							
Demonstration of Acceptability							
Principles of ESD	The risks and impacts to fauna of conservation significance from the physical presence of the Factory 3D MSS are consistent with the principles of ESD based on: • the environmental receptors are not expected to be significantly impacted. • the health, diversity and productivity of the environment is not expected to decrease; and • no significant impacts are expected in terms of biological diversity and ecological integrity.						
Summary of Acceptability							
The residual risk associated with vessel-fauna collisions during the Factory 3D MSS is minor given the application of the controls outlined above and the following points: • Regulatory requirements are incorporated; • Seismic campaign is consistent with Shell policy, standards and culture; • Good practice from industry guidelines and practical mitigations to reduce the risk associated with vessel-fauna collisions will be implemented; and • No stakeholder concerns have been raised. The potential risks and impacts of any release are not considered to pose any risk to the values of any receptors identified in section 5. The residual risk is considered acceptable.							

7.5. Unplanned Hydrocarbon Release

Two credible accidental hydrocarbon release scenarios have been identified for the Factory 3D MSS. Worst-cases for these identified scenarios have been considered in the environmental risk assessment and include:

- Loss of fuel during bunkering (10 m^3 of marine diesel). No mitigation measures applied.
- A short-term (instantaneous) surface release of 250 m^3 of MDO/MGO from a vessel, representing a fuel tank rupture after a vessel to vessel collision. No mitigation measures applied.

Each of these scenarios is discussed in detail below. As each scenario has been defined as the worst-case, or largest credible volume and duration, these unplanned events can also result in smaller spills. The potential consequences of these spills are much smaller than the large volume hydrocarbon releases considered below.

7.5.1. Accidental hydrocarbon release during bunkering

7.5.1.1. Environmental Aspects Arising from the Activity

Refuelling (also termed bunkering) of the seismic vessel from support vessels may occur periodically over the three-month survey. Diesel transfer is planned to take a minimum of 3-4 hours. The probability of a spill occurring during fuel transfer operations is low, however, this probability is inherently increased given the frequency of operations. Causes include hose rupture, coupling failures or tank overflow. Spillage volume is generally less than 160 litres (0.15 m^3), and potential quantities are reduced by visual observations, shutdown of pumps and automatic closure of safety valves. The maximum credible spill amount is considered to be 10 m^3, however, there is a very low likelihood of this volume being spilled should an incident occur during refuelling. Depending on the availability of contracted vessels, should the survey vessel have sufficient tank capacity to have endurance for the entire survey period, then there will be no offshore refuelling/bunkering as part of the petroleum activity.

7.5.1.2. Impact Assessment

Previous modelling for similar surface spills of marine diesel have found hydrocarbons to be contained within surface waters of approximately 1 km of the release location and unlikely to be found entrained or dissolved at significant depths. The closest sensitive receptors to the OA are Heywood Shoal (overlapping the OA), Cartier Island (9 km north of the OA) and Eugene McDermott Shoal (13 km north-east of the OA). Given Heywood Shoal is a submerged shoal with a plateau depth of 15 – 20 m and given the distance to the two other nearest sensitive receptors is significantly greater than the 1 km predicted containment buffer, these features are not expected to be affected by a small surface spill of MDO.

Therefore, impacts from a 10 m^3 MDO spill will be restricted to localised temporary declines to surface water quality within the OA as small amounts of MDO released to the marine environment will dilute and evaporate readily, resulting in negligible effects to the marine environment.

Table 7-6 – Risk Assessment for Marine Diesel Spill Due to Vessel to Vessel Collision

Project Component/ Activity	Environmental Value/Sensitivity				Evaluation – Unplanned		
	Physical Environment	Threatened species and ecological communities	Ecosystems, communities and habitats	Socio-economic and cultural environment	Significance	Likelihood	Residual Impact
10m^3 hydrocarbon spill during bunkering	X	-	-	-	Slight	Remote	Slight

Requirements, Control Measures, Environmental Performance Standards and ALARP Assessment	
For details of the requirements that apply to the activity, adopted control measures, environmental performance standards and ALARP assessments applicable to this event, please refer to Appendix A.	
Demonstration of Acceptability	
Principles of ESD	The impacts from a fuel spill during offshore refuelling are consistent with the principles of ESD based on: • The environmental values/sensitivities within the OA are not expected to be significantly impacted.
Summary of Acceptability	
The residual impact associated with a diesel spill during refuelling is negligible given the application of the controls outlined above and the following points: • The remote likelihood of the risk; • Regulatory requirements and Shell standards are incorporated; • All good practice developed from Shell's global vessel operations, industry guidelines and practical mitigations to reduce the risk associated with vessel collisions have been undertaken; and • No stakeholder concerns have been raised. The potential risks and impacts of any release are not considered to pose any risk to the values of any receptors identified in section 5. The residual impact is considered acceptable.	

7.5.2. Accidental hydrocarbon release caused by vessel collision.

7.5.2.1. Environmental Aspects Arising from the Activity

During the Factory 3D MSS there is a potential for a collision between the seismic vessel and another project vessel or third-party vessel. If this collision is significant there is a low potential for it to result in a breach of a vessel's hull and subsequent rupture of an MDO fuel tank. All project vessels will use MDO, with a maximum single wing tank capacity of approximately 250 m^3. For a collision of two vessels to occur within the project area both vessels will need to have a failure of one of the following; loss of steerage, loss of power, incompetent watch-keeping, and/or a failure of navigation systems.

Likelihood Analysis

In Australian waters between 1982 and 2010, of the 111 spills greater than 1 tonne, six were caused by vessel to vessel collisions. This spill frequency is low, compared to the 26,235 commercial vessel visits to Australian ports in 2010 alone (DNV 2011). The risk of a spill from vessel to vessel collision will depend on the severity, i.e. speed and aspect of the vessels during the event and the vessels involved.

With the application of the requirements of maritime law to prevent a vessel collision with another vessel the likelihood of a collision is considered to be remote. However, Shell must consider that whilst the likelihood may be remote the event could occur. Planning for the worst-case credible spill is required and as such a scenario must be selected to determine the spill volume.

Shell has identified two vessel types for this activity. One has a larger fuel capacity which is preferred so that bunkering risks can be eliminated. This larger vessel has wing tanks of ~250 m^3 and internal tanks with a capacity of 660 m^3. The other has a smaller capacity that will require at sea bunkering to take place and only has wing tanks of ~230 m^3 capacity.

Shell has determined the worst-case credible release from a loss of fuel from a vessel is an instantaneous release of 250 m^3 of MDO. This scenario involves a vessel being impacted by another vessel moving at near full speed, resulting in a puncture of the diesel tanks below the waterline. Shell has reviewed AMSA's Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities, which provides guidance on how to determine the worst-case scenario from vessel collisions. Given the two types of vessel options that may be used for this activity Shell has considered the larger vessel capacity in its planning. Other considerations in selecting what volume to use for modelling and response planning were:

- Either vessel selected will be double hulled and so half of the largest tank should be used.
- The internal tanks in the larger vessel are used for ballast, are unlikely to be topped up to limits, and will be de-ballasted in the event of a collision.
- Hydrostatic pressure will result in less than the full tank volume being lost.
- The acquisition vessel will be operating below 6 knots (well below the full speed required of a collision of sufficient force to penetrate a double skinned tank).
- The vessel will be 'W' class meaning that the vessel has redundant steerage and power supply to electric multi-direction propulsion.
- The vessel selected will comply with all relevant maritime laws (see Appendix A).

Based on the AMSA guidelines and the additional contextual matters listed above it is not considered credible that multiple tanks would rupture. Based on the design of the vessels that could be used, the application of maritime laws, and the control measures adopted by Shell, on balance, the worst-case credible scenario of a loss of 250 m^3 will be carried forward into the consequence analysis.

Consequences Analysis

MDO is a low viscosity distillate fuel. Diesel contains a high proportion of lighter hydrocarbons, such that evaporation is an important process contributing to the removal of spilt diesel from the sea surface. Evaporation will be enhanced by higher wind speeds and warmer sea and air temperatures. The general behaviour of diesel at sea can be summarised as follows:

- A slick of diesel will elongate rapidly in the direction of the prevailing wind and waves;

- Very rapid spreading of the low viscosity diesel will take place;
- Some diesel fuel oils may form an unstable emulsion at the thicker, leading edges of the slick;
- Speed of physical dispersion of the surface slick increases with wind speed. Up to 95% of a slick may disperse within about 4 hours of the spill in 15 knot winds, warm air and sea conditions; and
- Evaporation of diesel is likely to be enhanced due to the warmer prevailing air and sea temperatures of the Operational Area.

To inform the potential impacts from an MDO spill resulting from a vessel to vessel collision, stochastic numerical modelling was commissioned by Shell Australia for the Factory 3D MSS. Modelling was conducted for two adjacent but comparable release points within the OA. The two release points were identified as the worst-case scenario locations for a spill to occur, at the closest points to Cartier Island and to Browse Island as these were determined as the most sensitive receptors in proximity to the OA. For each location a short-term (instantaneous) surface release of 250 m^3 of MDO from a vessel was modelled, representing a fuel tank rupture after a collision. Results from this assessment are provided below.

Hydrocarbon Characteristics of Marine Diesel Oil

MDO is a mixture of volatile and persistent hydrocarbons with low proportions of highly volatile and residual components. Approximately 5% of the oil is shown to be persistent. The aromatic content of the oil is approximately 3%. If released in the marine environment and in contact with the atmosphere (i.e. surface spill), approximately 41% by mass of this oil is predicted to evaporate over the first two days depending on the prevailing conditions, with further evaporation slowing over time. The heavier (low volatility) components of the oil tend to entrain into the upper water column due to wind-generated waves but can subsequently resurface if wind-waves abate. Therefore, the heavier components of this oil can remain entrained or on the sea surface for an extended period, with associated potential for dissolution of the soluble aromatic fraction. (APASA 2018).

The physical properties and fractional boiling points of MDO are presented in **Table 7-7** and **Table 7-8**, respectively.

Table 7-7 – Physical Properties of Marine Diesel used in Modelling

Physical Properties	Marine Diesel
Density (kg/m^3)	829.1 (at 25 °C)
API	37.6
Dynamic viscosity (cP)	4.0 (at 25 °C)
Pour point (°C)	-14.0
Hydrocarbon property category	Group II
Hydrocarbon persistence classification	Non-persistent

Table 7-8 – Boiling-point Breakdown of Marine Diesel used in Modelling

Oil Type	Volatiles (%)	Semi-Volatiles (%)	Low Volatiles (%)	Residual (%)	Aromatics (%)
Boiling point (°C)	<180 C4 to C10	180 – 265 C11 to C15	265 – 380 C16 to C20	>380 >C20	Of whole oil <380 BP
	Non-persistent			Persistent	
Marine Diesel	6.0	34.6	54.4	5.0	3.0

Overview of Stochastic Spill Modelling

For a vessel to vessel collision, stochastic spill modelling was conducted for releases in two locations. Modelling provides an indication of potential trajectories which allows an assessment of potential impacts to the environment in the event of a spill. This impact assessment then informs the development of adequate controls and response measures to ensure the risk associated with these events is considered ALARP and Acceptable. The characteristics of each modelled scenario are provided in **Table 7-9**. Justification of these model parameters is provided below.

Table 7-9 – Summary of Modelled Hydrocarbon Spill Scenario

Parameters	Loss of fuel from vessel	
Release Location	Location 1: closest point within OA to Cartier Island	Location 2: closest point within OA to Browse Island
Latitude	12° 40' 36.88"	13° 37' 00.10"
Longitude	123° 35' 22.00"	123° 54' 58.00"
Depth	0 m (below mean sea level) – surface release	
Hydrocarbon Type	MDO	
Duration	Instantaneous	
Total Volume	250 m^3	

Each of the two spill scenarios (locations) was modelled using a stochastic modelling approach, where the release was repeatedly simulated using different metocean conditions. A total of 300 deterministic model runs were undertaken for each worst-case credible spill scenario (100 during summer, 100 during winter and 100 during transitional season). The aggregated deterministic results (300 deterministic runs for each release scenario – i.e. location) constitute the stochastic data set, from which probabilities of contact above thresholds are determined. Shell Australia considers environmental receptors identified as potentially being contacted with a probability of one or higher (≥1%). This will identify more receptors than would be impacted by a given release, and hence it is environmentally conservative.

Hydrocarbon Impact Thresholds

Spilled hydrocarbons can exist as a range of fates, or phases, in the marine environment. These are floating, entrained, dissolved and accumulated (i.e. stranded onshore) hydrocarbons. Each of these fates, or phases, can interact with the environment in diverse ways due to different pathways to receptors and impact mechanisms.

A series of impact thresholds for floating, entrained, dissolved and shoreline accumulated hydrocarbons were determined. These thresholds were applied to the hydrocarbon spill modelling studies and used to inform the assessment of potential impacts and risks. Three thresholds were applied to each fate, or phase, (low exposure, moderate exposure and high exposure); these are described in **Table 7-10**.

Table 7-10 also outlines thresholds used to derive the EMBA. The EMBA defines the outer boundary of the existing environment that may be affected from unplanned events. The EMBA includes all areas where hydrocarbon levels exceed thresholds concentrations where an ecological impact may occur. This approach has facilitated the assessment of all environmental values and sensitivities that could potentially be affected by the project and has formed the basis of the EPBC Protected Matters search (**Section 3.4.3.2**). Given a spill from a vessel collision could take place anywhere within the OA, yet only two release locations were modelled, the EMBA was derived using the spill extents from the two worst-case scenarios as a guide to predict the extent of spills from other locations within the OA.

Table 7-10 – Summary of Zones of Exposure and Thresholds

Exposure Zone	Threshold	Justification
Floating Hydrocarbon Threshold		
Exposure zone Low exposure (1 g/m^2-10 g/m^2)	1 g/m^2	This threshold is considered to provide a conservative extent of potential impacts to socio-economic receptors associated with visual amenity. The 1 g/m^2 threshold represents the practical limit of observing hydrocarbon sheens in the marine environment and therefore has been used to define the outer boundary of the low exposure zone. This threshold is considered below levels which would cause environmental harm and is more indicative of the areas perceived to be affected due to its visibility on the sea-surface.

		This exposure zone is not considered to be of significant biological impact but may be visible to the human eye. This exposure zone represents the area contacted by the spill and defines the conservative outer boundary of the EMBA from a hydrocarbon spill.
Adverse exposure zone Moderate exposure (>10 g/m^2-25 g/m^2)	10 g/m^2	**This threshold has been used to define the EMBA, given it is the level at which ecological impacts may occur.** Ecological impact has been estimated to occur at 10 g/m^2 as this level of oiling has been observed to mortally impact birds and other wildlife associated with the water surface (French *et al*. 1996, French 2000). The 10 g/m^2 threshold has been selected to define the moderate exposure zone. Contact within this exposure zone may result in impacts to the marine environment.
Adverse exposure zone High exposure (>25 g/m^2)	25 g/m^2	The 25 g/m^2 threshold is above the minimum threshold observed to cause ecological impact. Studies have indicated that a concentration of surface oil 25 g/m^2 or greater would be harmful for the majority of birds that contact the hydrocarbon at this concentration (Koops *et al*. 2004, Scholten *et al*. 1996). Exposure above this threshold is used to define the high exposure zone.
Shoreline Hydrocarbon Threshold		
Exposure zone Low exposure (10 g/m^2-100 g/m^2)	10 g/m^2	In previous risk assessment studies by French-McCay *et al*. (McCay *et al*. 2005a, 2005b), a threshold of 1 g/m^2 was used to assess the potential for shoreline contact (by oil stranding on shorelines/beaches). It is a conservative threshold used to define regions of socio-economic impact, such as the need for shore clean-up on man-made concrete/stone walls or on amenity beaches. A less conservative threshold of 10 g/m^2 has been defined as the zone of potential 'low' exposure. This exposure zone represents the area visibly contacted by the spill and defines the outer boundary of the EMBA from a hydrocarbon spill.
Adverse exposure zone Moderate exposure (>100 g/m2-1,000 g/m^2)	100 g/m^2	French *et al*. (1996) and French-McCay (2009) have defined an oil exposure threshold of 100 g/m2 for shorebirds and wildlife (furbearing aquatic mammals and marine reptiles) on or along the shore, which is based on studies for sub-lethal and lethal impacts. The 100 g/m^2 threshold has been used in previous environmental risk assessment studies (French *et al*. 2011, French McCay 2004, French-McCay 2003, French-McCay *et al*. 2012, National Oceanic and Atmospheric Administration 2013). This threshold is also recommended in AMSA's foreshore assessment guide as the acceptable minimum thickness that does not inhibit the potential for recovery and is best remediated by natural coastal processes alone (AMSA 2015). Thresholds of 100 g/m^2 and 1,000 g/m^2 will define the zones of potential 'moderate' and 'high' exposure on shorelines, respectively. Contact within these exposure zones may result in impacts to the marine environment.
Adverse exposure zone High exposure (>1,000 g/m^2)	1,000 g/m^2	
Entrained Hydrocarbon Threshold		
Exposure zone Low exposure (10 ppb-100 ppb)	10 ppb	The 10 ppb threshold represents the lowest concentration and corresponds generally with the lowest trigger levels for chronic exposure for entrained hydrocarbons in the Australian and New Zealand Environment and Conservation Council and Agricultural and Resource Management Council of Australia and New Zealand (2000; ANZECC & ARMCANZ) water quality guidelines. Due to the requirement for relatively long exposure times (>24 hours) for these concentrations to be significant, they are likely to be more meaningful for

		juvenile fish, larvae and planktonic organisms that might be entrained (or otherwise moving) within the entrained plumes, or when entrained hydrocarbons adhere to organisms or is trapped against a shoreline for periods of several days or more. This exposure zone is not considered to be of significant biological impact. This exposure zone represents the area contacted by the spill and conservatively defines the outer boundary of the EMBA from a hydrocarbon spill.
Adverse exposure zone Moderate exposure (>100 ppb-500 ppb)	100 ppb	The 100 ppb threshold is considered conservative in terms of potential for toxic effects leading to mortality for sensitive mature individuals and early life stages of species. This threshold has been defined to indicate a potential zone of acute exposure, which is more meaningful over shorter exposure durations. The 100 ppb threshold has been selected to define the moderate exposure zone. Contact within this exposure zone may result in impacts to the marine environment.
Adverse exposure zone High exposure (>500 ppb)	500 ppb	**This threshold has been used to define the EMBA.** The 500 ppb threshold is considered conservative high exposure level in terms of potential for toxic effects leading to mortality for more tolerant species or habitats. This threshold has been defined to indicate a potential zone of acute exposure, which is more meaningful over shorter exposure durations. The 500 ppb threshold has been selected to define the high exposure zone.
Dissolved Aromatic Hydrocarbon Threshold		
Exposure zone Low exposure (6 ppb-50 ppb)	6 ppb	The threshold value for species toxicity in the water column is based on global data from French *et al*. (1999) and French-McCay (2003, 2002), which showed that species sensitivity (fish and invertebrates) to dissolved aromatics exposure > 4 days (96-hour LC50) under different environmental conditions varied from 6 ppb-400 ppb, with an average of 50 ppb. This range covered 95% of aquatic organisms tested, which included species during sensitive life stages (eggs and larvae). Based on scientific literature, a minimum threshold of 6 ppb used to define the low exposure zones (Clark 1984, Engelhardt 1983, Geraci and St Aubin 1988, Jenssen 1994, Tsvetnenko 1998). This exposure zone is not considered to be of significant biological impact. This exposure zone represents the area contacted by the spill and conservatively defines the outer boundary of the EMBA from a hydrocarbon spill.
Adverse exposure zone Moderate exposure (>50 ppb-400 ppb)	50 ppb	A conservative threshold of 50 ppb was chosen as it is more likely to be indicative of potentially harmful exposure to fixed habitats over short exposure durations (French-McCay 2002). French-McCay (2002) indicates that an average 96-hour LC50 of 50 ppb could serve as an acute lethal threshold to 5% of biota. The 50 ppb threshold has been selected to define the moderate exposure zone. Contact within this exposure zone may result in impacts to the marine environment.
Adverse exposure zone High exposure (>400 ppb)	400 ppb	**This threshold has been used to define the EMBA.** A conservative threshold of 400 ppb was chosen as it is more likely to be indicative of potentially harmful exposure to fixed habitats over short exposure durations (French-McCay 2002). French-McCay (2002) indicates that an average 96-hour LC50 of 400 ppb could serve as an acute lethal threshold to 50% of biota.

		The 400 ppb threshold has been selected to define the high exposure zone.

Source: modified from RPS (2018)

Modelling Results

Considering the discharge characteristics of the spill scenario, the properties of MDO and its expected weathering behaviour, floating oil will be susceptible to entrainment into the wave-mixed layer under typical wind conditions at both release locations. Evaporation rates will be significant, given the moderate proportion of volatile compounds in the oil (41%). The low-volatility fraction of the oil (54%) will take longer durations of the order of days to evaporate, and the residual fraction of 5% is expected to persist in the environment until degradation processes occur (over periods of weeks to months). Considering the spill volume, there is a low potential for dissolution of soluble aromatic compounds. (RPS 2018)

Floating oil and shoreline accumulation (RPS 2018):

- Hydrocarbons on the sea surface at or greater than the threshold concentrations are predicted to remain relatively localised around the release location irrespective of season, with very low probabilities of contact to the nearest shoreline receptors.
- From the modelled release location closest to Cartier Island:
    - The minimum time to contact with any receptor by floating oil at the low, moderate and high thresholds is forecast at 1 hour over all seasons at the North-West Slope Trawl Fishery (NWSTF), Southern Bluefin Tuna Fishery (SBTF), Western Skipjack Fishery (WSF), Western Tuna and Billfish Fishery (WTBF), seabird BIAs and marine turtle BIA receptors, indicating that the oil upon arrival will be relatively unweathered.
    - Floating oil at high threshold concentrations could arrive at the Cartier Island AMP within 14 hours in summer and within 9 hours in winter and transitional months.
- From the modelled release location closest to Browse Island:
    - The minimum time to contact with any receptor by floating oil at the low, moderate and high thresholds is forecast at 1 hour across all seasons at the SBTF, WSF, WTBF, and whale shark BIA receptors, indicating that the oil upon arrival will be relatively unweathered.
    - Floating oil at low threshold concentrations will arrive at Browse Island within 45 hours in transitional months and within 119 hours in winter and will not contact this shoreline in summer.

Entrained oil:

- Probability contours calculated for entrained oil reveal seasonal trends in distribution, with oil typically migrating towards the north-east in summer, towards the west in winter and towards the south-west during transitional months.
- From the modelled release location adjacent to Cartier Island:
    - The minimum time to contact with any receptor by entrained oil at the low, moderate and high thresholds across all seasons is forecast at the NWSTF, SBTF, WSF, WTBF, seabird BIAs and marine turtle BIA receptors as approximately 1 hour.
- From the modelled release location adjacent to Browse Island:
    - The minimum time to contact with any receptor by entrained oil at the low, moderate and high thresholds across all seasons is forecast at the SBTF, WSF, WTBF, and whale shark BIA receptors as approximately 1 hour.

Dissolved oil:

- For both release locations, concentrations not predicted to exceed the high (400 ppb) threshold at probabilities greater than 1%.

Maximum extents for each hydrocarbon type and threshold are summarised in **Table 7-11**.

Table 7-11 - Maximum distances from the release locations to exposure zones of floating, entrained and dissolved oil (250 m³ MDO)

Entrained Oil Exposure Threshold	Maximum distance travelled (km) by a spill trajectory	
	Scenario 1 (closest to Cartier Island)	Scenario 2 (closest to Browse Island)
Floating Oil		
Low (1-10 g/m2)	291	263
Moderate (10-25 g/m2)	**75**	**72**
High (>25 g/m2)	42	47
Entrained Oil		
Low (10-100 ppb)	1,732	1,804
Moderate (100-500 ppb)	1,726	1,508
High (>500 ppb)	**275**	**271**
Dissolved Oil		
Low (6-50 ppb)	1,126	799
Moderate (50-400 ppb)	23	40
High (>400 ppb)	**-**	**-**

7.5.2.2. Impact Assessment

Table 7-12 summarises all sensitive receptors identified as being potentially impacted during a vessel to vessel collision for outlined ecological thresholds (**Table 7-11**). Potential impacts to these receptors in the unlikely event of vessel to vessel collision resulting in a fuel tank rupture are described in the National Energy Resources Australia (NERA) Consequence Analysis of an Accidental Release of Diesel Reference Case (NERA 2018). This Reference Case is considered relevant to the risk described for the Factory 3D MSS given that:

- Water depths within the OA are greater than 10 m (i.e. 24 to 455 m).
- Accidental release volume is <700 m³ (i.e. 250 m³).
- Fuel type is marine diesel, or MDO (i.e. consistent with hydrocarbon characteristics within the Reference Case).
- Other variables, including air temperature, release duration and consequence thresholds are consistent within those used in the Reference Case's impact analysis.
- Impacts not explicitly described within the Reference Case (e.g. for offshore islands and reefs, and shoals and banks) are described below.

Potential impacts to water quality and to conservation significant or other species are described in the NERA Reference Case are considered negligible (NERA 2018). Impacts not explicitly described within the Reference Case (NERA 2018; e.g. shoals and protected areas) are described below.

In addition to the Reference Case Shell has undertaken other modelling for its Prelude Operations. Using the same parameters above the modelled results for a 750 m³ release were located on the same reference points as were modelled for the Factory EP. The results were that the extent and duration of a spill were not significantly different when considering the thresholds related to these parameters of a spill.

<u>Shoals and Banks</u>
The Timor Sea region hosts numerous banks and shoals, five of which were identified by the stochastic modelling as potentially being contacted by MDO during a worst-case credible vessel spill scenario. Modelling results indicated the probability of the oil trajectory reaching this distance was relatively low with contact mostly restricted to entrained oil at a 1% probability of contact. Heywood Shoal, the only shoal located within the OA, was an exception to this with a slightly higher probability of contact for entrained of 3% and a low potential for floating oil to reach the area (maximum probability of 4% during summer months). The minimum time to contact at Heywood Shoal was 14 hours giving a reasonable amount of time for the MDO to weather.

The plateaus at Heywood Shoal, at their shallowest rise up to 15 m (Heyward *et al*. 2018) and is therefore not expected to be impacted by floating oil and unlikely to be impacted by entrained oil from a surface release of MDO. Given the depth of the shoals and banks within the EMBA (e.g. not within the upper 10 m of the water column) and the low probability of contact determined from stochastic modelling, impacts to shoals/banks are unlikely to be impacted in the event of a MDO spill resulting from a tank rupture.

Offshore Reefs and Islands

Offshore islands and reefs often host biological communities that are distinct from coastal islands and the mainland. Like the shoals and banks described above, offshore reefs and islands typically host light-dependent ecosystems characterised by benthic primary producers. Potential impacts to submerged receptors associated with offshore reefs and islands will be similar to those described for shoals and banks above. Unlike shoals and banks, offshore reefs and islands may be impacted by floating hydrocarbons and shoreline accumulation (in addition to entrained and dissolved hydrocarbons) should contact above thresholds occur.

Four offshore reefs and islands were identified by stochastic modelling as potentially being contacted by hydrocarbons above adverse exposure thresholds, including Browse Island, Scott Reef, Ashmore Reef and Cartier Island (**Table 7-12**). While floating hydrocarbons were only predicted to contact Cartier Island AMP (maximum 7% probability during transitional months), shoreline accumulation can occur where floating hydrocarbons have not reached due to contact and adherence of entrained hydrocarbons. Shoreline contact and accumulation is predicted at low probabilities for these four receptors with highest probabilities during transitional months.

The two highest probabilities and associated accumulation volumes were at Browse Island (for a spill at the closest point within the OA to this receptor) at a 9% probability with an average accumulation of 2 m^3 (maximum 37 m^3) and at Cartier Island AMP (for a spill at the closest point within the OA to this receptor) at a 17% probability with an average accumulation of 6 m^3 (maximum 80 m^3). Ashmore Reef AMP had a maximum probability of shoreline contact of 4% with an average accumulation of >1 m^3 (maximum 36 m^3). Contact was only predicted at Ashmore Reef for the spill scenario with a release location at the closest point to Cartier Island. At Scott Reef, contact was only predicted during transitional months (1% probability) for a release location closest to Browse Island, with average accumulation volumes predicted at <1 m^3 (maximum 2 m^3).

A worst-case scenario spill of 250 m^3 MDO during the Factory 3d MSS is predicted to have moderate impacts to offshore islands and reefs identified by stochastic modelling. Due to the location of the OA and the predominant drift trajectories, the areas of coastline most likely to be impacted by a spill are predicted to be the shorelines of Cartier Island and Browse Island.

Key Ecological Features

Five KEFs may be exposed to hydrocarbons above adverse impact thresholds in the event of a worst-case scenario MDO spill (**Table 7-12**) including:

- Continental slope demersal fish communities;
- Ashmore Reef and Cartier Islands and surrounding Commonwealth waters;
- Ancient coastline at 125 m depth contour;
- Carbonate bank and terrace system of the Sahul Shelf; and
- Seringapatam Reef and Commonwealth waters in the Scott Reef complex.

All but two of these KEFs are entirely sub-tidal. As a MDO spill is not expected to entrain or dissolve to significant depths in the water column, and given the depths to these features, no impacts are predicted to subtidal KEFs. Ashmore Reef and Cartier Islands and surrounding Commonwealth waters KEF and Seringapatam Reef and Commonwealth waters in the Scott Reef complex KEF are shallow features which also comprise shorelines.

At low probabilities these two KEFs are predicted to be contacted by floating hydrocarbons with a small chance of shoreline accumulation. Entrained hydrocarbons are also predicted with low probabilities at the Ashmore Reef and Cartier Islands and surrounding Commonwealth waters KEF. Oil pollution is considered a potential pressure on these two KEFs (see **Section 3.4.2**; DSEWPaC 2012a; 2012b). Impacts to these KEFs are discussed above in offshore reefs and islands.

Australian Marine Parks

Modelling results indicated three AMPs that may be contacted above adverse exposure thresholds, Cartier Island AMP, Ashmore Reef AMP and Kimberley AMP. These parks contain a range of environmental values such as marine biota, representative marine habitats and unique sea scapes. Environmental values for these AMPs are described in **Section 3.5.3**. Probability of contact for floating, entrained and shoreline accumulated hydrocarbons for Ashmore Reef and Cartier Island AMPs is discussed above in offshore reefs and islands. For the Kimberley AMP small amounts of entrained hydrocarbons were predicted at a 1% probability during summer and transitional months, with no shoreline contact expected. Given this, impacts to this receptor are unlikely. Refer to the above section for potential impacts to Ashmore Reef and Cartier Island AMPs.

Table 7-12 – Summary of Modelling Results for Vessel to Vessel Collision Scenario for Receptors Above Identified Thresholds

S = summer, W = winter and T = transitional months. Bolded season indicates worst-case scenario exposure. Where shoreline contact is predicted under multiple seasons, average (maximum) shoreline accumulation volumes are given for the worst-case scenario. Receptors with no shorelines are given N/A for shoreline accumulation measures.

Receptor Category *(Probability of being impacted)*

<1%	-		
1%		>25-50%	
>1-10%		>50-75%	
>10-25%		>75%	

Receptor Category	Hydrocarbon Phase Above Adverse Exposure Threshold									
	Scenario 1 (closest to Cartier Island)					Scenario 2 (closest to Browse Island)				
	Floating ≥10 g/m²	Shoreline accumulation ≥100 g/m²	Average (max) accumulation m³	Entrained ≥500 ppb	Dissolved ≥400 ppb	Floating ≥10 g/m²	Shoreline accumulation ≥100 g/m²	Average (max) shoreline accumulation m³	Entrained ≥500 ppb	Dissolved ≥400 ppb
Shoals and Banks										
Heywood Shoal		N/A	N/A			**S**,W,T	N/A	N/A	**S**,W	
Sahul Bank		N/A	N/A	S			N/A	N/A		
Vulcan Shoals		N/A	N/A	T			N/A	N/A		
Woodbine Bank		N/A	N/A	T			N/A	N/A		
Holothuria Banks		N/A	N/A				N/A	N/A	S	
Reefs and Offshore Islands										
Browse Island		T	<1(9)				S,W,**T**	2(37)		
Scott Reef South and Sandy Islet							T	<1(2)		
Mainland Coast-lines										
No coastlines predicted to be contacted.										
Key Ecological Features										
Ancient Coastline at 125 m depth contour		N/A	N/A			**S**,W,T	N/A	N/A	**S**,T	
Ashmore Reef and Cartier Island and surrounding Commonwealth waters	S,W,**T**	N/A	N/A	**S**,W,T						
Carbonate bank and terrace system of Sahul Shelf		N/A	N/A	**S,T**			N/A	N/A	S	
Continental Slope Demersal Fish Communities	**S,W,T**	N/A	N/A	S,**W**,T		S,**W**	N/A	N/A	**W**,T	

Receptor Category (Probability of being impacted)	Hydrocarbon Phase Above Adverse Exposure Threshold									
<1%: - ; 1%; >1-10%; >10-25%; >25-50%; >50-75%; >75%	Scenario 1 (closest to Cartier Island)					Scenario 2 (closest to Browse Island)				
	Floating ≥10 g/m²	Shoreline accumulation ≥100 g/m²	Average (max) accumulation m³	Entrained ≥500 ppb	Dissolved ≥400 ppb	Floating ≥10 g/m²	Shoreline accumulation ≥100 g/m²	Average (max) shoreline accumulation m³	Entrained ≥500 ppb	Dissolved ≥400 ppb
Seringapatam Reef and Commonwealth Waters in the Scott Reef Complex							T	<1(2)		
BIAs										
Turtle BIA	**S,W,T**	N/A	N/A	S,**W**,T			N/A	N/A		
Seabirds BIA	**S,W,T**	N/A	N/A	S,**W**,T			N/A	N/A	**S,W,T**	
Whales BIA	S,**W**,T	N/A	N/A	S,**W**,T			N/A	N/A	W	
Whale Shark BIA	**S**,W,**T**	N/A	N/A	**S**,T		**S,W,T**	N/A	N/A	S,**W**,T	
Marine Parks, Heritage Places and Ramsar Wetlands										
Kimberley AMP		N/A	N/A				N/A	N/A	S,T	
Ashmore Reef AMP		W,**T**	<1(36)	W						
Cartier Island AMP	S,W,**T**	S,W,**T**	6(80)	**S**,W			T	<1(5)		
Browse Island Nature Reserve		T	<1(9)				S,W,**T**	2(37)		
Scott Reef Nature Reserve							T	<1(2)		
Fisheries										
North-west Slope Trawl Fishery	**S,W,T**	N/A	N/A	S,**W**,T		S,**W**	N/A	N/A	S,**W**,T	
Southern Bluefin Tuna Fishery	**S,W,T**	N/A	N/A	S,**W**,T		**S,W,T**	N/A	N/A	S,**W**,T	
Western Skipjack Fishery	**S,W,T**	N/A	N/A	S,**W**,T		**S,W,T**	N/A	N/A	S,**W**,T	
Western Tuna and Billfish Fishery	**S,W,T**	N/A	N/A	S,**W**,T		**S,W,T**	N/A	N/A	S,**W**,T	

Table 7-13 – Risk Assessment for Marine Diesel Spill Due to Vessel to Vessel Collision

Environmental Aspect	Environmental Value/Sensitivity				Evaluation – Unplanned		
	Physical Environment	Threatened species and ecological communities	Ecosystems, communities and habitats	Socio-economic and cultural environment	Significance	Likelihood	Residual Impact
250 m^3 MDO spill due to vessel to vessel collision	X	X	-	X	Major	Remote	Moderate
Requirements, Control Measures, Environmental Performance Standards and ALARP Assessment							
For details of the requirements that apply to the activity, adopted control measures, environmental performance standards and ALARP assessments applicable to this event, please refer to Appendix A.							
Demonstration of Acceptability							

Value or Sensitivity	**Feature**	**Set acceptable levels of impact**	**Predicted impacts**
Benthic Communities	Heywood Shoal Eugene McDermott Shoal Goeree Shoal Vulcan Shoal Barracouta Shoals Echuca Shoal.	No unrecoverable or long-term effects on fish, benthic or coral assemblages from impacts and risk associated with the activity	In the unlikely event of a spill the cause effect pathway is through increased entrained and dissolved hydrocarbons (toxic effects) rather than through any smothering of benthic habitats. Increase hydrocarbon levels may extend for upto 6 weeks and the ecosystems at each of the shoal locations is expected to recover from exposure in weeks to months. Even if the event occurred the acceptable level is no predicted to be exceeded.
Commercial, Recreational and Traditional Fisheries	Social and economic features of each fishery within the ensonified area of the survey	No effect to the sustainability of the fish population and the sustainability of the fisheries in the Gascoyne and North Coast fishing marine bioregions.	Even in the unlikely event of a spill, there is no identified cause effect pathway from a 250m^3 diesel spill from the Factory activity that would lead to population level effect or threaten the sustainability of any fishery.
Listed Threatened and Migratory Species	Fish and Invertebrates	•No fish/invertebrate mortality or PTS effects •Non-peak spawning effects are short-term, localised, and recoverable	Toxic affects to fish and invertebrates and their life-cycle stages are predicted to be localised and limited to tainting in the short-term post-spill. Even in the unlikely event of a spill the consequence prediction is below the set acceptable level.

	Marine Reptiles, Birds and Sharks and Rays	•Effects limited to behavioural disturbance of a small number of individuals. •No local population impacts on breeding, migration or foraging. •No population level effects.	Marine fauna can be affected through smothering or toxic affects. The toxic affects are of concern in the event of a spill. Behavioural responses such as avoidance are unlikely. The acceptable levels may be exceeded if this event were to occur hence the adoption of all reasonably practicable controls to prevent the occurrence (ref. Appendix A).
	Marine Mammals	•No displacement of foraging, aggregating, calving/breeding, or migrating cetaceans from identified BIA's •No alteration to critical habitat •No injury to any marine mammal	Marine fauna can be affected through smothering or toxic affects. For the Factory activity the toxic affects are of concern in the event of a spill. Behavioural responses such as avoidance are unlikely. The acceptable levels may be exceeded if this event were to occur hence the adoption of all reasonably practicable controls to prevent the occurrence (ref. Appendix A). The extent of the entrained hydrocarbons does not overlap with any critical habitat and no direct injury could occur even in the unlikely event of a spill.
Key Ecological Features	Ancient Coastline at 125 m Depth Contour KEF	No increase in status of the regional pressures as a direct result of the planned activity.	All regional pressures 'of concern' have been considered and the activity will not increase the pressure on the values of each of the KEFs considered. Oil spills from shipping were assessed as part of the establishment of KEF's and for the five KEF's proximate to this activity this was not considered either of 'potential concern' or 'of concern' see Table 3-5.
	Continental Slope Demersal Fish Communities KEF		
	Ashmore Reef and Cartier Island and Surrounding Commonwealth Waters		
	Carbonate Bank and Terrace System of the Sahul Shelf		
	Seringapatam Reef and Commonwealth waters in the Scott Reef Complex		
Australian Marine Parks **(by IUCN Category)** **Including Offshore Reefs and Islands**	1a	No disturbance to the habitats, ecosystems, and native species of the AMP.	Toxic effects arising from a spill may have short-term disturbance to the habitats, ecosystems, and native species of the AMP. The acceptable levels may be exceeded if this event were to occur hence the adoption of all reasonably practicable controls to prevent the occurrence (ref. Appendix A).

Ports and Commercial Shipping	Osbourne Passge	No collisions with other commercial vessels.	Given the effectiveness of the control measures adopted for preventing collisions and the legislative requirements that apply to the activity no collisions with other vessels are predicted.
Tourism and Recreational Activities			No cause effect pathway identified.
Military and Defence Activities			No cause effect pathway identified.
Offshore E&P activities			No cause effect pathway identified.
Principles of ESD	The risks and impacts from the worst-case credible MDO release resulting from a vessel to vessel collision are inherently inconsistent with some of the principles of ESD based on the following: • environmental resources may be significantly impacted in the event a worst-case credible spill occurs, and • a worst-case credible spill may prevent others exercising their right to access environmental resources. Shell will apply a range of controls to ensure that a worst-case credible spill from the Factory 3d MSS does not occur. These include a range of industry best practices that have been developed through extensive industry experience. Following successful application of these controls, Shell considers the residual risk to be consistent with the principles of ESD. This consistency is achieved by: applying the precautionary principle in the assessment of hydrocarbon spill scenarios by: using worst-case credible spill scenarios. Industry statistics indicate most unplanned spills are significantly smaller than the worst-case credible spills. using a stochastic modelling approach for numerical modelling of the worst-case credible spill scenarios that includes a large number of deterministic runs covering a range of metocean conditions, and using environmentally conservative adverse exposure zone thresholds.		

Summary of Acceptability
The residual risk associated with a vessel to vessel collision resulting in a full capacity tank rupture and release to the marine environment during the Factory 3D MSS is moderate given the application of the controls outlined above and the following points: • The remote likelihood of risk; • Regulatory requirements and Shell standards are incorporated; • All good practice developed from Shell's global vessel operations, industry guidelines and Practical mitigations to reduce the risk associated with vessel collisions have been undertaken; and • No stakeholder concerns have been raised. The potential risks and impacts of any release are not considered to pose any risk to the values of any receptors identified in section 5. The residual impact is considered acceptable.

8. Environmental Performance Outcomes, Standards and Criteria

Shell's overarching environmental objective for the Factory 3D MSS is to reduce environmental impacts and risks to ALARP and acceptable levels. Acceptable levels of impact and risk have been determined for the Factory 3D MSS (see **Section 5.5**) and are used to inform the establishment of EPOs. The goal of EPOs is to:

- be consistent with the principles of ESD as defined in section 3A of the EPBC Act
- be consistent with relevant requirements including legislative requirements, plans of management and other statutory instruments applicable to the environmental management of the activity
- be relevant to identified environmental impacts and risks for the activity
- demonstrate that impacts and risks will be managed to an acceptable level
- set a measurable level against which the environmental performance of the titleholder can be assessed.

Specific EPOs, standards and measurement criteria for each aspect of the proposed activity that has the potential to cause adverse environmental impact are detailed in **Appendix A**. Compliance with EPOs is generally expected to be achieved by demonstrating compliance with all relevant environmental performance standards.

Appendix A includes a number of project specific and Shell Australia standards that have been set for the implementation of this EP. The measurement criteria comprise records that will provide evidence of compliance with each standard.

A number of regular health, safety and environment (HSE) checks are undertaken during the activity to ensure operating performance is maintained. Annual environmental performance review measures environmental performance against the outcomes and standards presented in this EP. Finally, **Section 9** describes incident reporting and investigation and how non-conformances with the outcomes and standards in **Appendix A** are addressed.

9. Implementation Strategy

The OPGGS(E) Regulations requires that an EP contains an implementation strategy that includes the following information:

- reporting requirements to the Regulator;
- description of the environmental management system used to manage the activity,
- a clear chain of command;
- measures to communicate employee and contractor responsibilities;
- sufficient monitoring, recording, auditing, management of non-conformance and review of environmental performance and the implementation strategy;
- sufficient monitoring and recording of emissions and discharges;
- an OPEP; and
- appropriate consultation of authorities and other relevant persons/organisations.

9.1. Management System

The Shell Commitment and Policy on Health, Safety, Security, Environment and Social Performance (HSSE and SP) applies globally and documents Shell's commitment to protect people and the environment (described in **Section 5.3**). This commitment is further supported by the Shell Group HSSE and SP Control Framework. The relevant environmental requirements from Shell's HSSE and SP Control Framework have been captured in this EP. This EP outlines how the aspects of the activity that represent environmental risks have been assessed and will be managed. Shell is responsible for assuring that the proposed activity is managed in accordance with this EP.

The management measures for each aspect of the operations are discussed in **Section 6** and **7**. For each aspect the EPO, EPS and MC are presented in **Section 8**.

9.1.1. Management of Change (MOC)

Management of change (MOC) is a compulsory Shell AI-PSM requirement to avoid incidents resulting from unforeseen consequences of Process Changes, Procedural Changes or Organisational Changes. Changes must be fully documented and reviewed by management, prior to decision and communication of the change to all relevant parties, and execution. The MOC procedure that applies is Shell Australia Management of Change (MOC) Procedure (TEC_GEN_001465). This procedure applies to any potential EP changes during the planning and execution of this scope.

All changes presented under the MOC process require Health, Safety, Security, Environment & Social Performance (HSSE&SP) screening and endorsement. In addition, any potential changes to the EP are assessed using the Management of Change (TEC_GEN_001465). If a change is considered significant as per Regulation 17 (5) or (6) and as determined by the MOC process, then a revised or new EP will be submitted to NOPSEMA for acceptance. The following examples or scenarios would generally be considered significant changes:

- Change in the stated timing of the survey outlines within the EP;
- An increase in the source power levels of the air gun; and
- Any increase in the acquisition area of the survey.

The following will also trigger the review of the management of a particular environmental impact or risk to ensure that ongoing management of impacts and risks are at ALARP and acceptable levels:

- Changes in regulatory requirements/standards;
- Information which may suggest an increase in environmental risks or impacts to those outlined in the EP;
- Prominent new scientific studies which may 'negatively' change the understanding of environmental risks and impacts; or
- Objections or claims raised which require changes in EP content.

9.1.2. Contractor Selection Process

As part of the Shell Australia contract and procurement processes there is a Shell Geophysical Operations Checklist which identifies the technical, safety, and procedural capabilities and past performance of seismic contractors to 'pre-qualify' for the formal tender process. The Checklist subsequently covers tender evaluation and selection of the preferred geophysical provider. The Checklist has the following features relevant to the environmental management system:

1) Contractor Pre-Selection (Pre-tender):
   a) HSSE capability Assessment which confirm contractor capability to meet HSE requirements
   b) Technical evaluation including vessel/crew availability and suitability, crew experience, and capability to handle environmental conditions & requirements
2) Contract Tendering and Bid Evaluation
   a) Confirm contractor capability to meet HSE requirements
      i) Verify past & current HSE performance
      ii) Verify HSE-MS in place and competence assurance process
   b) Technical evaluation:
      i) Vessel/Crew availability and suitability for the survey area
      ii) Crew experience
      iii) Fulfilling minimum requirements for source and recording equipment
      iv) Capability to handle environmental conditions & requirements
3) Pre-Mobilisation Planning:
   a) Hazard Identification Workshop (HAZID) performed with contractor project specific hazard identification workshop and agree mitigation measures to be put in place and owner
   b) Geohazards, nontechnical, environmental and local specific risks
   c) Vessel HSSE Inspections
   d) Emergency Response Planning to ensure key risk areas from the project HAZID are covered and emergency response is tested
   e) Project Execution and contractor HSSE plan(s) to ensure:
      i) Agreed objectives, project plan and KPIs
      ii) All necessary procedures and controls are in place
      iii) MOC procedures are in place
      iv) Waste management and environment management plan are part of the HSSE&SP plan
4) Mobilisation Assurance:
   a) Company Site Representative supervision and Onboarding. Briefing of QC personnel and representatives (MMO/MFO, technical, navigation, HSE, etc). Review major hazards in the projects, weather forecasts, geophysical aspects of project and expected deliverables, project operations Plan (crew change, resupply, etc), this Environmental Plan, Project HSE management plan and Emergency Response Plan
   b) HSSE inspections, incuding:
      i) Follow up from previous inspection and close-out of outstanding action points:
      ii) maritime inspection of vessels (follow-up of OVID)
      iii) Required staff training certificates, driving licenses and defensive driving courses
5) Survey Execution:
   a) Monitor HSSE&SP performance
   b) Ensure emergency drills are carried out
   c) Record and report all HSSE&SP incidents
   d) Initiate investigation of actual and potential incidents

In the final contract Shell Australian has the following clauses to ensure the competence of personnel carrying out the activity:

- Clause requiring the provision of Curriculum Vitae's from "Key Personnel"
- The minimum information to be supplied in Curriculum Vitae shall include:

    - Education - stating periods of educational establishments attended and qualifications attained with grades where applicable.
    - Details of safety and technical training courses attended together with dates.
    - Experience - stating employment history, project in which employee has been engaged, and positions held in the organisation.
    - Any references.
    - Any other information CONTRACTOR considers relevant.
- Key Personnel will include:
    - HSE advisor
    - Marine Fauna Obserer
    - Shell Company Site Representative

9.1.3. Contractor HSSE Management Process

Contractors and their sub-contractors carry out a number of activities on behalf of Shell Australia. Effective management of integrity, health and safety risks in contracts involves setting clear expectations and managing these risks throughout the contract lifecycle.

Shell implements specific pre and post contract award processes and activities aimed at ensuring that contracts consistently and effectively cover the management of HSSE & SP risks, and deliver effective management of HSSE & SP risks for contracted activities which is detailed in the HSSE & SP Contractor Management Strategy Manual. Contractor HSSE & SP Management is governed by the Shell HSSE & SP CF.

Key aspects of the Contractor HSSE Management are:

<u>Pre-contract Award Activities</u>

- Appointing a competent Contract Owner and contract holder for each contract.
- Assess contract HSSE & SP risk and contract mode: Identifying the HSSE & SP risks associated with the contracted activities and define how to manage the Risks.
- During the bid evaluation, assessing whether the Contractor has the capability and resources to manage the HSSE & SP risks, through HSSE & SP prequalification assessments (green-banding).
- Before contract award, confirming that the contractor meets requirements. Focus on closing gaps in draft Contract HSSE & SP Plan submitted by contractor
- Defining the Contractor HSSE KPIs.
- Defining the level of Company monitoring based on the capability of the Contractor and the Contract HSSE & SP risk.

<u>Post-contract Award Activities</u>

- Verifying that the Contractor and its personnel have been informed of the HSSE & SP requirements of the contract.
- Verifying that the Contractor manages the HSSE & SP requirements of the contract and review and approve the Contract HSSE & SP Plan when it is required.
- Monitoring and regularly assessing the HSSE & SP performance of the Contractor.
- Regularly reviewing the management of risks in contracted activities.

Post contract award, a formal gap assessment may be conducted as appropriate between each contractor's HSSE & SP MS and Shell's HSSE & SP CF.

9.1.3.1. Contractor Competency Requirements and Assurance

The contractors are responsible for the competence assurance of their personnel and for ensuring that all personnel have the appropriate level of competence required to safely and effectively carry out the work. The Contractor is also responsible for the development and implementation of a competence assurance plan. The contract holder is responsible for ensuring that the contractor's competence assurance system is reviewed, robust and meets the Shell requirements.

In addition to trade competencies and qualification requirements, the minimum competence requirements for key contractors working on any activity are based on the required contractor work scope and are developed in consultation between Shell and the contractor. The minimum environmental requirements for a contractor going offshore include the following:

- Facility HSSE Induction - including Waste Management, Chemicals Management and Oil spill awareness training

9.2. Environmental Management and Mitigation Measures

The management measures for each aspect of the operations are discussed in **Section 6** and **7**. For each aspect the EPO, EPS and MC are presented in **Section 8**.

9.3. Roles and Responsibilities

General responsibilities associated with this EP for key personnel are summarised below in **Table 9-1**.

Table 9-1 - Roles and Responsibilities

Role	Responsibilities Relevant to this EP
Shell Executive Vice President, Australia	• assumes overall responsibility for the successful completion of the survey; • assumes responsibility for resourcing and compliance with the Shell HSSE & SP Control Framework and all applicable legislative requirements; • assumes responsibility for planning, implementing and monitoring the program in accordance with the Shell HSSE & SP Control Framework; • coordinates the allocation of project resources to achieve environmental objectives, including implementation of this EP, with advice and assistance from the Shell Project Manager; • responsible for appropriate organisation and response in the event of a serious incident or emergency; • maintains communication with company personnel, government agencies and the media in the event of a serious incident; and • includes environmental requirements in contracts.
Shell Project Manager	• responsible for reviewing environmental risks and addressing them in accordance with the EP; • coordinate and reviews results of HSSE audit; • coordinates submission of environmental documentation; • coordinates the environmental education and induction of the survey vessel workforce; this includes communicating the project hazards and risks and the importance of following good work practices. • provides advice in the event of an oil spill or other environmental incident and participates in associated investigation; • reviews environmental performance at completion of survey operations; • coordinates preparation and submission of program close-out report to NOPSEMA; • responsible for reporting all reportable and recordable incidents to NOPSEMA. • responsible for executing the survey is consistently with this EP and relevant environmental legislative requirements or regulatory conditions; • facilitates clear communications between the Shell Executive Vice President, the Company Site Representative, Party Chief, Vessel Master and Technicians and Crew; • responsible for managing survey operations, resourcing and compliance with this EP; • responsible for putting in place the following documents: this EP; Vessel's ERP; and Vessel's SOPEP. • responsible for overall compliance with the EP; • responsible for overall compliance with all external reporting requirements; • commits necessary resources to facilitate an ERP in the event of an incident; • responsible for receiving regulatory approvals prior to seismic operations commencing; and • responsible for appropriate engagement with stakeholders.
Company Site Representative	• Ensures that the following documents are understood and adhered to by the Party Chief: project Execution Plan, vessels ERP, vessels SOPEP and this EP.

Role	Responsibilities Relevant to this EP
	• facilitates clear communications between the Shell Project Manager and Vessel; • investigates any hydrocarbon spills to the environment; • ensures records of daily logs, environmental incidents, waste inventory and cetacean sightings are completed and issued to the Shell Project Manager; • conducts a compliance audit during the program and forwards results to the Shell Project Manager; and • prepares a report of the overall environmental performance upon completion of program, including the results of audits and any incidents, and forward to Shell Project Manager for issuing to NOPSEMA.
Party Chief	• Ensures that the following documents are understood and adhered to by the vessel's crew: Vessels ERP, Vessels SOPEP, and this EP. • responsible for operating consistently with: • this EP and relevant environmental legislative requirements or regulatory conditions. • facilitates clear communications between the Shell Company Site Representative and survey vessel personnel; • investigates any hydrocarbon spills to the environment; • communicates operating policy and procedures to all vessel-based personnel and ensuring their compliance; • develops task specific procedures where required; • communicates emergency response procedures to all operations personnel and in a way that they are well understood; and • maintains records of daily logs, environmental incidents, waste inventory and cetacean sightings.
Fauna Observer	• Responsible for compliance with the standard management procedures, as outlined in the EPBC Policy Statement 2.1 – Interaction between offshore seismic exploration and whales (DEWHA 2008a), including adequate fauna watch and operational response; • records whale and dolphin sightings and operational response; and • provides daily reports and incident reports to the Party Chief.
Vessel Master	• Responsible for all vessel operations; • has overall authority for the safety of vessel and crew; • responsible for ensuring all vessel safety systems and features are operational; • investigates all accidents/incidents and near misses and reports these to the Shell Project Manager via the Company Site Representative; • responsible for training all technicians and crew such that they have the requisite skills, and competence to carry out their tasks and can respond as required in an emergency situation; and • responsible for keeping the Rescue Coordination Centre of AMSA (Canberra) updated on vessel movements during the survey.
Technicians and Crew	• Apply operating procedures in letter and in spirit; • follows good housekeeping procedures and work practices; • encourages improvement wherever possible; • report any incidents to the Vessel Master and Party Chief in a timely manner; • comply with procedures described; and • responsible for making seismic survey operations consistent with this EP.

9.4. Competence and Inductions

9.4.1. Competency

All personnel required to work on the Factory 3D MSS shall be employed on the basis they are competent to do their job.

Within Shell Australia, the HSSE and SP Control Framework requires people in HSSE Critical Positions to have their HSSE-MS competence assured. These people must attain a set proficiency level in three competences: HSSE Lead; HSSE Prepare; and HSSE Apply. People in HSSE Critical Positions are responsible for the development and maintenance of effective barriers to prevent incidents.

Shell Australia maintains a HSSE Critical Positions Register and HSSE Critical Positions have been identified and positional competency requirement HSSE profile to each role and defines required proficiency levels for each profile.

After assessment of individual competencies against position requirements, proficiency gaps will be addressed in training and coaching.

Additionally, all Shell Australia positions in the organisation have detailed job descriptions including Competency Requirements.

Only globally prequalified companies with whom Shell Australia has a service agreement qualify to bid for the survey. In addition, the bidders and vessel tendered will also undergo a local prequalification on HSE. A HSE pre-qualification questionnaire is included in the tender package, which will be evaluated by the HSE department in parallel to the technical and commercial evaluations.

9.4.2. Induction

All relevant personnel, including subcontractors will undertake an induction which includes a description of environmental responsibilities.

The induction will include:

- Shell Australia HSSE & SP Policy and Commitment;
- an outline of the information presented in this EP, particularly in regard to the key environmental aspects, identified impacts and risks;
- legislative requirements – including key MARPOL and EPBC requirements;
- environmental performance objectives for the program and the management strategies that will be applied to achieve those objectives (EPS and MC); and
- a description of environmental responsibilities for the company and individuals.

A record of each person's attendance at inductions will be recorded on an Induction Attendance Register.

9.5. Monitoring, Audits and Incident Investigation

This section of the EP outlines the measures undertaken by Shell Australia to regularly monitor the management of environmental risks and impacts of the activity against the EPO, EPS and MC, with a view to continuous improvement of environmental performance.

Emissions and discharges parameters which will be monitored during the Factory 3D MSS are detailed in relevant parts of **Section 6** and **7** and **Section 8**; and are summarised in **Table 9-2**. Relevant data may be used for annual NGERS and NPI reporting.

Table 9-2 – Sources of Emissions and Discharges for Monitoring

Source	Parameter to be Monitored	Monitoring Frequency	Monitoring Equipment/ Methodology *	Records	EP Reference
Discharge from bilge system	Oil Content Volume *As per IOPP Certificate	Per discharge	As per IOPP Certificate	Maintenance Records of oily water separator Oil Record Book	**Section 6.1.1.1**
Discharge from the sewage and greywater	Quality Volume As per ISPP Certificate	As per ISPP Certificate	As per ISPP Certificate	Maintenance Records of sewage treatment system	**Section 6.1.1.1**
Ballast Water	Volume Location	As required / per exchange	Ballast Water log	Ballast Water log	**Section 7.1**

Source	Parameter to be Monitored	Monitoring Frequency	Monitoring Equipment/ Methodology *	Records	EP Reference
Atmospheric Emissions	Diesel sulphur content	As required (every delivery)	Delivery certificates	Delivery certificates	**Section 6.4**
	Diesel volume used	As required (every delivery)	Delivery certificates	Delivery certificates	
Acoustic Discharges	Acoustic Source volume implemented, and area source is discharged	Throughout Survey	Acoustic Source Arrays	Seismic Observer Logs	**Section 6.5**
Non-hazardous wastes generated and disposed	Volume of wastes	As required (every delivery)	Garbage Record Book	Garbage Record Book	**Section 6.2**
Hazardous wastes generated and disposed	Volume of wastes	As required (every delivery)	Garbage Record Book	Garbage Record Book	**Section 6.2**
Accidental releases of hydrocarbons or chemicals	Type, volume and concentrations of release Incidents reported in accordance with Shell and regulatory requirements.	Per incident	Monthly incident reports and analysis. Volumes will be estimated based on technical data and evaluations (e.g. duration of release and known inventory)	Incident reports in FIM Monthly Environmental Incident Reports	**Section 7.5**

9.5.1. Audits

9.5.1.1. Planned Audits

Aside from the prequalification check, including the vessel compliance checks, and the daily checks made by the Shell Company Site Representative, no other audits are planned given the short duration of the vessel trips. The Shell Company Representative role is critical for monitoring the environmental performance for the activity. As such, this person has been captured as a control measure (see Appendix A) and their role in respect of audits, checks, and inspections is specified in the associated environmental performance standards.

The Shell Project Manager will review environmental performance upon completion of the activity. The review will involve an evaluation of records maintained during the activity and assessment of:

- records listed in **Section 9.10**;
- compliance with the requirements of the EP;
- compliance with company standards and procedures;
- environmental incidents or issues (e.g. fuel spills, unauthorised waste discharges); and
- any observations or reports of wildlife impact.

The results of the review and any recommended modifications to procedures will be incorporated into EPs for future similar operations.

9.6. Management and Review of Environment Plan

The only planned review of the EP will be after the completion of the activity, once the environmental performance of the program has been assessed. The results of the review will be incorporated into future operations.

However, if any new or increased impacts risks are identified during the Factory 3D MSS, an assessment of the risk and review of the EP is undertaken and, if determined to be a significant new or significantly increased risk, the activity leading to the new risk will not continue until acceptance of the management approach to the new / changed risks has been provided by NOPSEMA. A significant increase in risk would mean a change in an increase in a risk rating to Moderate or higher, as per the risk matrices (**Table 4-4** for planned impacts and **Table 4-6** for unplanned events), or any change which is not assessed as being ALARP and acceptable.

This review process will work to make sure that the specified controls and the EP are adequate to reduce the risks to ALARP and if the risk has changed, additional controls will be put in place, so that the risks can be continually reduced to ALARP.

9.7. Management of Incidents and Non-Conformances

All Health, Safety, Security and Environmental incidents and non-conformances are managed in accordance with the SA HSSE Incident Reporting, Investigation and Follow Up Procedure (HSE_GEN_000027) that describes the process of reporting, classification, investigation, follow-up and close out. Non-conformances are treated in the same way as incidents and for the purposes of this document will be referred to as incidents.

All incidents records are managed in an online electronic system Fountain Incident Management (FIM). Below is the overview of the incident management process:

- The system allows for incidents to be raised by any employee of the company including offshore personnel.
- The incident is then assigned to a Responsible Supervisor (Incident Owner) who then retains the ownership of the incident until closeout.
- The Responsible Supervisor initiates the Incident Investigation the depth of which depends on the actual and potential risk ranking of the incident.
- The recommendations of the investigation team are reviewed by the Incident Owner who then assigns the corrective and preventative actions to appropriate action party. Actions are tracked to closeout where the Incident Owner accepts that the remedial action is successfully completed based on the evidence recorded and logged in FIM.
- FIM provides functionality for automatic reminders for Incident Owner and Action Parties about the actions due. However, in addition reviews of outstanding actions are carried out both at asset/department level, and at the SA Business Assurance Committee level at regular intervals to ensure timely closeout of actions.

In addition to the Incident Management Process outlined above, SA also reports the number of non-compliances to the Shell Group on a quarterly basis, along with other HSE data in accordance with Shell Group Performance Monitoring and Reporting (PMR) standard. This information is reviewed in a dedicated HSE Business Performance Review where SA performance is reviewed by the Shell Group.

All employees or contracted staff are encouraged to submit incident reports to alert the organisation about the occurrence of an incident or non-conformance. The Company Site Representative is responsible for making sure these reports are raised in the FIM system. Incidents will be reported to Shell by the Company site representative.

Shell Group audits are undertaken across all Shell businesses on an intermittent basis. This auditing process assures the HSSE & SP management system as a whole, of which Incident Management is a part.

The incident investigation process works to understand the cause of an incident and the reason why a control / mitigation measure has failed and to rectify the fault to prevent recurrence and the reporting process works to track performance and allows sharing of learnings. This process contributes to reducing the risks to ALARP.

9.8. Reportable and Recordable Incidents – External

9.8.1. Reportable Incidents

NOPSEMA will be notified of all reportable incidents under Regulation 26 of the OPGGS(E)Regulation within 2 hours of the incident and in writing with 3 days. Under the OPGGS(E) Regulations, **Reportable Incidents** are defined as *'an incident relating to the activity that has caused, or has the potential to cause, moderate to significant environmental damage'*. The Shell Group RAM (**Table 4-4** and **Table 4-6**) uses severity levels 0 to 5 to define environmental consequences (no effect, slight effect, minor effect, moderate effect, major effect and massive effect'). All environmental effects with a severity 3 or greater (i.e. moderate to massive) are considered Reportable Incidents. Based on the risk assessment, four events are considered moderate consequence or higher:

- Physiological damage to sensitive marine fauna from acoustic emissions;
- Introduction of invasive marine species;
- Death of threatened, migratory or cetacean species from collision with a vessel; and
- Diesel spill resulting from a vessel to vessel collision.

Additional reportable incidents are also captured in **Table 9-3**. The reportable incident report will contain all material facts and circumstances concerning the reportable incident, actions taken to avoid or mitigate any adverse impacts and corrective action taken. This report will be made to NOPSEMA (phone: +61 86461 7090, submissions@nopsema.gov.au). The NOPSEMA incident reporting guidance, plus the Incident Response Form (FORM FM0831 – Reportable Environmental Incident) can be located at:

http://www.nopsema.gov.au/environmental-management/notification-and-reporting/

9.8.2. Recordable Incidents

Recordable incidents in the OPGGS(E) Regulations are defined as '*an incident arising from the activity that breaches a performance objective or standard in the Environment Plan that applies to the activity and is not a reportable incident*'. Performance objectives and standards for the program are detailed in **Section 4**.

NOPSEMA will be notified of all Recordable Incidents, according to the requirements of Regulation 26B of the OPGGS(E) Regulations. A report of Recordable Incidents must be given to NOPSEMA '*as soon as practicable after the end of each calendar month, and in any case not later than 15 days after the end of the calendar month'*.

As per the OPGGS(E) Regulations, the report will comprise:

- *A record of all Recordable Incidents that occurred during the calendar month;*
- *All material facts and circumstances concerning the Recordable Incidents that the titleholder knows or is able, by reasonable search or enquiry, to find out;*
- *Any action taken to avoid or mitigate any adverse environment impacts of the Recordable Incidents; and*
- *The corrective action that has been taken, or is proposed to be taken, to prevent similar Recordable Incidents.*

Shell Australia will email the report on a monthly basis to NOPSEMA.

Recordable incidents are captured in **Table 9-4**.

9.9. Reporting

Shell also has internal reporting requirements against environment parameters identified in the Shell Group Performance Monitoring and Reporting (PMR) standard. This data is used as the basis for an annual Shell Group external HSE report (Shell Sustainability Report), which is publicly and externally reported.

Table 9-3 – Externally Reportable Incidents

Incident	Legislation	Timing of Notification with respect to the occurrence of the incident.	Contact Details
Uncontrolled release of petroleum liquids > 80 L.	OPGGS (Safety) Regulations (Chapter 2, Part 4, Sub regulation 2.41 (2)	ASAP and in writing within 3 days afterward.	**NOPSEMA** Incident Notification: (08) 6461 7090 Incident Reports submissions@nopsema.gov.au
Any spill to water	Technical Guideline for the Preparation of Marine Pollution Contingency Plans for Marine and Coastal Facilities (2015).	ASAP once pollution has been confirmed	**AMSA** via Australian Search and Rescue (**AusSAR**) Phone: 1800 641 792 or +61 2 6230 6811 Incident Reporting Requirements: https://www.amsa.gov.au/forms/incident-report AMSA POLREP: https://amsa-forms.nogginoca.com/public/polrep.htmlhttps://www.amsa.gov.au/environment/maritime-environmental-emergencies/national-plan/Contingency/Oil/documents/Appendix7.pdf
Any breach in biosecurity, including exchange of ballast water within the 12 nm limit.	OPGGS(E) Regulations 2009 Reg 26. Biosecurity Act 2015; Australian Ballast Water Management Requirements 2011.	ASAP once the breach is confirmed.	**NOPSEMA** Incident Notification Phone: +61 8 6461 7090 Incident Reports submissions@nopsema.gov.au **DAWR** Phone: 1800 798 636. Or online at: http://www.agriculture.gov.au/pests-diseases-weeds/report
Death or injury of threatened, migratory or cetacean species from collision with a vessel.	EPBC Act 1999, Chapter 5, Part 13, Division 3, subdivision C, 232 (2).	Within 7 days include the time, place, circumstances, species affected and the consequences of the action.	**DOEE,** The Secretary Phone: +61 2 6274 1111 Fax: +61 2 6274 1666 protected.species@environment.gov.au
Reportable incidents for this EP***: • Physiological damage to sensitive marine fauna from	OPGGS(E) Regulations 2009 Reg 26.	Verbally within 2hrs of the incident occurring.	**NOPSEMA** Incident Notification: (08) 6461 7090
	OPGGS(E) Regulations 2009 Reg 26(6).	Written record of the verbal notification as soon as practical post the verbal notification.	**NOPSEMA** Incident Reports submissions@nopsema.gov.au **DMP** Email: webmaster@dmp.wa.gov.au

Incident	Legislation	Timing of Notification with respect to the occurrence of the incident.	Contact Details
acoustic emissions; • Introduction of invasive marine species; • Death of threatened, migratory or cetacean species from collision with a vessel; and • Diesel spill resulting from a vessel to vessel collision.			Ph: +61 (08) 9222 3333 **NOPTA** Email: titles@nopta.gov.au Ph: +61 8 6424 5300
	OPGGS(E) Regulations 2009 Reg 26A.	Written incident report within 3 days. Form: N-03000-FM0831**.	**NOPSEMA** submissions@nopsema.gov.au Or via secure file transfer at: https://securefile.nopsema.gov.au/filedrop/submissions
	OPGGS(E) Regulations 2009 Reg 26A(5).	Copy of the written incident report within 7 days of giving the written report to NOPSEMA.	**DMP** Email: webmaster@dmp.wa.gov.au Ph: +61 (08) 9222 3333 **NOPTA** Email: titles@nopta.gov.au Ph: +61 8 6424 5300

* If in state waters, contact DoT (08 9480 9924), and DMP Petroleum Environment Duty Phone within 2hrs.

** Incident Response Form (FORM FM0831 – Reportable Environmental Incident) can be located at:

http://www.nopsema.gov.au/environmental-management/notification-and-reporting.

*** A reportable environmental incident means an incident relating to the activity that has caused or has the potential to cause moderate to significant environmental damage. (by Shell standards this is considered to be a severity of 3 or greater on the Shell Ram.

Table 9-4 – Externally Recordable Incidents

Incident	Legislation	Timing of Notification with respect to the occurrence of the incident.	Contact Details
Breach of any performance standard or objective (Table 6.1) in this EP.	OPGGS(E) Regulations 2009 Reg 26B And Part 1 (4) Definition of "recordable incident".	As soon as practicable after the end of each calendar month and in any case not later than 15 days after the end of the calendar month. Form: N-03000-FM0928	Send completed form to: **NOPSEMA** submissions@nopsema.gov.au Or via secure file transfer at: https://securefile.nopsema.gov.au/filedrop/submissions

9.9.1. Notifications

NOPSEMA has developed a new, online system to submit EPs and financial assurance documents. Titleholders are encouraged to submit their documents through:

- https://online.nopsema.gov.au.

A cover sheet is not required if submitting via the online portal.

If submitting via NOPSEMA secure file transfer, then a cover sheet[13] and some form of cover letter must accompany all documents submitted for assessment from the duty holder that clearly states what the submission is, the reason for submission, and the action required of NOPSEMA including, where appropriate, the applicable legislation.

NOPSEMA requests that one electronic consolidated text searchable PDF copy of the submission be provided

- Via Secure File Transfer: https://securefile.nopsema.gov.au/filedrop/submissions (NOPSEMA-preferred); or
- Via email: submissions@nopsema.gov.au

9.9.1.1. Start and end of an activity

Regulation 29 of the OPGGS(E) Regulations 2009 requires that a titleholder must notify NOPSEMA using Form 1405 (located at: http://www.nopsema.gov.au/environmental-management/environmental-resources/ on NOPSEMA's website) that an activity:

- is to commence at least 10 days before the activity commences; and
- is completed within 10 days after the completion.

9.9.1.2. Notification of the end of the Environment Plan

Regulation 25A of the OPGGS(E) Regulations 2009 requires the title holder to notify NOPSEMA using Form 1408 (located at: http://www.nopsema.gov.au/environmental-management/environmental-resources/ on NOPSEMA's website) that:

- the activity or activities to which the plan relates have ended; and
- all the obligations under the EP have been completed.

9.9.2. Compliance Reporting

Regulation 26C requires that an Environmental Performance report will be submitted to NOPSEMA. This report will be submitted within 3 months of completion of the activity, given the activity is less than 1 year long, one report is deemed sufficient.

9.10. Records & Storage

The OPGGS(E) Regulations requires that the titleholder of an activity must store and maintain a document or other record for the period of 5 years from the making of the document or other record; and in a way that makes retrieval of the document or other record reasonably practicable.

The documents or other records stipulated by the regulation are listed below:

- *the environment plan in force for the activity;*
- *revisions of the environment plan;*
- *written reports (including monitoring, audit and review reports) about environmental performance, or about the implementation strategy, under the environment plan;*
- *records of emissions and discharges into the environment made in accordance with the environment plan;*

[13] Cover sheet can be downloaded from here: https://www.nopsema.gov.au/environmental-management/assessment-process/environment-plans/

- *records of calibration and maintenance of monitoring devices used in accordance with the environment plan;*
- *records and copies of reports mentioned in regulations 26 and 26A, relating to reportable incidents; and*
- *records and copies of reports mentioned in regulation 26B, relating to recordable incidents.*

9.11. Emergency Response

The Oil Pollution Emergency Plan (OPEP) is presented in **Appendix G**. It links to Shell Australia's Emergency Response Plan (GEN_GEN_000014). The OPEP will be tested prior to the commencement of the activity by way of a walkthrough by the offshore vessel Emergency Response Team (ERT) and onshore Incident Magangement Team (IMT). This will test the communications between offshore and onshore personell, ERT functionality, Emergency Response Plans, and to ensure that the Emergency Response Team members are aware of their roles and responsibilities in the event of an incident.

9.11.1. Mechanism to examine the effectiveness of the response arrangements against the objectives of testing

Objectives for spill exercises will be specific, measurable, achievable, realistic and time bound. This will enable the objectives to be clearly evaluated as being met or not. An independent assessor (either internal or external) will examine the effectiveness of the response arrangements during a spill exercise to determine the outcome of the objectives. The assessor will make written findings and recommendations from the test for consideration by Shell Australia to assist in identifying deficiencies with response arrangements and continually improve the overall response readiness of Shell.

Actions addressing systematic deficiencies from the exercise will have actions put against them where appropriate and they will be tracked to closure in the Shell Australia action tracking system.

10. Stakeholder Consultation

As operator, Shell Australia has consulted with relevant persons in accordance with the NOPSEMA Decision-making guideline – Criterion-10A(g) Consultation Requirements (N-04750-GL1629) under the OPGGS (Environment) Regulations 2009 for the Factory 3D Seismic Survey campaign.

Shell has ensured that all relevant persons have been provided with sufficient information and had the opportunity to raise any objections or claims.

Shell has addressed objections and claims raised in relation to this EP and can demonstrate that the risk or impact in question has been reduced to ALARP and will be at an acceptable level.

10.1. Shell General Business Principles and Stakeholder Consultation

Shell Australia's consultation is undertaken in line with the Shell General Business Principles and relevant legislative requirements. Key to these principles is that Shell employees share a set of core values - honesty, integrity and respect for people.

Key principles:

Local Communities: Shell aims to be a good neighbour by continuously improving the ways in which we contribute directly or indirectly to the general wellbeing of the communities within which we work. We manage the social impacts of our business activities carefully and work with others to enhance the benefits to local communities and mitigate any negative impacts from our activities. In addition, Shell companies take a constructive interest in societal matters, directly or indirectly related to our business.

Communication and Consultation: Shell recognises that regular dialogue and consultation with our stakeholders is essential. In our interactions with local communities, we seek to listen and respond to them honestly and responsibly. Part of this commitment is ensuring those people and organisations that are impacted by our activities are engaged, and that their concerns are heard and responded to.

10.2. Shell's Stakeholder Consultation Process

In supporting Shell's adherence to the Shell Business Principles, from the initial discovery of the resource, is a comprehensive stakeholder strategy which ensures that:

- The external context is monitored and understood;
- Stakeholder needs, interests, concerns and expectations are understood, and shared outcomes are defined;
- There is a clear and direct link between risks/opportunities and stakeholders;
- Stakeholder engagement protocols are established and consistent, coordinated external engagements;
- Scenario planning is undertaken for potential stakeholder responses; and
- Explicit inclusion of external perspectives in business decisions.

10.3. Shell Consultation Representatives

Shell Australia has a Perth based External and Government Relations team, which includes Social Performance, who facilitate stakeholder and community engagement in Australia on behalf of the business with support teams in Canberra, Melbourne and Queensland (QGC). This team manages the interface for the business with external stakeholders such as, communities, NGOs, Government(s) and the media. Working as an integrated team allows a 'whole of Shell view' to be provided in stakeholder engagements and ensure stakeholders receive consistent and coordinated information. This is important where, for example, exploration activities have similar stakeholders to other Shell activities in the region (e.g. Prelude FLNG) and therefore require an aligned approach.

10.4. Stakeholder Consultation Plans

The External Relations team maintain an Integrated Stakeholder Consultation plan for the portfolio which includes a stakeholder matrix, engagement strategy for each activity and a feedback mechanism via sda_exploration@shell.com. This engagement plan is a 'live' document that is updated as the exploration portfolio changes.

10.5. EP Consultation Strategy

The consultation strategy (**Figure 10-1**) for this EP reflects the short-term nature of the activity.

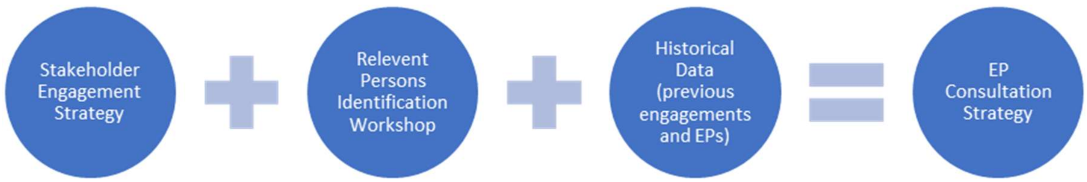


Figure 10-1 - Development of Consultation Strategy

10.6. Relevant Stakeholders

Shell has a robust internal process to identify, prioritise and understand stakeholders as outlined below.

Table 10-1 – Process to identify, prioritise and understand stakeholders

1. Identify Stakeholders against specific business objectives
2. Prioritise stakeholders based on impact, influence and stakeholder views/concerns
3. Analyse value drivers and views on our activities
4. Define desired shared outcomes
5. Early engagements with stakeholders to validate/confirm risks and opportunities

This process was used to develop the Factory 3D MSS Stakeholder Matrix and formed the foundation for the Relevant Persons Identification process.

Shell identified key stakeholders who could be potentially impacted by or who's interests and activities may be affected by the Factory 3D MSS and the environmental impacts and risks associated with the planned activity and unplanned events.

Shell Australia reviewed its internal database of stakeholders which was used for consulting on the Bratwurst 1 well and Prelude FLNG. Feedback was sought from the Factory 3D Seismic survey team and the Prelude FLNG consultation team to assist in designing the stakeholder engagement approach.

A draft stakeholder list of relevant and interested persons was circulated internally and to Shell Australia's environmental consultants for review. Following feedback from the team, a workshop was held with representatives from Shell's exploration, environmental and external relations teams to review the stakeholder list.

Shell requested updated extracts from Australian Fisheries Management Authority (AFMA) and the Department of Primary Industries and Regional Development (DPIRD) to assist in finalising the stakeholder list.

Shell Australia met with NOPSEMA to gain insights into effective consultation.

A review of stakeholders identified that the key stakeholders were from the commercial fishing industry and that they needed to be provided a specific letter which offered the opportunity for the stakeholder to participate in face-to-face meetings with Shell, if the stakeholder required further information or clarification of the activity.

In summary relevant persons were identified based on the following information:

- Commonwealth and WA State government agencies under relevant Legislation.
- Non-government organisations that have interest/activities in operational area.
- GIS shapefiles of commercial fishery license areas.

- Current status reports of WA fisheries and aquatic resources (Gaughan and Santoro 2018).
- Current status reports of Commonwealth fisheries and aquatic resources (ABARES 2018).
- Current list of licence holders extracts (provided by DPIRD 2018).
- Scientific literature.

Therefore, key stakeholders identified include the commercial fishing industry including WA State fisheries licence holders, Commonwealth Fisheries licence holders, Federal and State Governments and agencies, Local Governments, industry/business, community groups, non-government organisations (NGO)s and others as detailed in **Table 10.2**.

Once relevant persons were identified, Shell determined the most appropriate consultation approach and associated information to communicate based on the:

- Functions, interests and activities of the relevant persons;
- Prior feedback and information from relevant persons on their perspectives and how they prefer to be engaged; and
- Information gathered during the EP process.

The result was a list of all relevant persons who require formal consultation and their specific information requirements **Table 10.2**.

Table 10-2 – Relevant Persons and Consultation Process Table

Category	Relevant Persons	Functions, Interests or Activities	Consultation Approach	Ongoing Consultation[14]
Australian Government	Australian Institute of Marine Science (AIMS)	The Australian Institute of Marine Science (AIMS) is Australia's tropical marine research agency. They play a pivotal role in providing large-scale, long-term and world-class research that helps governments, industry and the wider community to make informed decisions about the management of Australia's marine estate. AIMS is a Commonwealth statutory authority established by the Australian Institute of Marine Science Act 1972.	Letter	Not required
Australian Government	Australian Marine Safety Authority (AMSA) including AMSA RCC	AMSA is Australia's national agency responsible for maritime safety, protection of the marine environment, and maritime aviation search and rescue. AMSA are a statutory authority established under the Australian Maritime Safety Authority Act 1990 (AMSA Act).	Letter	Not required
Australian Government	Australian Border Force	The Department of Immigration and Border Protection is responsible for immigration and customs border policy.	Letter	Not required
Australian Government	Australian Hydrographic Service	The Royal Australian Navy (RAN) Australian Hydrographic Service (AHS) is the Commonwealth Government agency responsible for the publication and distribution of nautical charts and other information required for the safety of ships navigating in Australian waters. They operate under the navigation act.	Letter	Contact at least 4 weeks prior to commencement of activity so they can issue notice to mariners.
Australian Government	Dambimangari Aboriginal Corporation	Creating opportunities for its members to return to country in the Dambimangari Native Title area north of Derby.	Letter	Not required

[14] Ongoing consultation relating to consultations required in the event of a spill are outlined within the OPEP.

Australian Government	Department of Agriculture and Water Resources	Biosecurity regulator Administrator of MOU74 Box	Letter	Not required
Australian Government	Department of Communications and the Arts	The Department's role is to provide an environment in which all Australians can access and benefit from communications services, creative experiences and culture.	Letter	Not required
Australian Government	Department of the Environment and Energy	The Department designs and implements the Australian Government's policies and programmes to protect and conserve the environment, water and heritage and promote climate action. The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places defined in the Act as matters of national environmental significance.	Letter	Not required
Australian Government	Department of Foreign Affairs and Trade (DFAT)	The department provides foreign, trade and development policy advice to the government. Manages and provides advice to Gov't on Australia's International obligations for marine protection	Letter	Not required
Australian Government	Department of Jobs and Small Business	The Australian Department of Jobs and Small Business is a department of the Government of Australia charged with the responsibility for employment, job services and the labour market, workplace relations, small business, and deregulation.	Letter	Not required
Australian Government	Department of Mines, Industry Regulation & Safety	DMIRS is the State's regulator for the resources sector in WA, DMIRS is the lead agency in administering Western Australia's multi-agency regulatory framework. The department ensures the State's safety, health and environmental standards are world best practice and consistent with relevant State and Commonwealth legislation, regulations and policies. It is also responsible for the collection of royalties and has a lead role in providing geoscientific information, which supports private investment in resources exploration and development.	Letter and follow up emails	Control measure added to EP that a commencement notification will be sent to DMIRS via petroleum.environment@dmirs.wa.gov.au
Australian Government	Department of Water & Environmental Regulation	The Department of Water and Environmental Regulation supports Western Australia's community, economy and environment by managing and regulating the state's environment and water resources.	Letter	Not required

		The department is responsible for environment and water regulation, serving as a 'one stop shop' for industry and developers, with the aim of streamlining and simplifying regulation.		
Australian Government	Director of National Parks	The Director of National Parks' responsibilities include: • Managing Commonwealth reserves and conservation zones • Protecting biodiversity and heritage in Commonwealth reserves and conservation zones • Carrying out research relevant to Commonwealth reserves • Cooperating with other countries to establish and manage national parks and nature reserves in those countries • Making recommendations to the Australian Government Minister for the Environment	Letter and follow up emails	Not required
Australian Government	Federal Member for Kimberley - Melissa Price	Member for Kimberley – interested in major activities occurring in the Kimberley region.	Letter	Not required
Australian Government	Parks Australia (Director of Nationals Parks)	The Director of National Parks is a corporation established under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), the principal Commonwealth legislation for establishing and managing protected areas. The corporation is constituted by the person appointed to the office named the Director of National Parks. Under the EPBC Act, the Director of National Parks' responsibilities include: •Managing Commonwealth reserves and conservation zones •Protecting biodiversity and heritage in Commonwealth reserves and conservation zones •Carrying out research relevant to Commonwealth reserves •Cooperating with other countries to establish and manage national parks and nature reserves in those countries	Letter and Email	Not required

		•Making recommendations to the Australian Government Minister for the Environment		
NT Government	NT Department of Primary Industry and Resources - Fisheries Division	The department brings together many of the key functions that drive economic development on NT lands, coastal areas and inland waterways, and its operations cover the whole of the Territory. Industry sectors are mines, energy, fisheries, livestock, horticulture, agriculture.	Letter	Not Required
NT Government	Darwin Port	The Port of Darwin is strategically positioned as Australia's nearest port to Asia and the nation's 'northern gateway' for Australasian trade. It is also a key support hub for the expanding offshore oil and gas fields in the Arafura Sea, Timor Sea and waters off the coast of Western Australia. It is the only port between Townsville and Fremantle with full access to multi-modal transport services.	Letter	Not required
WA State Government	Kimberley Ports Authority	The Kimberley Ports Authority has been enabled under the Ports Legislation Amendment Act 2014. The responsibilities of the Kimberley Ports Authority are as follows: • To facilitate trade and to plan for growth and development of the port. • To control business and other activities in the port. • To be responsible for the safe and efficient operation of the port. • To maintain and preserve property controlled by the port. • To protect the environment in which the port operates. • To use port assets for profit. • To act in accordance with prudent commercial principles.	Letter	Not required
WA State Government	WA Department of Biodiversity, Conservation & Attractions (including Broome Office	•Manage Western Australia's parks, forests and reserves to conserve wildlife, provide sustainable recreation and tourism opportunities, protect communities and assets from bushfire and achieve other land, forest and wildlife management objectives. •Inspire and act for wildlife conservation.	Letter	Not required

		•Conserve and enhance Kings Park and Botanic Garden and Bold Park with the community, and to conserve biological diversity generally. •Grow visitor numbers and yield by providing best-in-class tourism products, experiences and service while enhancing Rottnest Island's unique heritage and environment. •Provide scientific excellence and deliver effective conservation of Western Australia's biodiversity.		
WA State Government	WA Department of Primary Industries and Regional Development - Department of Fisheries	A primary responsibility of the Department of Primary Industries and Regional Development is to conserve, sustainably develop and share the use of Western Australia's aquatic resources and their ecosystems for the benefit of present and future generations. We do this through managing fisheries and aquatic ecosystems, assessment and monitoring of fish stocks, enforcement and education, biosecurity management and licensing commercial and recreational fishing activity, including commercial aquaculture.	Letters and emails	Not required
WA State Government	WA Department of Transport (DOT)	The Department of Transport is WA Government agency with responsibility for Marine transport.	Letters and emails, provision of OPEP for approval.	Not required
WA State Government	State Member for Kimberley	Member for Western Australian Parliament for the Kimberley region	Letter	Not required
NOT FOR PROFIT AND NON-GOVERNMENTAL ORGANISATIONS				
Environmental NGO's	Australian Conservation Foundation	The Australian Conservation Foundation (ACF) stands for ecological sustainability. We get to the heart of environmental problems by tackling the underlying social and economic causes. We work across society to influence urgent, transformative action to deliver lasting change on the scale required to secure a sustainable environment. We bring people together to champion the true value of our environment and its critical role in sustaining all other systems and in achieving human wellbeing.	Letter and follow up email	Not required
Environmental NGO's	Australian Marine Conservation Society	The Australian Marine Conservation Society (AMCS) is the voice for Australia's ocean wildlife. We are an independent charity, staffed by a committed group of professional and passionate	Letter and follow up email	Not required

		scientists, educators and advocates who have defended Australia's oceans for 50 years. Our paid and volunteer staff work every day on behalf of the community to protect our ocean wildlife.		
Environmental NGO’s	Conservation Council of WA	For over 45 years, the Conservation Council has been WA’s outspoken and independent voice for the environment and communities. As WA’s peak environmental group we represent tens of thousands of individual supporters and over 100 Member Groups with diverse interests across the state.	Letter and follow up email	Not required
Environmental NGO’s	Greenpeace	Greenpeace is an independent campaigning organisation that uses non-violent direct action to expose global environmental problems and to force solutions which are essential to a green and peaceful future. Greenpeace's goal is to ensure the ability of the earth to nurture life in all its diversity.	Letter and follow up email	Not required
Environmental NGO’s	Wilderness Society	Member based organisation which campaigns on environmental issues in Australia	Letter	Not Required
Environmental NGO’s	WWF	WWF has long recognised that the planet’s species, people, habitats, governments and global markets are directly and often delicately inter-related. We also know that meaningful conservation cannot take place without addressing the complex relationships that exist between these elements.	Letter - no email address available	Not required
Not-for-Profit Organisation	Australian Marine Oil Spill Centre (AMOSC)	AMOSC operates Australia’s major marine oil spill response equipment stockpile for the Australian Oil&Gas Industry on 24 hour stand-by for rapid response anywhere around the Australian coast.	Letter	Not required
FISHERIES				
Commonwealth Fishery	Commonwealth Fishing Association	The Commonwealth Fisheries Association (CFA) is the peak body representing the collective rights, responsibilities and interests of a diverse commercial fishing industry in Commonwealth regulated fisheries. The CFA was formed in April 2002 as a non-profit organisation.	Letter and follow up email	Not required

Commonwealth Fishery	North West Slope Trawl Fishery	The North West Slope Trawl Fishery is located in deep water from the coast of the Prince Regent National Park to Exmouth between the 200m depth contour to the outer limit of the Australian Fishing Zone.	Letter	Not required
Commonwealth Fishery	Southern Bluefin Tuna Fishery	The Southern Bluefin Tuna Fishery covers the entire sea area around Australia, out to 200 nm from the coast	Letter	Not Required
Recreational Fisheries	RecFishWest	RecFishWest is the peak body representing 740,000 recreational fishers in WA. We are a not-for-profit community organisation that strives to ensure high quality fishing experiences are maintained and enjoyed, as an integral part of the WA lifestyle.	Letter and follow up email	Not required
WA State Managed Fishery	Mackerel Managed Fishery	The Mackerel Managed Fishery uses near-surface trolling gear from vessels in coastal areas around reefs, shoals and headlands to target Spanish mackerel.	Letter	Not required
WA State Managed Fishery	North Coast Shark Fishery	Commercial shark fishing in WA takes place in the north and south of the State. The northern and southern shark fisheries have a State and joint-authority management component due to the distribution of several shark stocks across state boundaries. Both fisheries also operate under Commonwealth approvals. The Northern Shark Fishery comprises the State-managed WA North Coast Shark Fishery in the Pilbara and western Kimberley, and the Joint Authority Northern Shark Fishery in the eastern Kimberley.	Letter	Not required
WA State Managed Fishery	Northern Demersal Scalefish Fishery	The boundaries of the NDSF are all waters of the Indian Ocean and Timor Sea off the north coast of WA east of 120° 00.079' east longitude and north of 19°59.917' south latitude	Letter, phone calls and emails	Consultation will be on-going with licence holders from the NDSF. Consultation will focus on the compensation process for economic loss as a direct result of the survey. Shell Australia will also develop a communications procedure which it will provide to NDSF licence holders for review ahead of commencement of the survey (Appendix A EPS 1). There will be iterative engagements to finalise this if required. Once finalised, this process will be implemented as apart of ongoing

				consutlations before and during the survey. The NDSF licence holders will receive notification prior to commencement of the activity.
WA State Managed Fishery	Pearl Oyster Fishery	The Western Australian Pearl Oyster Fishery is the only remaining significant wild stock fishery for pearl oysters in the world. It is a quota based, dive fishery, operating in shallow coastal waters along the North West Shelf.	Letter	Not required
WA State Managed Fishery	Pearl Producers Association	The Pearl Producers Association (PPA) is the peak industry representative body for licensees in WA and the NT.	Letter and follow up email	Not required
WA State Managed Fishery	West Coast Deep Sea Crustacean Fishery	The West Coast Deep Sea Crustacean Managed Fishery targets Crystal (Snow) crabs, giant king crabs and champagne (spiny_ crabs. Using baited pots in waters deeper than 150m (and mostly at depths of between 500m – 800m) along the continental shelf of the West Coast and Gascoyne Bioregions, this fishery is quota-based.	Letter	The licence holders will be informed prior to commencement of activity (not currently fishing in survey area)
WA State Fisheries and (some) Commonwealth Fisheries	Western Australian Fishing Industry Council	The peak commercial fishing industry body to represent the industry in WA.	Letters and follow up emails and meeting	Not required as they are not affected by the activity. NDSF may choose to include WAFIC in ongoing consultations.

It is not possible to obtain a list of licence holders in the Pearl Oyster Managed Fishery (POMF; including pearl farms in the Kimberley Region) from DPIRD as this fishery is administered under the Pearling Act 1990 rather than under the WA Fish Resources Management Act 1994. DPIRD advise that the best way to contact licence holders in the POMF is via the peak industry body for this fishery - the Pearl Producers Association (PPA). PPA supported this advice.

All Commonwealth managed fisheries are administered through AFMA. The CFA has previously advised that they have an obligation to inform their members of potential projects, and that consultation at the fishery level is best handled by regional industry associations where they exist.

Copies of stakeholder engagement letters, fact sheets and consultation update letters sent to stakeholders were provided to NOPSEMA as part of the EP submission.

The stakeholder letter provides information concerning the generic location, timing and nature of the proposed activities, and contact details if stakeholders wish to participate in face to face meetings with Shell.

10.7. Stakeholder Consultation Meetings

All stakeholders were informed via the stakeholder engagement letter that Shell was available for face-to-face meetings to discuss the Factory EP. Shell offered face-to-face meetings, prior to submission of the EP to NOPSEMA with key stakeholders - including WA and Commonwealth fisheries licence holders, fisheries bodies and organisations, and State and Commonwealth government departments identified **Table 10.2** above.

A summary of these meetings is included in **Table 10.3**.

Shell has responded in writing to all stakeholders and met with stakeholders as required in face-to-face meetings. A summary of the items discussed, concerns raised, outcomes and agreed were documented.

10.8. Stakeholder Update Letters

Consultation with all relevant stakeholders identified via the consultation process described above in **Section 10.6** have continued during the EP assessment period.

The following consultation updates have been sent out whilst the EP has been under assessment:

- June 2019 – Factory EP Activity Update – 1
  - The purpose of this update was to provide stakeholders with an opportunity to provide comments prior to the EP being re-submitted, additional mitigation controls proposed as well as to advise stakeholders of the recent changes to the proposed EP, such as:
    - Timing changes
      - No acquisition in March and October.
      - Defined periods of proposed acquisition: the survey will be acquired wholly within the period of November 2019 to the end of February 2020 or April 2020 to the end of September 2020.
      - The survey will be completed in one single campaign of up to 90 days with 17 days included for downtime which could result from extreme weather conditions, equipment issues. The survey activity will take up to 73 days
    - EP validity increased to the end of September 2020 from the date of acceptance by NOPSEMA
    - Communication and interaction protocols developed with fisheries licence holders to allow for areas of the survey to be changed to minimise impact on active fishing within the OA
    - No full power operation of the acoustic source in water depths shallower than 70 m
    - Soft starts implemented to align with the WA Fisheries Publication No, 112, 2013 Guidance statement on undertaking seismic surveys in WA waters.

10.9. Stakeholder Submissions and Assessment of Merit

Responses were received from stakeholders contacted during the pre-survey consultation, details of these submissions and Shell assessment of merits are provided in **Appendix A.** A list of measures adopted as a result of consultation are included with **Table 5-1**.

10.10. Sufficient Information and Reasonable Period

Shell has provided sufficient information to relevant persons in order that they are able to make an informed assessment of the proposed activity. Shell has determined that a minimum 30 days is reasonable period for formal consultation. This is a common duration specified for matters that are open to public comment and Shell's historic engagements supports that it is enough time to allow for a relevant person to assess the information provided by Shell in a letter containing all the risks as outlined in the EP and respond detailing any objections or claims.

The 30-day period acts as a minimum period in Shell's consultation planning processes, and relevant persons are explicitly asked to respond within that time. However, Shell acts on a case by case basis depending on the response received from relevant persons and will allow for requests to extend this period if requested.

10.11. Pre-Survey Consultation

Shell are aware of the importance of identifying new stakeholders during a two (2) year EP. Therefore, the list of relevant stakeholders will be reviewed annually and prior to all survey updates and / or notifications, and consultation will be carried out with any newly identified stakeholders every six (6) months.

Relevant stakeholders will be identified by Shell as described above in **Section 5.1**, and using the following tools:

- Existing environmental knowledge;
- Previous experience;
- Internet research;
- Initial project emails;
- Existing networks and forums;
- Social media;
- Scientific literature; and
- Other research tools such as GIS shapefiles of commercial fishery license areas.

Pre-survey planning will review the current fishing effort for all commercial fisheries with licensed areas overlapping the Factory OA, primarily by requesting an updated and valid extract of entries from the Fisheries Public Register and through on-going and direct consultation with fishers, DoF and AFMA and via review of catch and effort data in the latest release of annual reports from the Departments: WA State of the Fisheries Report; and ABARES Fishery Status Report. Any commercial fishery changes (including changes to fishery status or license holders) will be evaluated for potential interactions with and impacts from the proposed survey activities, and if required, the EP will be revised accordingly (**Section 10.6**).

Shell shall notify relevant stakeholders of the Factory survey to be carried out under this EP that may affect their interests or activities in line with agreed protocols established as part of the stakeholder engagement process, or a minimum of **three (3) weeks**, whichever is the longer in each respective case.

It is anticipated that by a minimum of **three (3) weeks prior to commencing**[15] the survey within the Factory OA, Shell will have contacted relevant stakeholders to provide specific information for the proposed activity, including:

- size, location and geographical coordinates for the survey;
- likely commencement date and duration;
- survey parameters (airgun array and streamer spread);
- survey and support vessels details;
- a risk assessment summary of the Factory EP impacts and risk assessment and EP Sections relevant to particular stakeholder groups - e.g. fisheries, marine safety;
- offer of a 48-hr lookahead to all relevant stakeholders;
- contact details of the titleholder for stakeholder submissions;
- survey vessels call signs and contact details;
- requests for information (including fishing vessel names and call signs), concerns or issues, face-to-face meeting request; and

[15] *Unless a prior agreement has been made with specific stakeholders for a longer notification period, see Section 10* ***below****.*

- additional information as agreed in any Cooperation and Interaction Protocol Plan and Ongoing Consultation Plans that may result from stakeholder engagement;

Stakeholders that have an agreed Cooperation and Interaction Protocol Plan in place with Shell (**see Appendix 1E**), will be contacted as specified in their respective agreements, to initiate meaningful discussions and feedback.

At any point during the consultation plan or the validity of the Factory EP, stakeholders will have a further opportunity to raise with Shell any new specific concerns or issues regarding the proposed survey. At any time during the lifetime of the EP, after the six (6) monthly update, or as soon as a potential issue or concern arises they can contact Shell. Stakeholders need not wait for a pre-survey notification, they have already been informed via the first contact notification that a survey is proposed within the Factory OA. Any new specific concerns or issues regarding the proposed survey will be assessed as outlined below in **Section 5.7**.

Shell and their environmental management team, through their experience in the industry, have good knowledge and understanding of the stakeholders within the area covered by the Factory OA and their potential areas of concern. Those with concerns are generally limited to NGOs and specific fisheries licence holders. Consequently, Shell is confident that the approach and timeframes outlined above are acceptable to allow any claims or objections to be raised and appropriately dealt with.

A minimum of **three (3) weeks** prior to the commencement of a proposed survey, Shell will consult a number of additional stakeholders, primarily within the offshore exploration and petroleum industry. These consultations will include, as far as possible, other geophysical companies operating in or adjacent to the Factory EP OA, plus holders of petroleum titles within and adjacent to any particular project specific operational area within the proposed Factory EP OA. The primary objectives of consultation will be to ascertain if there are any other surveys proposed for areas within or adjacent to the Factory EP OA during same time period, for details of any other petroleum activities that may be planned for the relevant area. Dependent upon local geology and data quality, concurrent seismic surveys usually require a minimum separation distance of 40 km between the two operating survey vessels to avoid noise interference with the received signals. If separation distances between the survey vessels are closer than 40 km then the two proponents routinely work out procedures for simultaneous operations to eliminate or minimise the potential for noise interference and data corruption. For instance, a time-sharing arrangement where, over a 24-hour period each vessel will acquire for a period of 12 hours whilst the seismic array of the other vessel are shutdown.

10.12. Ongoing Consultation

Consultation with particular relevant stakeholders will continue throughout the validity of the Factory EP as outlined in **Table 10-2** above. Shell will comply with reasonable requests by stakeholders for additional information and requests for updates during the Factory EP survey. In addition, existing and new stakeholders will be notified of any changes to scope of the EP that may affect their interests or activities a minimum of **three (3) weeks**[15] in advance of the proposed survey to be undertaken under that change. Significant changes to scope will trigger a review of the EP, and a potential revision, as described in **Section 10**. Any notification to stakeholders will contain contact details of where any claims/objections/queries or concerns may be directed. Contact details will include the EP liaison person, telephone number and email address.

As required under sub regulation 16(b), Shell shall assess the merits of any new claims or objections made by a relevant stakeholder whereby they believe the activity may have adverse impacts upon their interest or activities.

If the claim has merit, where appropriate, Shell shall modify management of the activity. The assessment will be done using the methodology outlined for the internal risk assessment in **Section 9**

Shell shall endeavour to finalise the assessment of merit of any claim or objection received during a survey within <u>two (2) weeks of receipt</u> and undertake any resulting management of change (MOC) actions as soon as practicable, but preferably within that week timeframe. The assessment of merit and any resulting MOC actions shall be shared with the concerned stakeholder. If the outcome of the assessment of merit of a claim or objection received during a survey suggests that new or increased impacts and risks are significant then this will trigger a revision to the EP as described in **Section 10** given that under sub regulation 8(1) it is an offence for a titleholder to continue if a significant new impact or risk, or a significant increase in the impact or risk, is not provided for in the EP in force.

If a significant new or increased impact or risk is identified as a result of an internal risk assessment described in **Section 10** and it is not already appropriately covered under the EP, as required under sub regulation 17 (6), Shell shall submit a proposed revision to the EP. Shell shall determine at the time of the internal risk assessment, whether a risk or impact is considered 'significant' (e.g. has resulted in an increased residual risk ranking) based on information available at that time (e.g. reviewed scientific information, stakeholder claims or concerns). Notification to existing and new stakeholders of significant new or increased risks will be issued prior to submission of the revised EP as part of a new consultation process for the revised EP.

Pending internal approval, Shell will seek to establish a compensation process with the NDSF for direct impacts during the period of the seismic survey that can be attributed to Shell Factory 3D activities with evidence. This will be initiated by seeking to make direct contact with NDSF in order to establish a compensation process by which claims of direct losses as a direct result of the Factory 3D Seismic Survey would be considered. Claims will be considered for the period of the seismic survey only.

10.13. Regular Updates

All critical updates (i.e. survey commencing/finishing) will be sent out directly to existing and new stakeholders via the process described above in **Section 10.5**.

As part of this process, every six (6) months Shell shall check that identified existing stakeholders are still relevant and correct, and also identify new stakeholders (via organisational bodies such as AFMA, AMSA, DoF, lessons learnt etc.). Updates may be a stand-alone notice or part of a notification associated with the ongoing survey. Stakeholders will be offered the opportunity for face-to-face meetings. Updates may be a stand-alone notice or part of a notification associated with the Factory survey.

10.14. Post Survey Notification

On completion of individual surveys, notification will be sent to relevant stakeholders and those that request post survey notification identified in **Table 10-2** as receiving ongoing consultation.

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11.2. Acronyms

11.2.1. List of Acronyms

Acronym	Definition
ABS	Australian Bureau of Statistics
ADB	Asian Development Bank
AFMA	Australian Fisheries Management Authority

Acronym	Definition
AFZ	Australian Fishing Zone
AHT	Anchor Handling Tug
AHS	Australian Hydrographic Service
ALARP	As Low as Reasonably Practicable
AMOSC	Australian Marine Oil Spill Centre
AMP	Australian Marine Park
AMSA	Australian Maritime Safety Authority
AMSA JRCC	Australian Maritime Safety Authority Joint Rescue Coordination Centre
ANSD	Australian National Shipwrecks Database
ANZECC & ARMCANZ	Australian and New Zealand Environment and Conservation Council and Agricultural and Resource Management Council of Australia and New Zealand
APPEA	Australian Petroleum Production and Exploration Association
AusSAR	Australian Search and Rescue
BIA	Biologically Important Area
BoM	Bureau of Meteorology
Bonn Convention	Convention of the Conservation of Migratory Species of Wild Animals 1979
BOP	Blowout Preventer
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CAMBA	The China Australia Migratory Birds Agreement
CO_2	Carbon Dioxide
COLREGS	International Regulations for Preventing Collisions at Sea 1972
DAWR	Department of Agriculture and Water Resources
DEC	Department of Environment and Conservation
DEH	Department of Environment and Heritage
DEWHA	Department of Environment, Water, Heritage and the Arts
DHA	Department of Home Affairs
DMP	Department of Mines and Petroleum
DO	Dissolved Oxygen
DoEE	Department of the Environment and Energy
DoF	Department of Fisheries
DPIRD	Department of Primary Industries and Regional Development
DPLH	Department of Planning, Lands and Heritage

Acronym	Definition
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
DSV	Drilling Supervisor
EAA	East Asian-Australasian
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999
EPs	Environmental Plans
EPOs	Environmental Performance Outcomes
EPS	Environmental Performance Standards
ESD	Ecologically Sustainable Development
ESHIA	Environment, Social, and Health Impact Assessment
FIM	Fountain Incident Management
FLNG	Floating Liquefied Natural Gas
GHG	Greenhouse Gas
HEMP	Hazards and Effects Management Process
HSE	Health Safety and Environment
HSSE	Health, Security, Safety, the Environment
HSSE & SP	Health, Security, Safety, the Environment and Social Performance
HSSE & SP-MS	Health, Security, Safety, the Environment and Social Performance Management System
IADC	International Association of Drilling Contractors
IOGP	International Association of Oil and Gas Producers
IOPP	International Oil Pollution Prevention
IFC	International Finance Corporation
IMO	International Maritime Organisation
IMS	Invasive Marine Species
ITF	Indonesian Throughflow
IUCN	International Union for Conservation of Nature
IWCF	International Well Control Forum
JAMBA	The Japan Australia Migratory Birds Agreement
KEF	Key Ecological Features
LNG	Liquified Natural Gas
LP	Low Pressure
MAFMF	Marine Aquarium Fish Managed Fishery
MARPOL	International Convention for the Prevention of Pollution from Ships

Acronym	Definition
MDRT	Measured Depth Rotary Table
MNES	Matters of National Environmental Significance
MOC	Management of Change
MODU	Mobile Offshore Drilling Unit
MoU	Memorandum of Understanding
MSL	Mean Sea Level
NADF	Nonaqueous drilling fluids
NAXA	North Australian Exercise Area
NDSF	Northern Demersal Scalefish Fishery
NERA	National Energy Resources Australia
NGER	National Greenhouse and Energy Reporting
NGOs	Non-Government Organisations
NIMS	Non-indigenous Marine Species
NMR	North Marine Region
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NOPTA	National Offshore Petroleum Titles Administrator
NO_X	Oxides of Nitrogen
NPF	Northern Prawn Fishery
NPI	National Pollutant Inventory
NT	Northern Territory
NWMR	North-west Marine Region
NWS	North West Shelf
NWSTF	North West Slope Trawl Fishery
OBM	Oil-based Mud
OCNS	Offshore Chemical Notification Sheme
ODS	Ozone Depleting Substance
OIM	Offshore Installation Manager
OPEP	Oil Pollution Emergency Plan
OPGGS	Offshore Petroleum and Greenhouse Gas Storage
OPGGS (E) Regulations	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations, 2009
OSMP	Operational and Scientific Monitoring Program
PAH	Polycyclic Aromatic Hydrocarbon

Acronym	Definition
PFW	Produced Formation Water
ppm	Parts Per Million
PSD	Particle Size Distribution
PSU	Practical Salinity Unit
PTS	Permanent Threshold Shift
PTTEP	Petroleum Authority of Thailand Exploration and Production
PWSNT	Parks and Wildlife Service Northern Territory
RAM	Risk Assessment Matrix
RO	Reverse Osmosis
ROV	Remotely Operated Vehicle
SBM	Synthetic Based Mud
SCE	Solid Control Equipment
SOLAS convention	The International Convention for the Safety of Life at Sea, 1974
SO_X	Sulphur Oxides
SWEO	Senior Well Engineer Operations
TSS	Total Suspended Solids
TTS	Temporary Threshold Shift
WA	Western Australia
WAFIC	Western Australian Fishing Industry Council
WAM	Western Australian Museum
WAMSI	Western Australian Marine Science Institution
WB	World Bank
WBM	Water Based Mud
WDTF	Western Deepwater Trawl Fishery
WOMP	Well Operations Management Plan
WSF	Western Skipjack Fishery
WTBF	Western Tuna and Billfish Fishery
UNEP IP	United Nations Environment Program Industry and Environment
VOC	Volatile Organic Compounds
VSP	Vertical Seismic Profiling

12. Appendices

Appendix A Requirements and Commitments

Please refer to separate Excel document containing details of:

- applicable legislative and other requirements for the activity
- control measures, environmental performance standards, ALARP assessments for each environmental aspect.

FACTORY SEISMIC EP - Report on all consultations between Shell and any relevant person

Stakeholder	Consultation Method / Type	Date Sent	Date Response Received	Summary of Response Received	Objections and Claims arising from the response	Shell Assessment of merit of each objection and claim	Statement of Response to the objection or claim
WA State and Commonwealth							
Australian Institute of Marine Science (AIMS)	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Australian Marine Safety Authority (AMSA) including AMSA RCC	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Phone / Email	1-Mar-2019	6-Mar-2019	AMSA confirmed receipt of the consultation package and informed Shell in the future to place 'Attention Nautical Advice' in the Subject of your emails to ensure that it gets through to the Navigation Safety section of AMSA. AMSA provided a vessel traffic plot of the Bratwurst well-1 location and permit blocks AC/P65 and WA-534-P where the proposed 3D Marine Seismic Survey (MSS) will be conducted. Relevant to the proposed Factory survey: - AMSA requested for the 3D MSS, Shell send the latitude and longitude coordinates of the OA with the next update. - AMSA identified there will be heavy vessel traffic encountered within both permit block AC/P65 and WA-534-P during the survey activities. Especially in the southern and south-eastern section of WA-534-P. AMSA advised Shell to adhere to the following: - When drilling or conducting the MSS, the Master of each vessel (semi-submersible or jack-up rig) should notify AMSA's Joint Rescue Coordination Centre (JRCC) through rccaus@amsa.gov.au (Phone: 1800 641 792 or +61 2 6230 6811) for promulgation of radio-navigation warnings 24-48 hours before operations commence. - AMSA's JRCC will require the vessel details (including name, callsign and Maritime Mobile Service Identity (MMSI), satellite communications details (including INMARSAT-C and satellite telephone), area of operation, requested clearance from other vessels, and need to be advised when operations start and end. - AMSA requested Shell contact the Australian Hydrographic Office at datacentre@hydro.gov.au no less than four working weeks before operations with the details related to the operations. The AHO will promulgate the appropriate Notice to Mariners (NTM), which will ensure other vessels are informed of your activities. - In the future please visit AMSA's spatial data gateway and Spatial@AMSA portal to download digital data sets and maps to obtain a vessel traffic plot showing vessel Automatic Identification System (AIS) data for your area of interest. Also, FYI a form for requesting customised information and data is also available via the Spatial@AMSA portal.	AMSA identified there will be heavy vessel traffic encountered within both permit block AC/P65 and WA-534-P during the survey activities. Especially in the southern and south-eastern section of WA-534-P. AMSA advised Shell to adhere to the following: - When drilling or conducting the MSS, the Master of each vessel (semi-submersible or jack-up rig) should notify AMSA's Joint Rescue Coordination Centre (JRCC) through rccaus@amsa.gov.au (Phone: 1800 641 792 or +61 2 6230 6811) for promulgation of radio-navigation warnings 24-48 hours before operations commence. - AMSA's JRCC will require the vessel details (including name, callsign and Maritime Mobile Service Identity (MMSI), satellite communications details (including INMARSAT-C and satellite telephone), area of operation, requested clearance from other vessels, and need to be advised when operations start and end. - AMSA requested Shell contact the Australian Hydrographic Office at datacentre@hydro.gov.au no less than four working weeks before operations with the details related to the operations. The AHO will promulgate the appropriate Notice to Mariners (NTM), which will ensure other vessels are informed of your activities. - In the future please visit AMSA's spatial data gateway and Spatial@AMSA portal to download digital data sets and maps to obtain a vessel traffic plot showing vessel Automatic Identification System (AIS) data for your area of interest.	Shell accepts the information provided by AMSA and will make updates to the EP accordingly. Shell accepts AMSA's request to providing notification to the AMSA's RCC as per Table 8-1.	The EP environment description was updated as a result of the information provided by AMSA. Shell responded to AMSA and agreed to contacting the AHO 4 weeks prior to the commencement of operations. Shell provided AMSA with the Factory OA coordinates as requested. Shell provided AMSA with the additional controls proposed to mitigate heavy vessel traffic within the OA.
	Email	12-Mar-2019	n/a	No response received			
	Letter	1-Jul-2019	n/a	No response received	-	-	-
Australian Border Force	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Australian Hydrographic Office	Letter	2-Nov-2018	7-Nov-2018	AHO confirmed receipt of the consultation package. AHO requested Shell to: - Keep us AHO informed when firm dates are available for the activity. - Ideally AHO need 3 weeks' notice so they can publish any appropriate notice to mariners, and AHO can be flexible as long as we know in advance.	Keep AHO informed when firm dates are available for the activity. Ideally AHO need 3 weeks' notice so they can publish any appropriate notice to mariners, and AHO can be flexible as long as we know in advance.I14	Shell accepts AHO request to providing notification to the AHO as per Table 8-1.	Shell reponded accepting AHO request to providing notification to the AHO as per Table 8-1.
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Dambimangari Aboriginal Corporation	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Department of Agriculture and Water Resources	Letter	2-Nov-2018	21-Nov-2018	DAWR requested Shell to forward a copy of the consultation letter and any relevant attachments to our marine pest mailbox – pestsmarine@agriculture.gov.au for our team here to review.	DAWR recommended Shell reference the Australian Government National Biofouling Management Guidance for the Petroleum Production and Exploration Industry: http://www.marinepests.gov.au/marine_pests/publications/Documents/Biofouling_guidance_petroleum.pdf DAWR requested to be kept informed of any additional updates regarding the activities.	Shell accepts DAWR request reference Australian Government National Biofouling Management Guidance for the Petroleum Production and Exploration Industry. DAWR's request to be kept informed is reasonable.	Shell responded to DAWR and thanked them for the advice and informed DAWR they would get in touch if they have any further queries.
	Email	21-Nov-2018	22-Nov-2018	DAWR responded by acknowledging the Appendix fact sheets in relation to Marine Pests: Ballast water exchange operations will comply with the International Maritime Organisation (IMO) International Convention for the Control and Management of Ships' Ballast Water and Sediments 2004 (as appropriate to vessel class), Australian Ballast Water Management Requirements and related requirements. Biofouling management for vessels in accordance to the IMO Guidelines. DAWR recommended Shell reference the Australian Government National Biofouling Management Guidance for the Petroleum Production and Exploration Industry: http://www.marinepests.gov.au/marine_pests/publications/Documents/Biofouling_guidance_petroleum.pdf DAWR requested to be kept informed of any additional updates regarding the activities.			
	Email	22-Nov-2018	n/a	No response received			-

	Letter	2-Jul-2019	n/a	No response received	-	-	-
Department of Communications and the Arts	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Department of the Environment and Energy	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Department of Foreign Affairs and Trade (DFAT)	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Department of Jobs and Small Business (Department of	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Department of Mines, Industry Regulation & Safety	Letter	2-Nov-2018	22-Nov-2018	DMIRS confirmed receipt of the consultation package and informed Shell they have reviewed the information package and no further information is required at this stage. DMIRS requested Shell keep DMIRS informed on Shell Australia's activities in Commonwealth waters. Any future notifications to be sent through to petroleum.environment@dmirs.wa.gov.au.	DMIRS requested Shell keep DMIRS informed on Shell Australia's activities in Commonwealth waters. Any future notifications to be sent through to petroleum.environment@dmirs.wa.gov.au.	Shell accepts DMIRS request to be kept informed through the provided email.	-
	Letter	28-Jun-2019	5-Jul-2019	DMIRS confirmed receipt of the consultation package and informed Shell that no further information is required at this stage. DMIRS also acknowledges that NOPSEMA will regulate the survey under the OPGGS(E) Regulations. DMIRS requested that a commencement notification be sent to petroleum.environment@dmirs.wa.gov.au prior to the start of the survey.	DMIRS requested that a commencement notification be sent to petroleum.environment@dmirs.wa.gov.au prior to the start of the survey.	Shell accepts DMIRS request that commencement notification be sent to the provied email.	-
Department of Water & Environmental Regulation	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Director of National Parks / Parks Australia	Letter	2-Nov-2018	30-Nov-2018	DNP confirmed receipt of the consultation package and informed Shell they will provide comments in a weeks time.	-	-	-
	Email	3-Dec-2018	7-Dec-2018	DNP confirmed receipt of the consultation package and noted that the planned activities do not overlap any Australian Marine Parks. Relevant to the Factory survey DNP confirmed with Shell that the Factory operational area is 10 km from the Cartier Island Marine Park and therefore there is no authorisation requirements from the DNP. DNP advised Shell that in preparing the EP and OPEP the DNP should be considered. In the context of the management plan objectives and values, Shell should ensure that the EP: - identifies and manages the impacts and risks on marine park values to an acceptable level and has considered all options to avoid them or reduce them to as low as reasonably practicable. - clearly demonstrates that the activity will not be inconsistent with the management plan. Advised that notification is required should there be any oil/gas pollution incidents which could threaten or occur in or likely to impact a marine park as soon as possible. Notification should be provided to the 24 hour Marine Compliance Duty Officer on 0419 293 465. The notification should include: - titleholder details - time and location of the incident (including name of marine park likely to be effected) - proposed response arrangements as per the Oil Pollution Emergency Plan (e.g. dispersant, containment, etc); and - contact details for the response coordinator.	Notification is required should there be any oil/gas pollution incidents which could threaten or occur in or likely to impact a marine park as soon as possible. Notification should be provided to the 24 hour Marine Compliance Duty Officer on 0419 293 465. The notification should include: - titleholder details - time and location of the incident (including name of marine park likely to be effected) - proposed response arrangements as per the Oil Pollution Emergency Plan (e.g. dispersant, containment, etc); and - contact details for the response coordinator.	Shell accepts DNP's request to advice the required person of oil pollution as per the OPEP.	-
	Email	10-Dec-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	30-Jul-2019	Please note the values of the Cartier, Ashmore and Kimberly marine parks outlined within the North-west Marine Parks Network Management Plan 2018 (management plan). Following our previous advice to you on 7 December 2018 and based on the information you have provided, the operational area of the seismic surveys (in AC/P65 and WA-534-P) is approximately 10 km, 45 km and 50 km from Cartier Island, Kimberly and Ashmore Reef marine parks respectively. Please be advised that the advice we provided on 7 December 2018 is still applicable (including the details relating to emergency responses). Confirm that we do not require further notification of progress made in relation to this activity unless details regarding the activity change and result in an overlap with a marine park or new impact.	-	-	-
NT Department of Primary Industry and Resources - Fisheries Division	Letter	2-Nov-2018	n/a	No response received	-	-	-

	Letter	29-Jun-2019	n/a	No response received	-	-	-
WA Department of Biodiversity, Conservation & Attractions (including Broome Office)	Letter	2-Nov-2018	16-Nov-2018	DBCA acknowledged receipt of the consultation package and informed Shell that due to the location of the proposed exploration activities within Commonwealth waters DBCA has no comments to provide on the activities. DBCA requested Shell provide any future petroleum notifications to the following email address: EMBAdmin@dbca.wa.gov.au	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
WA Department of Primary Industries and Regional Development - Department of Fisheries	Letter	2-Nov-2018	n/a	No response received from the Department	-	-	-
	Phone call / email	n/a	8-Nov-18	DPIRD informed Shell that public access is allowed to the DPIRD fish cube database but the protocols and process are still under development. DPIRD provided their Guidance Statement on undertaking seismic surveys in WA waters.	-	-	-
	n/a	n/a	28-Nov-18	Provided a summary of commercial fishing interests in the area including: - Kimberley Prawn Managed fishery - Mackerel managed fishery - Northern demersal Scalefish managed fishery - Recreational and charter fishing may also occur Summary of potential effects of exploration drilling on fish populations and the operators of fishers who harvest these resources. Therefore, the Department recommends that Shell Australia initiate and maintain ongoing consultation with the Western Australian Fishing Industry Council, Recfishwest and directly with fishers (contact details of licensed fishers can be obtained through the Department's public register). - Seabed alteration and disturbance from sample collection during a survey can impact on benthic habitats, disrupt predator/prey interactions and negatively affect fish populations. The Department therefore requests that risks to seabed disturbance and underwater noise are identified and mitigation strategies are developed and implemented during the survey to reduce the associated impacts. - The Department also requests that, where possible, surveys are not conducted during identified spawning periods and provided a table of the spawning periods for key fish species within the proposed area. . - The Department recommends that all vessel managers minimise the risk of translocating marine pests into or within WA waters. This can be achieved by accurately assessing and then reducing the level of risk and Vessel Check is recommended for this purpose. - The Department also recommends that the suspected or confirmed presence of any marine pest or disease be reported within 24 hours by email or telephone. - With respect to developing an Oil Pollution Emergency Plan (OPEP), the Department requests that specific strategies are developed in the EP and/or OPEP to mitigate risks/potential impacts on spawning grounds and nursery areas for key fish species in the area. When developing the OPEP the Department requests that Shell collects baseline marine data to compare against any post-spill monitoring data and that these data are made available to the Department upon request. - The Department requests that all potential impacts to fisheries, fish and fish habitat described in this letter are specifically identified in the final Environment Plans and strategies to be undertaken by Shell Australia to mitigate or minimise these impacts are described. Should there be any objections or claims raised during the consultation process, the Department requests that these conflicts are resolved to the satisfaction of the regulator i.e. the National Offshore Petroleum Safety and Environment Management Authority.	The Department requests surveys are not conducted during identified spawning periods. The Department recommends using DPIRD'S Vessel Check to minimise translocating IMS . The Department recommends reporting all suspected or confirmed presence of any marine pest or disease be reported within 24 hours by email or telephone. The Department requests that specific strategies are developed in the EP and/or OPEP to mitigate risks/potential impacts on spawning grounds and nursery areas for key fish species in the area. When developing the OPEP the Department requests that Shell collects baseline marine data to compare against any post-spill monitoring data and that these data are made available to the Department upon request. The Department requests that all potential impacts to fisheries, fish and fish habitat described in this letter are specifically identified in the final Environment Plans and strategies to be undertaken by Shell Australia to mitigate or minimise these impacts are described.	Shell considered the Departments claim to not conduct surveys within identified spawning periods. However, based on recent information provided by DPIRD (through WAFIC), Shell are not able to exclude all spawning periods as this will cover all but 2-3 months of the year for key species within the NDSF. Shell will use DPIRD'S Vessel Check to minimise translocating IMS for all vessels used for the activity. Shell will report all suspected or confirmed presence of any marine pest or disease be reported within 24 hours by email or telephone. Shell will develop specific strategies in the OPEP to mitigate risks/potential impacts on spawning grounds and nursery areas for key fish species in the area. The sailline plan will minimise the duration of the survey which will minimse potential impacts on fish spawnning. Shell will collect baseline marine data to compare against any post-spill monitoring data and that these data are made available to the Department upon request. It is not reasonable to collect baseline data for a specific exploration activity as proposed. Shell will identify all potential impacts to fisheries, fish and fish habitat in the final Environment Plans and strategies to be undertaken by Shell Australia to mitigate or minimise these impacts are described.	
	Email	10-Dec-18	11-Dec-18	DPIRD informed Shell that the catch data will vary year to year but latest figures for 2016-17 for the Northern Demersal Scalefish Fishery (2016-17) is 1,222,228 kgs	-	-	-
	Email	28-Dec-18	7-Jan-19	DPIRD informed Shell that the closures are not for fish conservation or sustainability reasons the closures are not under DPIRD legislation and DPIRD does not have a preference for the type of exclusion zone or structure to cover the wellhead	-	-	-
	n/a	n/a	26-Feb-19	DPIRD requested confirmation that the lowest water depth is in the proposed acquisition area and the seismic source volume proposed to be use for the survey	-	-	-
	Email	26-Feb-19	6-Mar-19	The Department expects that Shell in its Environment Plan (EP) has considered and incorporated the recommendations published by NOPSEMA on the Acoustic Impact evaluation and management guidance https://www.nopsema.gov.au/environmental-management/assessment-process/environment-plans/. •The Department also expects that Shell has incorporated the outcomes and developed the appropriate controls from the Risk Assessment of the potential impacts of seismic air gun surveys on marine finfish and invertebrates in Western Australia, June 2018, http://www.fish.wa.gov.au/Documents/research_reports/frr288.pdf, refer to the summary table below. •With the proposed 3480 cubic inch seismic source and the lowest operational water depth of acquisition at 70/75m the Department would not support any proposed seismic survey where the risk to stocks is high or severe, unless scientific peer reviewed literature can demonstrate otherwise, refer to the summary tables from the workshop below. Reducing the seismic source, still puts the risk range between high and severe for immobile invertebrates and high for demersal finfish, your control measures state that the full acoustic source will not be used in water depths shallower than 70m, what seismic source will you use? •The Department is concerned as the proposed survey can still expose stock to high risk, and given that stocks in the Kimberley area, particularly gold band snapper, is fully allocated from a sustainability perspective, any addition risk could potentially impact long term sustainability. •The calculation of the area in relation to the % in Figure 1, make assumptions that the fishers can fish in all areas of the fishery, see map below. So the EMBA, Operational Area and Survey area % would be greater if the calculation was based on where the fishers operate, in relation to the proposed survey. Consider revising the calculations based on the spatial fishcube data, and the EMBA, Operational Area and Survey area and update the maps to include the areas of the Northern Demersal Scalefish Fishery. The survey area encompasses parts of area B and C and as the fishcube data shows the proposed area of operation is in an area where significant catch and effort takes place. As this is an effort-controlled fishery, it appears as if part of Area B and C will be impacted by the survey. That effort allocation is not transferable to other areas. •Other consideration into the % calculations relates to the not just considering the impact to the fishery but the fish stocks as well. •Cumulative impact – Has Shell obtained the other seismic data already gathered in the area? This may enable Shell to reduce the operational area of the proposed survey.	The Department does not support any proposed seismic survey where the risk to stocks is high or severe, unless scientific peer reviewed literature can demonstrate otherwise. Reducing the seismic source, still puts the risk range between high and severe for immobile invertebrates and high for demersal finfish. Department claims the proposed survey can still expose stock to high risk, and given that stocks in the Kimberley area, particularly gold band snapper, is fully allocated from a sustainability perspective, any addition risk could potentially impact long term sustainability. Department recommends Shell should consider revising the calculations based on the spatial fishcube data, and the EMBA, Operational Area and Survey area and update the maps to include the areas of the Northern Demersal Scalefish Fishery. Other consideration into the % calculations relates to the not just considering the impact to the fishery but the fish stocks as well. Cumulative impact – Has Shell obtained the other seismic data already gathered in the area? This may enable Shell to reduce the operational area of the proposed survey.	The EP assessment takes into consideration impacts to the fish population and impacts at a population level are not predicted in the assessment. Mortality to fish is not predicted. Impacts to site-attached species are not predicted. Impacts to demersal fish species are limited to short term behavioural impacts and recoverable TTS. Demersal species are able to flee from the source.	See below
		18-Mar-19	8-Apr-19	DPIRD informed Shell that the overarching data release requirements are based on Section 250 of the Fish Resource Management Act 1994. The 3 boat rule ensures that no individual including fishers can deduce what another individual has provided	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	Shell considers the level of consultation to be adequate.	n/a

	Email	11-Jul-19	N/a	no response from Department	-	-	-
	Email	19-Jul-19	19-Jul-19	Shell sent an email requesting further information on the new Spawning data referenced by WAIFC. Department replied that there are no scientific papers yet on the data and further information is being collected.	-	-	Shell incorporated the new spawning information into the EP as part of the impact assessment.
WA Department of Transport (DOT)	Letter	2-Nov-2018	8-Nov-2019	DoT confirmed they received the consultation package and they would like to comment on the Bratwurst OPEP. DoT requested consultations are conducted as per DoT Industry guidance note. Consultations must come through the marine pollution inbox and DoT request a 6 week period for consultation.	-	At a company level, Shell commits to ongoing consultation with the DoT regarding their role as State marine pollution coordinator as per the DoT's Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (Sep 2018).	Shell responded by providing the Bratwurst OPEP as requested via the marine pollution inbox. There was no response regarding the factory survey
	Email	30-Nov-2018	n/a	No response received from the Department	-		n/a as no response has been received.
	Email	11-Dec-2018	11-Dec-2018	DoT confirmed receipt of the OPEP and Emily Gifford will review and respond if there are any queries.	-		No response sent to stakeholder as no objection or claim was raised.
	Email	11-Dec-2018	28-Dec-2018	DoT responded and provided Shell with comments regarding the Bratwurst OPEP. DoT requested that the revisions are made to the document, and a reminder to add DoT to the circulation list for the final OPEP document once accepted. Comments included: - As per Appendix 6 of the Industry Guidance Note September 2018 DoT requests that Petroleum Titleholders provide 'a highlighted copy of the OSCP/OPEP as prepared for submission to the regulatory agencies. Accompanying this should be a table listing out the sections where the specific information is covered in the OSCP/OPEP.' - Please provide indication of timing and duration of the activity - Provide details of the environmental risk assessment related to marine oil pollution Provide further details around oil spill modelling scenarios, including: - how many scenarios were run/ were scenarios seasonal - maps of the trajectory modelling outputs that were used to infer the worst case spill scenarios, including the zone of potential impact - Provide details of incident control centre arrangements - Provide details on proposed IMT structure including integration of DoT arrangements. Diagrams should illustrate the Control and Coordination structure specific to this response, for example cross jurisdictional arrangements. - Provide more detail on the initial 10 personnel that are to be provided to the Department of Transport's (DoT) Incident Management Team during a cross-jurisdictional response. For example, where would these personnel be sourced from/ what qualifications or skillsets would they have to fulfil their role? - Provide detail on the exercises that are routinely undertaken to ensure that Shell is prepared to respond to a potential spill. - Refer to current Industry Guidance Note: September 2018. Update 'Dec 17' to 'Sep 18' on page 22 and throughout document	-		No response sent to stakeholder as no objection or claim was raised.
	Email	3-Jan-2019	12-Feb-2019	DoT acknowledged receipt of Shells response to DoT's initial personnel requirements and provides sufficient information to address Item 7.	-		-
	Email	12-Feb-2019	n/a	No response received from the Department	-		-
	Email	18-Feb-2019	n/a	No response received from the Department	-		-
	Letter	29-Jun-2019	12-Jul-2019	DOT responded by email to say "Thank you for providing us with information regarding the proposed Factory 3D seismic survey. If there is any risk of a spill to State waters as a result of this activity, please ensure that the Department of Transport is consulted in accordance with the requirements outlined in the Department of Transport Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (September 2018) which can be accessed here - https://www.transport.wa.gov.au/mediaFiles/marine/MAC_P_Westplan_MOP_OffshorePetroleumIndGuidance.pdf"	-	Shell has prepared an OPEP for the activity but this does not affect state waters and therefore it was not provided to DOT	Shell has prepared an OPEP for the activity but this does not affect state waters and therefore it was not provided to DOT
State Member for Kimberley	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Non-For-Profit and NGO's							
Australian Conservation Foundation	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Australian Marine Conservation Society	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Conservation Council of Western Australia	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Greenpeace	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Wilderness Society	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
WWF	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Australian Marine Oil Spill Centre (AMOSC)	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Commonwealth Fisheries							
Australian Fishery Management Association (AFMA)	Email	6-Dec-2018	7-Dec-2018	AFMA responded to Shell's request and advised Shell that the only licence holders fishing in this area are: - North West Slope Trawl; and - Western Deepwater Trawl Fishery. Only the following licence holders are currently active: AUSTRAL FISHERIES PTY LTD SEAFRESH HOLDINGS PTY LTD SEAFRESH HOLDINGS PTY LTD & FABRON HOLDINGS PTY LTD W.A. SEAFOOD EXPORTERS PTY LTD The following are not active: FM INVESTMENTS (NSW) PTY LIMITED M G KAILIS PTY. LTD. RAPTIS FISHING LICENCES PTY LTD AFMA advised that the Joint Shark Fishery are State fishers and Shell needs to contact the Western Australian Fisheries and the	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Commonwealth Fishing Association	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
North West Slope Trawl Fishery - SEAFRESH HOLDINGS PTY LTD &	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
North West Slope Trawl Fishery - (WESTMORE SEAFOODS & SHARK BAY SEAFOODS)	Email	8-Jan-2019	n/a	No response received	-	-	-
	Email	30-Jan-2019	n/a	No response received	-	-	-
	Letter	1-Mar-2019	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
North West Slope Trawl Fishery - MG Kailis Pty Ltd	Letter	1-Mar-2019	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Northern Prawn Fishery - AUSTRAL FISHERIES PTY LTD	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Northern Prawn Fishery - FM INVESTMENTS (NSW) PTY	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Northern Prawn Fishery - M G KAILIS PTY. LTD.	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Northern Prawn Fishery - RAPTIS FISHING LICENCES PTY LTD	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Northern Prawn Fishery - W.A. SEAFOOD EXPORTERS PTY LTD	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Northern Prawn Fishery - W.A. SEAFOOD EXPORTERS PTY LTD	Letter	1-Mar-2019	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Recreational Fisheries							
RecFishWest	Letter	2-Nov-2018	14-Dec-2018	Recfish thanked Shell for the correspondence and said Given the location of this activity, it is highly unlike that this survey will impact upon recreational fishers.	-	-	-
	Letter	29-Jun-2019	3-Jul-2019	RecFishWest thanked Shell for the update and said the planned activity is unlikely to impact recreational fishing due to the distance offshore.	-	-	-
WA State Fisheries							
Mackerel Managed Fishery - Augustus Rose Pty Ltd	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - BILYARA HOLDINGS PTY LTD	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - C/ ADAM HUNTER PTY LTD	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-

Mackerel Managed Fishery - Q	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - P	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - EMGEKAY INVESTMENTS P/L	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - O	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - N	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - M	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - L	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - J & T FISHING CO PTY LTD	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - K	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - KAI NOMINEES PTY LTD	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Northern Demersal Scalefish Fishery - KFM LEASING PTY LTD	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - Kybret Pty Ltd	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - J	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - MISS DEB A DELL FISHERIES PTY	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - I	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - H	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - G	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - F	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - E	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - ROBERT & JUDITH COOPER	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - D	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - C	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - SABEA FISHING CO PTY LTD	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - Sagacity Pty Ltd	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - B	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - SIMPSON SEAFOODS PTY LTD	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - SPANIARD FISHING PTY LTD	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - Augustus Rose Pty Ltd	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - VIENCY PTY LTD	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - WEST COAST CRABS PTY LTD	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - WESTERN WILD FISHERIES	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - ZAMIA BAY PTY LTD	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Mackerel Managed Fishery - MARETERRAM FISHERIES	Email		19-Nov-2018	Mareterram Fisheries responded and informed Shell of the following: - Mareterram Fisheries operate mackerel vessels in the Kimberley and Pilbara, and prawn trawlers in Shark Bay. - There are no set fishing grounds in the fishery with vessels targeting higher densities of fish as they occur. - Most fishing is done adjacent to islands and shoals. - Mackerel gear is not set, with the vessels trolling for fish or line fishing at night. It is difficult to gauge what, if any gear conflict there may be between our respective operations.	Mareterram fisheries requested Shell to keep X and the Y informed of your activities	Shell accepts Mareterram request to be kept informed of the proposed activities.	Shell accepts Mareterram request to be kept informed of the proposed activities.
	Letter	29-Jun-2019	n/a	No response received	-	-	-
North Coast Shark Fishery - NORTHFISH HOLDINGS PTY LTD	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
North Coast Shark Fishery - SHINE YEAR FISHERIES (AUST)	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
North Coast Shark Fishery - TASMANIAN SEAFOODS PTY LTD	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Northern Demersal Scalefish Fishery - E	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Northern Demersal Scalefish Fishery - Old Brown Dog	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Phone call	28-Nov-2018		Following up on letter sent to NDSF, Shell called and asked for meeting to understand fishing activities and how we can work together. X indiciated that to many request from oil and gas companies and he didn't have time. He said that he would like us to engage through Y and WAFIC and she is across the issues and their views.	Shell said they would work with WAFIC as a vehicle for consultation		

	Email	14-Jan-2019	14-Jan-2019	Old brown Dog responded to the consultation package and the key concerns raised were: - Shell should consider not doing the activity at all - Concerned about impact on commercial fishing activities resulting from seismic vessels and forcing fishing vessels to move out of the way even if they are catching viable amounts of fish in an area that the seismic vessel is acquiring data (towing equipment through) - Believes that seismic is having a detrimental effect on their business, provides references to support this - As a pre-existing industry they feel they are being pushed around by seismic operators. - Concerned about impact of perceived disruption to fish behaviours from seismic work - Unwilling to meet unless there is a specific new approach to resolve this - Shell should consider 'make good' compensation	Shell should consider not doing the activity at all - Concerned about impact on commercial fishing activities resulting from seismic vessels and forcing fishing vessels to move out of the way even if they are catching viable amounts of fish in an area that the seismic vessel is acquiring data (towing equipment through) - Claims that seismic is having a detrimental effect on their business, provides references to support this - As a pre-existing industry they feel they are being pushed around by seismic operators - Concerned about impact of perceived disruption to fish behaviours from seismic work - Unwilling to meet unless there is a specific new approach to resolve this - Shell should consider 'make good' compensation	Shell will consider NWSA claim for no acquisition during spawning periods for key indicator sp• After reviewing the concerns of the licence holder, Shell developed an additional set of control measures to reduce the risk to ALARP. •These measure are: oReduce the window of time for validity of the EP from 2 years to 6 months. EP validity will now be from July to December 2019 [see below for additional survey timing information] oNo seismic acquisition will occur in the immediate vicinity (within 5 km) of Heywood Shoals during the month of October which is a key spawning time; the survey will operate in the areas which are further away from Heywood Shoals during this period. oNo operation of the full acoustic source will be in water depths shallower than 70 m to minimise noise impacts in shallow areas such as Heywood Shoals. oEnvironmental performance and compliance will be monitored and assured by Shell site representatives for environmental health and safety. oAs is standard practice, soft start procedures will be implemented, as identified in the Western Australia Fisheries Publication No, 112, 2013 Guidance statement on undertaking seismic surveys in WA waters. oDevelopment of communication and interaction protocols with Fisheries licence holders. With sufficient prior notice of approx. 24 hours, areas for the survey may be changed to minimise impact on active fishing within the operational area oFishing from the survey and support vessels is prohibited and will be a condition of the contract. •Shell considered the requirement for "make good" compensation but determined that controls could be put in place to reduce risk to ALARP and therefore compensation was not required. •Shell Australia is of the view that it has reduced the risk to as low as is reasonably possible (ALARP). Given all the environmental sensitivities (as outlined in Table 1 of our letter of 26 February 2019) there is no time during the year we can identify which is free from all environmental sensitivities. Shell Australia has worked on timing that attempts to complete the survey prior to October as this is a key spawning time but should the survey occur in October it will not occur within 5km of Heywood Shoals which noise modelling indicates reduces the risk of impact. ecies in the NDSF.	Shell responded by letter on 26 February with an additional set of control measures to address his concerns. These measures are:These measure are: oReduce the window of time for validity of the EP from 2 years to 6 months. EP validity will now be from July to December 2019 [see below for additional survey timing information] oNo seismic acquisition will occur in the immediate vicinity (within 5 km) of Heywood Shoals during the month of October which is a key spawning time; the survey will operate in the areas which are further away from Heywood Shoals during this period. oNo operation of the full acoustic source will be in water depths shallower than 70 m to minimise noise impacts in shallow areas such as Heywood Shoals. oEnvironmental performance and compliance will be monitored and assured by Shell site representatives for environmental health and safety. oAs is standard practice, soft start procedures will be implemented, as identified in the Western Australia Fisheries Publication No, 112, 2013 Guidance statement on undertaking seismic surveys in WA waters. oDevelopment of communication and interaction protocols with Fisheries licence holders. 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	Letter	26-Feb-2019	n/a	No response received	-	-	-
	Email	12-Mar-2019	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Northern Demersal Scalefish Fishery - Northern Wildcatch Seafoods Australia (NWSA)	Email	2-Nov-2018	23-Jan-2019	NWSA responded to the follow up email from Shell and the key concerns raised were: - 73% of the NDSF fishery is owned by NWSA and is concerned that ongoing seismic activity is having a detrimental impact on the business - Provided resource papers on spawning periods and studies of noise impacts on fish species.	NWSA objects to the timing of the survey and requests the survey is done outside of key indicator species spawning periods.	Shell will consider NWSA claim for no acquisition during spawning periods for key indicator sp• After reviewing the concerns of the licence holder, Shell developed an additional set of control measures to reduce the risk to ALARP. •These measure are: oReduce the window of time for validity of the EP from 2 years to 6 months. EP validity will now be from July to December 2019 [see below for additional survey timing information] oNo seismic acquisition will occur in the immediate vicinity (within 5 km) of Heywood Shoals during the month of October which is a key spawning time; the survey will operate in the areas which are further away from Heywood Shoals during this period. oNo operation of the full acoustic source will be in water depths shallower than 70 m to minimise noise impacts in shallow areas such as Heywood Shoals. oEnvironmental performance and compliance will be monitored and assured by Shell site representatives for environmental health and safety. oAs is standard practice, soft start procedures will be implemented, as identified in the Western Australia Fisheries Publication No, 112, 2013 Guidance statement on undertaking seismic surveys in WA waters. oDevelopment of communication and interaction protocols with Fisheries licence holders. With sufficient prior notice of approx. 24 hours, areas for the survey may be changed to minimise impact on active fishing within the operational area oFishing from the survey and support vessels is prohibited and will be a condition of the contract. •Shell considered the requirement for "make good" compensation but determined that controls could be put in place to reduce risk to ALARP and therefore compensation was not required. •Shell Australia is of the view that it has reduced the risk to as low as is reasonably possible (ALARP). Given all the environmental sensitivities (as outlined in Table 1 of our letter of 26 February 2019) there is no time during the year we can identify which is free from all environmental sensitivities. Shell Australia has worked on timing that attempts to complete the survey prior to October as this is a key spawning time but should the survey occur in October it will not occur within 5km of Heywood Shoals which noise modelling indicates reduces the risk of impact. ecies in the NDSF.	Shell will not acquire data within 5 km of Heywood Shoal during the month of October.
	Letter	26-Feb-2019	n/a	No response received	-		-
	Email	26-Feb-2019	n/a	n/a	-		-
	Email	12-Mar-2019	13-Mar-2019	Stakeholder sent further correspondence that was still not happy with the window of July – December 2019 for the survey timing and would like the survey to be at a time when there is no spawning.	NWSA objects to the timing of the survey and requests the survey is done outside of key indicator species spawning periods.		Shell repeated to NWSA the controls proposed: - "No seismic acquisition will occur in the immediate vicinity (within 5 km) of Heywood Shoals during the month of October which is a key spawning time; the survey will operate in the areas which are further away from Heywood Shoals during this period." and - "No operation of the full acoustic source will be in water depths shallower than 70 m to minimise noise impacts in shallow areas such as Heywood Shoals."
	Email	19-Mar-2019	24-Mar-2019	Stakeholder sent further correspondence which acknowledged Shell's position on additional controls but that he does not agree with it or acknowledge that they are acceptable to reduce the risk. The stakeholder would like the survey to occur outside of any spawning times.	NWSA objects to the timing of the survey and requests the survey is done outside of key indicator species spawning periods.		Shell repeated to NWSA the controls proposed: - "No seismic acquisition will occur in the immediate vicinity (within 5 km) of Heywood Shoals during the month of October which is a key spawning time; the survey will operate in the areas which are further away from Heywood Shoals during this period." and - "No operation of the full acoustic source will be in water depths shallower than 70 m to minimise noise impacts in shallow areas such as Heywood Shoals."
	Email	20-Apr-2019	Shell still wants to consult with the Fisheries licence holder.J199:M199	Don't wish to consult anymore as they don't think it will be worthwhile. Asked that Shell: •Strictly comply with NOPSEMA approval •They receive adequate pre start notification, acquisition plan and daily updates. •Seismic acquirer stays away from their fishing vessels They will be observing their rights in relation to losses they may suffer due to seismic survey	NDSF informed Shell their fishery does not want to consult anymore as they do not think it will be worthwhile. NDSF requested to be kept informed of the proposed activities, pre-start notification acquisition plan and daily updates. Seismic vessel stays away from their fishing vessels.	Shell will adhere to NDSF request to be kept informed of the survey.	Shell preference is to continue to consult with the Fisheries licence holder.
	Email	12-Jun-2019	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Northern Demersal Scalefish Fishery - LENDEN NOMINEES PTY	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Northern Demersal Scalefish Fishery - A	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Northern Demersal Scalefish Fishery - NDSF LICENCES	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Northern Demersal Scalefish Fishery - B	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Northern Demersal Scalefish Fishery - C	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Northern Demersal Scalefish Fishery - D	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Pearl Oyster Fishery	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
Pearl Producers Association	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
West Coast Deep Sea Crustacean Fishery - ALLPLAINS	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-
West Coast Deep Sea Crustacean Fishery - DA, JC, LM, NC, JG & HP DORRINGTON T/A DEEP SEA WATER SERVICES	Letter	2-Nov-2018	13-Nov-2018	Yennett pty ltd and Deepsea Water Services responded to the consultation package and informed Shell that they operate and fish for deep sea crabs in depths out to 1,000 ftms along the WA coast. Yennett Requested Shell to keep them informed of the survey. Yennett is currently fishing way south of the proposed survey area.	-	-	-
	Letter	29-Jun-2019	29-Jun-2019	Neil on behalf of the fishery responded to Shell, sending thanks for the update but that the location will have no impact on the fishery. Request that Shell continue to provide updates on project movements	-	-	-
Kimberley Professional Fisherman's Association	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Letter	29-Jun-2019	n/a	No response received	-	-	-

Western Australian Fishing Industry Council	Letter	2-Nov-2018	n/a	No response received	-	-	-
	Phone call	3-Nov-2018		Shell called WAFIC to inform her a letter had been sent to WAFIC. X talked a length about WAFIC's frustrations with the Oil and Gas Sector and consultation and the time it takes WAFIC to respond to all consultations. They raised the impost on the time of licence holders with no compensation. There was no discussion about the content of the consultation letter as WAFIC has not yet received it	WAFIC raised issues with oil and gas sector consultation and that she would review the letter and respond. They said compensation was important and should be considered	Shell has considered the claim for compenstation and has committed ot working with NDSF licence holders to develop a framework	Shell awaited WAFIC's reponse to the letter and responded as below.
	Email	5-Nov-2018	7-Nov-2018	WAFIC was of the opinion this was a generic consultation that wasn't specific to the commercial fishing industry and believe the consultation process can be improved by including information, risk assessments and mitigations specific to their sector. Maps were not provided with their preferred descriptor of latitudes and longitudes and they requested that the coast line and distance from coast of the activity be provided rather than just the operational area. The risks and mitigations provided were not specific and relevant to commercial fishing activities, especially regarding seismic assessment. The following points were suggested to improve the consultation process: - Consultation and EP process must cover potential impacts to commercial fishing activity, the resource (key indicator species, fish spawning, environment, food chain) and should include all fisheries within legal boundaries in all or part of proposed drilling or seismic area - Consultation needs to be upfront to assess above criteria and clearly explain to stakeholders how Shell will reduce risk to ALARP - There is zero reference to how Shell will mitigate any risks to commercial fishing activities either by avoiding peak fishing activity/spawning of key indicator species - Timing of proposed survey must be at the best possible ALARP time taking into account commercial fishing activity, spawning and other environmental considerations - It is unacceptable for Shell to propose survey times (May to December 2019 or 2020) without a full ALARP assessment of risks associated with all aspects of commercial fishing contained within your consultation for these times. - If there is a delay in the proposed survey, WAFIC and commercial fishing stakeholders will be insisting and expecting the survey to be pushed back to the best ALARP level "window of opportunity", potentially the following year In relation to the above, what process does Shell have in place to quantitatively assess any damage to fish stocks, fish spawn, foo chain due to the seismic activity. To address this will Shell: - Do any bespoke pre-survey environmental assessments to ensure there is baseline information in place? - If not, what science will Shell use to have complete understanding of the marine environment prior to the commencement of the seismic survey - What science is shell using to demonstrate they have full understanding of fish spawning practices in the region of the proposed survey and how does Shell plan to avoid any survey dates with may potentially impact fish/crustacean spawning periods of commercial fishing key indicator species - What science is shell using to demonstrate they have full understanding of fish behavioural activities and will completely avoid all seismic activities during key fish schooling, migrating patterns etc. - Where there is an absence of science, it is our expectation that commercial fisher knowledge and locational history and understanding of the resource be used in lieu as the key base of available information.	WAFIC objected to the consultation materials that had been provided to fisheries licence holders: Maps were not provided with adequate distances and context of the mainland was insufficient. WAFIC objected to the risks and mitigations that they were not specific or relevant to commercial fisheries activities. WAFIC objected to the survey timing without Shell providing a full ALARP Assessment.	Shell undertook one-on-one consultation with licence holders as recommended by WAFIC. The consultation communications can be found in Appendix D - Shell considered the requirement for "make good" compensation but determined that controls could be put in place to reduce risk to ALARP and acceptable levels therefore compensation was not required. - Shell added a number of additional control measures to survey following consultation with WAFIC and to address the issues and concerns they raised regarding potential impacts to commercial fishing activity and impacts on spawning. These controls are: - Reduce the window of time for validity of the EP from 2 years to 6 months. EP validity will now be from July to December 2019 [see below for additional survey timing information] - No seismic acquisition will occur in the immediate vicinity (within 5 km) of Heywood Shoals during the month of October which is a key spawning time; the survey will operate in the areas which are further away from Heywood Shoals during this period. - No operation of the full acoustic source will be in water depths shallower than 70 m to minimise noise impacts in shallow areas such as Heywood Shoals. - Environmental performance and compliance will be monitored and assured by Shell site representatives for environmental health and safety. - As is standard practice, soft start procedures will be implemented, as identified in the Western Australia Fisheries Publication No, 112, 2013 Guidance statement on undertaking seismic surveys in WA waters. - Development of communication and interaction protocols with Fisheries licence holders. With sufficient prior notice of approx. 24 hours, areas for the survey may be changed to minimise impact on active fishing within the operational area - Fishing from the survey and support vessels is prohibited and will be a condition of the contract. WAFIC endorsed Shell Australia to consult with individual, relevant fishers for the activity.	Shell responded to WAFIC objections and claims on 25-Feb-2019 (see below): Shell will provide WAFIC with updated consultation information, including maps and distances to the mainland as requested.
				Can Shell also address cumulative impacts – WAFIC seek a review of all past seismic surveys which have taken place over part or all of this proposed survey area for the past 10 years. Please note survey date, duration, strength. Cumulative impacts are a significant issue for the commercial fishing sector. Perception of multiple surveys is also an issue Shell also need to address broader environmental plan related comments: - Shell to note that a 'no reply' from a commercial fishing licence holder does not indicate a lack of interest in the seismic survey and drilling activity or lack of impact on the commercial licence holders commercial fishing activity and resource. It does not represent an 'unspoken agreeance' to Shell's proposed activities. Stakeholder fatigue and the overall pressure to commercial fishing does not provide the ideal environment to respond to multiple, often concurrent, oil and gas consultations. - Face to face consultation should be an integral part of Shell's engagement strategy including regional areas - Shell to allow for an appropriate timeframe to competently complete engagement with the commercial fishing sector taking into account that fishers are often away from port for days and weeks. Please allow for 8 weeks minimum from dissemination of EP consultation information and appropriate letter/email/phone/meeting follow-up as required. What is Shell's and contractors and subcontractors policy in relation to 'no fishing from support/commercial vessels'? - Commercial fishing industry expect zero recreational fishing from any support or - O&G commercial vessel due to impact on safety and resource - Can shell confirm that no fishing from support/commercial vessels' policy is abided by all operator/title holder level and also strictly enforced and communicated with contractors/subcontractors - What is the communication strategy to deliver this requirement to all staff, contractors and sub-contractors - What is Shell's audit/compliance policy/process regarding recreational fishing on support/commercial vessel, do you have a ruling which prohibits bringing any recreational fishing gear on to any vessel. What is Shell's communication policy with all staff and vessel crew, contractors and sub-contractors regarding interacting and protecting the rights of active commercial fishers on the water: - All support vessels outside the range of the seismic activity must divert around active commercial fishing activity - All support vessels are to avoid any close and or disruptive engagement with any commercial fishing activity - All support vessels in the vicinity of a commercial fishing vessel to do their utmost not to create an ocean disturbance risking the split of schooling fish etc.			

				Commercial fisheries overlapping part or all of the proposed drilling and seismic survey site which are potentially active in this area include: - Northern demersal scalefish managed fishery (area 2) - Mackerel (area 1) - Joint Authority shark fishery - Western tuna and billfish - North west slope trawl (commonwealth managed, hard to see from the map provided if it overlaps, please check the most recent information regarding boundaries here https://www.legislation.gov.au/Details/C2017G00026, this fishery starts at the 200 m water depth line. Commercial fisheries overlapping part or all of the proposed Shell drilling and seismic survey site which are not active in this area (and therefore do not require consultation) but must be addressed regarding impact on spawning and key indicator species include: - West coast deep sea crustacean managed fishery - Pearl oyster managed fishery (requires direct consultation for all activities via the Pearl Producers Association) - Marine aquarium fish managed fishery - Specimen shell managed fishery - WA north coast shark fishery (Northern Zone) a closed fishery) - Southern blue fin tun (commonwealth managed) – migration route - Western skip jack tuna (commonwealth managed) – inactive fishery WAFIC conclude the letter by stating when they are available to meet to discuss further. A follow up email from WAFIC to Shell confirmed their attendance for the workshop and asked for the following items to be addressed as part of the agenda: - Discussion regarding impacts on the fishery/fishers and a process for a 'make good' arrangement. This would need to be part of the EP. WAFIC provided an email that details the funding they have received to establish a seismic research portal/web site and to identify any research gaps relating to commercial fishing and seismic activity			
	Email	28-Nov-2018	29-Nov-18	WAFIC advised Shell of a suitable time and requested Shell advise WAFIC of the agenda in advance of the meeting. WAFIC also requested the agenda include discussion regarding impacts on the fishery / fishers and a process for a "make good" arrangement, and stated that this will need to be part of the formal environment plan.	-	-	-
	Email	N/A	13-Dec-18	WAFIC contacted Shell seeking assistance and support. The Western Australian Fishing Industry Council (WAFIC) has secured funding from the Fisheries Research Development Corporation (FRDC) for a three year project part of which covers the following: A Seismic Research Portal / web site · A publicly accessible portal – to be housed on the FRDC website (http://www.frdc.com.au/) · Seismic focussed a "one stop shop" for research papers etc covering commercial fishing activities / commercial fishing resource and offshore O&G seismic surveys etc · Australian papers · International papers · Where possible, peer reviewed · Need to ensure relevance for ready and easy access by the commercial fishing sector, O&G and the broader community Research Gaps · Commercial fishing activities / commercial fishing resource and offshore seismic research gap analysis · Prioritisation of research gaps · Deliver a set number of supported research applications relevant to the potential effects of oil and gas offshore seismic activities on commercial fishing / commercial fishing stocks etc · As "science gaps" become evident refer the information back to the FRDC in "real time" – not at the end of the project – for FRDC consideration and potential allocation to fill the gap sooner rather than later. Seeking your support with the following please: · Please send me (attachments / links etc) applicable papers to meet the above · Specific research papers with the key focus being on oil and gas offshore seismic activities and the potential impacts on commercial fishing / commercial fishing stocks etc · Please also send other papers which may not be a perfect match but which you believe can still contribute to the library · If you have already identified research gaps – please advise so they can be incorporated into the project Please feel free to on-send this to your global colleagues, the aim is to get this site up and publicly accessible sooner rather than later. Please also do not hesitate to contact if you need any additional information.	-	-	-

Meeting	14-Dec-2019		Meeting with WAFIC Factory 3D Seismic survey and Bratwurst well Friday 14th December 2018 - WAFIC office, Fremantle Attendees: Shell Environmental advisor GeoscientistGovernment Relations Advisor WAFIC Chief Executive Officer Executive Officer, Oil and Gas Shell outlined the agenda: Background on Bratwurst well Background on Seismic Survey Discussion on WAFIC feedback of 7 November Next Steps Shell thanked WAFIC for their time and welcomed discussing the proposed survey and working together. Bratwurst Shell provided summary of activity as per correspondence WAFIC indicated that drilling wells was standard business and WAFIC and the fishing licence holders were not focussed on this activity but the focus is on seismic. Requested that when Bratwurst well was caped that Shell look at seeking a cautionary zone in the area rather than an exclusion zone and the impact on fishing licence holders was greater. Shell committed to looking at this. Factory 3D Seismic Shell provided a list of commercial fisheries which Shell understands overlap the factory operational area and are potentially active. Shell outlined that it's understanding is that the only active fisheries currently in the area is the Northern Demersal Scalefish Fishery. WAFIC said that could be right but they haven't done a recent analysis. This is something for Shell to determine WAFIC agreed to the list of no active fisheries. Shell talked through each of the issues raised by WAFIC in its email of 7 November. No fishing Policy - Shell indicated it is imposing a ban on fishing on all vessels during the Bratwurst and Seismic campaigns. This includes all vessels supporting the activities.	WAFIC reiterated the objections and claims in their email of 7 November. THe meeting was structure to talk through the issues. Those initial objections were: WAFIC objected to the consultation materials that had been provided to fisheries licence holders: Maps were not provided with adequate distances and context of the mainland was insufficient. WAFIC objected to the risks and mitigations that they were not specific or relevant to commercial fisheries activities. WAFIC objected to the survey timing without Shell providing a full ALARP Assessment WAFIC objected to the consultation received stating that it was barely different to the correspondence sent on the 5th November. WAFIC claim that Shell should consider 'make good' fishery compensation model to fisher impacted by the survey.	Shell undertook one-on-one consultation with licence holders as recommended by WAFIC. The consultation communications can be found in Appendix D - Shell considered the requirement for "make good" compensation but determined that controls could be put in place to reduce risk to ALARP and acceptable levels therefore compensation was not required. - Shell added a number of additional control measures to survey following consultation with WAFIC and to address the issues and concerns they raised regarding potential impacts to commercial fishing activity and impacts on spawning. These controls are: - Reduce the window of time for validity of the EP from 2 years to 6 months. EP validity will now be from July to December 2019 [see below for additional survey timing information] - No seismic acquisition will occur in the immediate vicinity (within 5 km) of Heywood Shoals during the month of October which is a key spawning time; the survey will operate in the areas which are further away from Heywood Shoals during this period. - No operation of the full acoustic source will be in water depths shallower than 70 m to minimise noise impacts in shallow areas such as Heywood Shoals. - Environmental performance and compliance will be monitored and assured by Shell site representatives for environmental health and safety. - As is standard practice, soft start procedures will be implemented, as identified in the Western Australia Fisheries Publication No, 112, 2013 Guidance statement on undertaking seismic surveys in WA waters. - Development of communication and interaction protocols with Fisheries licence holders. With sufficient prior notice of approx. 24 hours, areas for the survey may be changed to minimise impact on active fishing within the operational area - Fishing from the survey and support vessels is prohibited and will be a condition of the contract. WAFIC endorsed Shell Australia to consult with individual, relevant fishers for the activity.	Shell responded to WAFIC objections and claims on 25-Feb-2019 (see below): Shell will provide WAFIC with updated consultation information, including maps and distances to the mainland as requested.
Email	N/A	31-Jan-19	Further to the letter sent to stakeholders by Shell on 8th January 2019 (attached above) and WAFIC's original reply to Shell of 7th November 2018 (including your corro of 5th November 2019). WAFIC also met with Shell at WAFIC on Friday 14th December to discuss this survey and the feedback WAFIC had previously provided. Shell email comment regarding the meeting was that "It was a very valuable meeting and has given us good insights into the issues the fishing industry experience with seismic surveys". WAFIC was of the opinion that at the meeting Shell representatives made it clear to WAFIC that Shell was very receptive to the issues commercial fishers faced, that Shell was a company of good intent and reputation, that Shell wanted to do the right thing regarding this survey and engagement, that Shell was receptive to a formal "make good" process – my key takeaway was that the issues raised by WAFIC on behalf of commercial fishers would be addressed via revised, targeted, issues highlighted, commercial fisher focused correspondence. Did WAFIC get this so wrong? WAFIC Notes the correspondence of 8th January 2019 addressed to "To Whom it may Concern" was sent to WAFIC by Westmore Seafoods (North West Slope Trawl fishery). I have also been copied into correspondence sent to Shell by Old Brown Dog Fishing Company (Northern Demersal Scalefish Fishery Area 2) and Northern Wildcatch Seafood Australia (Northern Demersal Scalefish Fishery Area 2) - both attached above – replying to the Shell letter of 8th January 2019. WAFIC note the following: · Your correspondence sent on 8th January 2019 was barely any different to your earlier version albeit with reference to a fishery by name and a potential risk being "fisheries". · The only reference to commercial fishing was "Disruption of commercial or recreational fishing mitigated by Notice to Mariners on onboard radar etc technologies, buoys and chase vessels. How does these mitigation strategies assist commercial fishers? How can you justify what appears to be a "coming through ready or not" approach without identifying where fishers fish, how you will avoid key fishing areas and how you will completely avoid peak spawning for key indicator species? If you cannot mitigate against physical commercial fishing disruptions and impacts on the commercial fishing resource, do you expect the commercial fishing sector to take full responsibility for the losses they will incur as a result of this activity? · Note in your letter and also advised by WAFIC that you offered to meet personally with key stakeholders. Our time is valuable, there needs to be a reason for a meeting. There is no point in having a meeting for Shell to ask a significant commercial fishing operator if they have any issues with this survey. Not our job. It is your job to identify the issues (I gave you a significant heads up on that) and mitigate these issues to ALARP level. Then we are ready to sit down and talk, especially if a workable "window of opportunity" cannot be lined up and especially if the next phase of this consultation leads into a need for a make good process. · Shell letter noted that Hell would consult with "those who may be impacted by its activities ('relevant persons') to ensure they have received sufficient information and been given a reasonable period to raise any claims or objections". Considering this activity is in the far north roughly 200 kilometres from the coast – besides the commercial fishing sector, what other relevant persons who may be impacted by this activity are there? Recreational fishers certainly do not go that far out, perhaps a marine tourism / charter operator – but really way out there and not targeting the Kimberley coast? Specifically, the commercial fishing sector is your only relevant person who may be impacted by this activity. WAFIC note again from their email of 7th November that: · There is zero reference to how Shell will mitigate any risks to commercial fishing activities either by avoiding any peak fishing activity or avoiding peak spawning of key indicator species etc. · Timing of the proposed seismic survey must be at the best possible ALARP time taking into account commercial fishing activity, spawning periods and other environmental considerations. · It is unacceptable for Shell to propose survey times (May to December 2019 or in 2020) without a full ALARP assessment of risks	WAFIC objected to the consultation materials that had been provided to fisheries licence holders: Maps were not provided with adequate distances and context of the mainland was insufficient. WAFIC objected to the risks and mitigations that they were not specific or relevant to commercial fisheries activities. WAFIC objected to the survey timing without Shell providing a full ALARP Assessment WAFIC objected to the consultation received stating that it was barely different to the correspondence sent on the 5th November. WAFIC claim that Shell should consider 'make good' fishery compensation model to fisher impacted by the survey.	As above: - Shell attempted to undertake one-on-one consultation with licence holders as recommended by WAFIC. The consultation communications can be found in Appendix D. - Shell considered the requirement for "make good" compensation but determined that controls could be put in place to reduce risk to ALARP and acceptable levels therefore compensation was not required. - Shell added a number of additional control measures to survey following consultation with WAFIC and to address the issues and concerns they raised regarding potential impacts to commercial fishing activity and impacts on spawning. These controls are: - Reduce the window of time for validity of the EP from 2 years to 6 months. EP validity will now be from July to December 2019 [see below for additional survey timing information] - No seismic acquisition will occur in the immediate vicinity (within 5 km) of Heywood Shoals during the month of October which is a key spawning time; the survey will operate in the areas which are further away from Heywood Shoals during this period. - No operation of the full acoustic source will be in water depths shallower than 70 m to minimise noise impacts in shallow areas such as Heywood Shoals. - Environmental performance and compliance will be monitored and assured by Shell site representatives for environmental health and safety. - As is standard practice, soft start procedures will be implemented, as identified in the Western Australia Fisheries Publication No, 112, 2013 Guidance statement on undertaking seismic surveys in WA waters. - Development of communication and interaction protocols with Fisheries licence holders. With sufficient prior notice of approx. 24 hours, areas for the survey may be changed to minimise impact on active fishing within the operational area - Fishing from the survey and support vessels is prohibited and will be a condition of the contract.	Shell responded to WAFIC objections and claims on 25-Feb-2019 (see below): Shell will provide WAFIC with updated consultation information, including maps and distances to the mainland as requested.
Email	1-Feb-2019	n/a	No response received	-	-	-
Email	21-Feb-2019	n/a	No response received	-	-	-
Email	25-Feb-2019	n/a	No response received	-	-	-
		n/a	No response received	-	-	-
Email	12-Mar-2019	n/a	No response received	-	-	-

	Email	12-Jun-2019	8-Jul-2019	I have Bcc'd the two key parties in this fishery. WAFIC is responding below but as always, 100% defers to licence holder view. Note Shell is proposing a survey duration of up to 73 days, with approximately 44 days of acquisition with EP validity proposed to the end of September 2020. I have addressed points raised by Shell in the email of 12th June – where the issue is at and suggested next steps. Peak Spawning – Key Indicator Species Your email of 12th June •Discuss our commitment to no acquisition in October and March and understand any impacts of the proposed operational windows Please find attached above the revised fish spawning information sent recently from DPIRD (Fisheries). This is the most up-to-date fish spawning information from DPIRD, dated May 2019. Goldband Snapper - Kimberley: Nov-May (extended peak spawning period) Red Emperor - Sept-June (with bimodal peaks from Sept-Nov and Jan-Mar) Peak spawning is not just October and March. Based on spawning information alone, Shell's suggestion in the email of 12th June to specifically exclude October and March from the EP and conduct a single acquisition operation between November 2019 to February 2020 or between April 2020 to end September 2020 is unworkable. November to February – peak spawning in all months for Goldband Snapper and peak spawning for Red Emperor including a bimodal peak October/November and Jan to March. April to September – April and May peak spawning for Goldband Snapper and bimodal peak in September for Red Emperor. Commercial fishers consistency provide feedback regarding the impact to spawning (this is a global issue and concern). In addition, DPIRD (Fisheries) also do not support seismic activities during peak spawning – potential impacts and concerns. DPIRD is the custodian / owner / benefactor / key research facility for Western Australian state-managed fisheries. Any 3D seismic surveys conducted during these times are not to an ALARP level from a commercial fishing perspective and come at a cost to the environment, to the sustainability of this closely managed fishery – impacts to future prospectivity. Next Steps: •Shell to acknowledge the most recent spawning data received from DPIRD. •Shell to advise (noting the above points especially if you don't already have this information), how you will work the current spawning information into the EP. Survey Timing Your email of 12th June •Discuss how best to work together during the proposed windows to mitigate impacts on your commercial activity •Discuss our plan to be flexible in acquisition of the survey to accommodate commercial fishing activities contingent on clear two-way communication	New key species fish spawning data provided to consider in the impact assessment (data is from DPIRD) Consider FishCube data to look at fishing catch and vessels over a monthly basis and consider this along with the new key spawning information to consider the best timing to carry out the survey. The NDSF is impacted by seismic surveys every single year. This impact is untenable and debilitating. This survey has a considerable and major impact. Consider cummulative impacts from other siesmic surveys across the entire NDSF, not just within the OA. Consider a framework for compensation	The information provided by DPIRD reflects the latest and best information provided. Shell's prediction of impact (see attached EP Extract) to the fishery is short term and localised based on the attached impact assessment. Therefore, there is no effect on a cumulative basis over 10 years. Shell sees merits in establishing a compensation framework in the circumstances surrounding this activity.	Shell has updated the EP and provides the updated relevant content for you. In summary, Shell considers that it is not feasible to completely avoid the extended peak spawning months for these species whilst balancing other environmental priorities for protection such as direct effects to the NDSF (see impact matrix below). We are proposing to maintain exclusion zones in October and March as previously committed to. Shell recognises that the Factory survey will overlap some of the new extended peak spawning. Shell will address how plankton, including fish plankton, is predicted to be impacted in the EP. Shell's prediction of impact to the fishery is short term and localised based on the attached impact assessment. Therefore, there is no effect on a cumulative basis over 10 years. Shell sought view on some principles of a draft compensation protocol.
	Letter	29-Jun-2019	n/a		-	-	-
	email	1-Aug-2019	1-Aug-2019	WAFIC have had a quick review of you're the information provided by Shell and seek further clarity before taking next steps, The consultation, proposed mitigations and fishery analysis has been inadequate to date. Table 6-1 Table 6-1 copied below notes the percentage of the fishery overlapping the operational area. This information is inaccurate, irrelevant and misleading and a misuse of information. It is not the size of the fishery that counts, it is WHERE they fish that is relevant to any EP engagement. Compensation WAFIC's view of the principals proposed in the NERA protocol is one thing (which also has to be reviewed by licence holders), you note that Shell is supportive of reducing the consultation burden, however, I cannot find anywhere in your correspondence whereby Shell agrees to a compensation process in any form with potential affected parties with Shell's 3D survey ie Northern Demersal Scalefish commercial fishers. You have provided an ambiguous response without clarifying that Shell has agreed to compensation to affected parties. Please confirm Shell's commitment to a compensation assessment with affected parties to the Shell Factory 3D seismic survey. Regarding the NERA proposal – this is early days. Cumulative Impacts Shell notes no cumulative impacts – we disagree. There are more surveys coming, recent surveys have just finished, over the same fishery. Even if previous and future surveys do not overlap the Shell Factory survey, when different surveys overlap the same fishery (ie Northern Demersal Scalefish) this is when you need to assess the cumulative impacts. I will cross-check other information provided when I have the time.	Use of percentage overlap with the fishery is not accurate and misrepresents the infromation. There will be cummulative impacts associated with the NDSF when considering the whole fishery.	The percentage overlap information provided within the EP is provided for context only. It is accurate and further information is provided such as "From 2007 to 2018 fishing effort[1] (based on both fishing days and catch weight) within the OA has accounted for ~9% of the total fishing effort within the NDSF and the area where behavioural impacts may occur, up to 45 km from the FPZ, accounts for ~20% of the total fishing effort within the NDSF" which analyses the fishery and how it overlays the proposed survey area. There	Further to our conversation on Monday: •Table 6-1 has been moved to a different section of the EP and is therefore not associated with the impact assessment. I also confirm that the following text is included in the EP with FishCube analysis to quantitatively address the impact on the Fisheries. o"From 2007 to 2018 fishing effort[1] (based on both fishing days and catch weight) within the OA has accounted for ~9% of the total fishing effort within the NDSF and the area where behavioural impacts may occur, up to 45 km from the FPZ, accounts for ~20% of the total fishing effort within the NDSF." •We are finalizing internal Shell approval to propose compensation framework; I hope to have mandate next week to proceed with negotiations.
	Email	7-Aug-2019	N/a	-	-	-	-
Finder No 11 Pty Ltd - AC/P45	email	2-Jul-2019	2-Jul-2019	Aaron Bond (Finder Energy) requested the shapefiles of the survey	-	-	-
	email	3-Jul-2019	n/a	No response received			
	email	3-Jul-2019	3-Jul-2019	Y thanked Shell for providing the shapefiles			
Carnarvon Petroleum Limited - AC/P62	email	2-Jul-2019	n/a	No response received	-	-	-
Mitsui E&P Australia Pty Ltd; Murphy Australia AC/P59 Oil Pty Ltd - AC/P59	email	2-Jul-2019	n/a	No response received	-	-	-
Mitsui E&P Australia Pty Ltd; Shell Australia Pty Ltd - AC/P41	email	2-Jul-2019	n/a	No response received	-	-	-
Osaka Gas Crux Pty Ltd; SGH Energy WA Pty Ltd; Shell Australia Pty Ltd AC/RL9	email	2-Jul-2019	n/a	No response received	-	-	-
INPEX Browse E&P Pty Ltd; Murphy Australia Oil Pty Ltd AC/P36	email	2-Jul-2019	n/a	No response received	-	-	-
INPEX Browse E&P Pty Ltd; Total E&P Australia Exploration Pty Ltd WA-343-P	email	2-Jul-2019	n/a	No response received	-	-	-
IPB West Pty Ltd WA-485-P	email	2-Jul-2019	n/a	No response received	-	-	-
SGH Energy WA377P Pty Ltd - WA-377-P	email	2-Jul-2019	3-Jul-2019	Email response sent requesting Shell to provide a map or shapefile containing boundary coordinates showing the location of the OA in relation to the WA-377-P title	-	-	-
IPB Browse Pty Ltd WA-471-P	email	2-Jul-2019	n/a	No response received	-	-	-
IPB West Pty Ltd WA-485-P	email	2-Jul-2019	n/a	No response received	-	-	-

Auralandia Pty Ltd; Coldron Pty Ltd; Cornea Oil & Gas Pty Ltd; Cornea Petroleum Pty Ltd; Cornea Resources Pty Ltd; Enegex NL;Moby Oil & Gas Limited; Octanex Cornea pty Ltd; Octanex limited WA-54-R	email	2-Jul-2019	n/a	No response received	-	-	-

			Relevant Environmental Impacts and Risks														
	Legislative and Other Requirements [Regulation 13(4)a]		Planned Events							Unplanned Events							[Regulation 13(4)b]
ID	Type	Requirement	Physical Presence	Discharges of deck and bilge water	Discharges of treated sewage, grey-water and putrescible waste	Light Emissions	Atmospheric Emissions	Acoustic Emissions (Seismic)	Acoustic Emissions (Non-seismic)	Invasive Marine Species	Unplanned Seabed Distrurbance	Unplanned loss of solid waste or dropped objects	Unplanned loss of survey equipment	Unplanned loss of chemicals or hazardous liquid waste	Unplanned collisions (marine species)	Unplanned hydrocarbon release	How will this be met?
1	Conservation Advice	Conservation advice on fin whale (*Balaenoptera physalus* ; October 2015)(DoE 2015d)						✓							✓		Through consideration in the impact assessment and assurance that the objectives of the document can be met (see relevant EP section)
2	Conservation Advice	Conservation advice on humpback whale (*Megaptera novaeangliae*) (October 2015) (DoE 2015b)						✓							✓		Through consideration in the impact assessment and assurance that the objectives of the document can be met (see relevant EP section)
3	Conservation Advice	Conservation advice on sei whale (*Balaenoptera borealis* ; October 2015)(DoE 2015c)						✓							✓		Through consideration in the impact assessment and assurance that the objectives of the document can be met (see relevant EP section)
4	Conservation Advice	Conservation advice on leatherback turtle (*Dermochelys coriacea* ; DEWHA 2009a)				✓		✓							✓		Through consideration in the impact assessment and assurance that the objectives of the document can be met (see relevant EP section)
5	Conservation Advice	Conservation advice on short-nosed sea snake (*Aipysurus apraefrontalis* ; DSEWPaC 2010a)				✓		✓									Through consideration in the impact assessment and assurance that the objectives of the document can be met (see relevant EP section)
6	Conservation Advice	Conservation advice on leaf-scaled sea snake (*Aipysurus foliosquama* ; DSEWPaC 2010b).				✓		✓									Through consideration in the impact assessment and assurance that the objectives of the document can be met (see relevant EP section)
7	Conservation Advice	Conservation advice on whale shark (*Rhincodon typus* ; October 2015)(DoE 2015l)						✓						✓	✓		Through consideration in the impact assessment and assurance that the objectives of the document can be met (see relevant EP section)
8	Conservation Advice	Conservation advice on speartooth shark (*Glyphis glyphis* ; April 2014; DoE 2014c),														✓	This species is not expected to transit the OA, but may occur in discrete locations within the EMBA. Through consideration in the impact assessment and assurance that the objectives of the document can be met (see relevant EP section)
9	Conservation Advice	Conservation advice on northern river shark (*Glyphis garricki* ; April 2014; DoE 2014d),														✓	This species is not expected to transit the OA, but may occur in discrete locations within the EMBA. Through consideration in the impact assessment and assurance that the objectives of the document can be met (see relevant EP section)
10	Conservation Advice	Conservation advice on dwarf sawfish (*Pristis clavata* ; October 2009)(DEWHA 2009b),														✓	This species is not expected to transit the OA, but may occur in discrete locations within the EMBA. Through consideration in the impact assessment and assurance that the objectives of the document can be met (see relevant EP section)
11	Conservation Advice	Conservation advice on green sawfish (*Pristis zijsron* ; 2008; DEWHA 2008b)														✓	This species is not expected to transit the OA, but may occur in discrete locations within the EMBA. Through consideration in the impact assessment and assurance that the objectives of the document can be met (see relevant EP section)
12	Conservation Advice	Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015e)												✓		✓	Through consideration in the impact assessment and assurance that the objectives of the document can be met (see relevant EP section)
13	Conservation Advice	Conservation advice on Australian lesser noddy (*Anous tenuirostris melanops* ; October 2015)(DoE 2015j)														✓	Through consideration in the impact assessment and assurance that the objectives of the document can be met (see relevant EP section)
14	Conservation Advice	Conservation advice on red knot (*Calidris canutus* ; May 2016; DoE 2016a)												✓		✓	Through consideration in the impact assessment and assurance that the objectives of the document can be met (see relevant EP section)
15	EBPC Policy	EPBC Act Policy Statement 2.1 - Interaction between offshore seismic activities and whales (2008)						✓							✓		Through the performance required of the MFOs and project vessels
16	EBPC Policy	Australian National Guidelines for Whale and Dolphin Watching 2017							✓						✓		Through the performance required of the project vessels
17	Guidance	Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (NOAA 2018)							✓								Through the performance required of the MFOs and project vessels
18	Guidelines	Australian Government National Biofouling Management Guidance for the Petroleum Production and Exploration Industry								✓							Through the marine assurance system and IMS procedure control measures
19	International Standard	The International Convention for the Prevention of Pollution from Ships 1973, as modified by the Protocol of 1978 (MARPOL 73/78)		✓	✓		✓									✓	Through the marine assurance system control measure, and consultation with AMSA and AHS
20	International Standard	The Convention on Wetlands of International Importance (Ramsar 1975)				✓		✓								✓	Through endorsement of the Environment Regulations under Part 10 of the EBPC Act
21	International Standard	The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979						✓							✓		Through endorsement of the Environment Regulations under Part 10 of the EBPC Act
22	International Standard	The International Convention on Oil Pollution Preparedness, Response and Co-operation 1990 (OPRC 90)														✓	Through the marine assurance system control measure and adoption of control measures for oil spill response
23	International Standard	International Convention for the Safety of Life at Sea (SOLAS)	✓													✓	Through the marine assurance system control measure
24	International Standard	The Protocol to International Convention on the Prevention of Marine Pollution by Dumping of Waste and Other Matter 1972 (London Dumping Convention)										✓					Through the marine assurance system control measure
25	International Standard	The Convention for the Control of Trans-Boundary Movements of Hazardous Wastes and their Disposal 1989 (Basel Convention)								✓				✓			Through the marine assurance system control measure
26	International Standard	The Japan Australia Migratory Birds Agreement (JAMBA)				✓											Through the marine assurance system control measure
27	International Standard	The Republic of Korea Migratory Birds Agreement (ROKEMBA)				✓											Through the marine assurance system control measure
28	International Standard	The China Australia Migratory Birds Agreement (CAMBA)				✓											Through the marine assurance system control measure
29	International Standard	United Nations Framework Convention on Climate Change					✓										Through the marine assurance system control measure
30	International Standard	International Convention for the Control and Management of Ship's Ballast Water and Sediments 2004								✓							Through the marine assurance system and IMS procedure control measures
31	International Standard	Recommended monitoring and mitgation measures for cetaceans during marine seismic survey geophysical operations (Report 579 IAGC & IOGP 2017)						✓									Through the performance required of the MFOs and project vessels
32	Legislation	Marine Order 21(Safety of Navigational and Emergency Procedures)				✓										✓	Through the marine assurance system control measure
33	Legislation	Marine Order 30 (Prevention of Collisions; as appropriate to vessel class)	✓													✓	Through the marine assurance system control measure
34	Legislation	Marine Order 70 (Seafarer certification)	✓													✓	Through the marine assurance system control measure
35	Legislation	Marine Order 71 (Masters and deck officers)	✓													✓	Through the marine assurance system control measure
36	Legislation	Marine Order 72 (Engineer officers)														✓	Through the marine assurance system control measure
37	Legislation	Marine Order 91 (Marine pollution prevention - oil)		✓												✓	Through the marine assurance system control measure
38	Legislation	Marine Order 95 (Marine pollution prevention - garbage)										✓		✓			Through the marine assurance system control measure
39	Legislation	Marine Order 96 (Marine pollution prevention - sewage)		✓	✓												Through the marine assurance system control measure
40	Legislation	Marine Order 97 (Marine pollution prevention - air pollution					✓										Through the marine assurance system control measure
41	Legislation	Marine Order 98 (Marine pollution prevention - antifouling systems)								✓							Through the marine assurance system control measure
42	Legislation	EPBC Regulations 2000 – Part 8, Division 8.1.							✓						✓		Precautionary zones and adaptive management procedures, inductions and reporting
43	Legislation	Biosecurity Act 2015								✓							Through the IMS risk assessment control measure
44	Legislation	Biosecurity Regulations (e.g. Australian ballast water management requirements)								✓							Through the IMS risk assessment control measure

	Legislative and Other Requirements [Regulation 13(4)a]		Planned Events							Unplanned Events							[Regulation 13(4)b]
ID	Type	Requirement	Physical Presence	Discharges of deck and bilge water	Discharges of treated sewage, grey-water and putrescible waste	Light Emissions	Atmospheric Emissions	Acoustic Emissions (Seismic)	Acoustic Emissions (Non-seismic)	Invasive Marine Species	Unplanned Seabed Distrurbance	Unplanned loss of solid waste or dropped objects	Unplanned loss of survey equipment	Unplanned loss of chemicals or hazardous liquid waste	Unplanned collisions (marine species)	Unplanned hydrocarbon release	How will this be met?
45	Legislation	Offshore Petroleum and Greenhouse Gas Storage Act 2006 (OPGGS Act)	✓													✓	Through demonstration of financial assurance and adoption of a compensation control measure
46	Legislation	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Through acceptance of the EP
47	Legislation	Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations 2009	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	These are met through an accepted safety case
48	Legislation	Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Through endorsement of the Environment Regulations under Part 10 of the EBPC Act
49	Legislation	Environment Protection and Biodiversity Conservation Regulations 2000 (EPBC Regulations)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Through endorsement of the Environment Regulations under Part 10 of the EBPC Act
50	Legislation	Environment Protection (Sea Dumping) Act 1981	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	There is no planned dumping of waste material as apart of this activity
51	Legislation	Protection of the Sea (Prevention of Pollution from Ships) Act 1983		✓	✓		✓									✓	Through the marine assurance system control measure
52	Legislation	Australian Maritime Safety Authority Act 1990														✓	Through the marine assurance system control measure, and consultation with AMSA and AHS
53	Legislation	Navigation Act 2012	✓													✓	Through the marine assurance system control measure, and consultation with AMSA and AHS
54	Legislation	Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS)	✓													✓	Through the marine assurance system control measure
55	Legislation	EPBC Regulations (8.07) helicopters (including gyrocopters)							✓								Through the performance required of the MFOs and project vessels
56	National Standard	National Biofouling Management Guidance for the Petroleum Production and Exploration Industry 2009								✓							Through the IMS risk assessment control measure
57	National Standard	Australian Quarantine and Inspection Service Australian Ballast Water Management Requirements.								✓							Through the IMS risk assessment control measure
58	National Standard	AS/NZS ISO 31000:2018 Risk management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Consistency with the assessment processes in the EP
59	National Standard	AS/NZS ISO HB 203:2012 Managing environment related risk	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Consistency with the assessment processes in the EP
60	National Standard	AS/NZS 4360:2004 Risk management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Consistency with the assessment processes in the EP
61	National Standard	Australian Ballast Water Management Requirements 2016								✓							Through the marine assurance system and IMS procedure control measures
62	National Standard	Approved Criteria for Classifying Hazardous Substances [NOHSC: 1008 (2004)]												✓			Through the marine assurance system control measure
63	National Standard	National Plan for Maritime Environmental Emergencies														✓	Through the implementation strategy and OPEP/SOPEPs
64	National Standard	APPEA Code of Environmental Practice						✓									Through the performance required of the MFOs and project vessels
65	North West Australina Marine Park Management Plan	Ashmore Reef: Strict nature reserve (IUCN category Ia) Managed to conserve ecosystems, habitats and native species in as natural and undisturbed a state as possible. The zone allows only authorised scientific research and monitoring.						✓								✓	Through consideration in the impact assessment and assurance that the objectives of the document can be met (see relevant EP section)
66	North West Australina Marine Park Management Plan	Kimberley: Multiple Use Zone/Managed resource protected area (IUCN category VI) Managed to allow ecologically sustainable use while conserving ecosystems, habitats and native species. The zone allows for a range of sustainable uses, including commercial fishing and mining where they are consistent with park values.														✓	Through consideration in the impact assessment and assurance that the objectives of the document can be met (see relevant EP section)
67	North West Australina Marine Park Management Plan	Cartier Island: Strict nature reserve (IUCN category Ia) Managed to conserve ecosystems, habitats and native species in as natural and undisturbed a state as possible. The zone allows only authorised scientific research and monitoring.				✓		✓						✓		✓	Through consideration in the impact assessment and assurance that the objectives of the document can be met (see relevant EP section)
68	Recovery Plan	Conservation management plan for the blue whale; A recovery plan under the *Environment Protection and Biodiversity Conservation Act 1999* 2015-2025 (October 2015; DoE 2015a)						✓							✓		Through consideration in the impact assessment and assurance that the objectives of the document can be met (see relevant EP section)
69	Recovery Plan	Recovery plan for marine turtles in Australia 2017-2027 (June 2017; Commonwealth of Australia 2017a)				✓		✓							✓		Through consideration in the impact assessment and assurance that the objectives of the document can be met (see relevant EP section)
70	Recovery Plan	Whale shark (*Rhincodon typus*) Recovery Plan 2005 - 2010 (2005; May 2005)(Department of Environment and Heritage (DEH) 2005a)						✓							✓		Through consideration in the impact assessment and assurance that the objectives of the document can be met (see relevant EP section)
71	Recovery Plan	Recovery Plan for the White Shark (Carcharodon carcharias; August 2013)(DSEWPaC 2013b)												✓		✓	Through consideration in the impact assessment and assurance that the objectives of the document can be met (see relevant EP section)
72	Recovery Plan	Sawfish and River Sharks Multispecies Recovery Plan (November 2015)(DoE 2015m)														✓	This species is not expected to transit the OA, but may occur in discrete locations within the EMBA. Through consideration in the impact assessment and assurance that the objectives of the document can be met (see relevant EP section)

					Relevant Environmental Impacts and Risks																
	Defined Acceptable Levels of Impact				Planned Events							Unplanned Events								Environmental Performance	
Item	Value/Sensitivity	Acceptable Level Statement	Environmental Features in the EMBA	Acceptable Level of Impact to the Value/Sensitivity	Physical Presence	Discharges of deck and bilge water	Discharges of treated sewage, grey-water and putrescible waste	Light Emissions	Atmospheric Emissions	Acoustic Emissions (Seismic)	Acoustic Emissions (Non-seismic)	Invasive Marine Species	Unplanned Seabed Disturbance	Unplanned loss of solid waste or dropped objects	Unplanned loss of survey equipment	Unplanned loss of chemicals or hazardous liquid waste	Unplanned collisions (marine species)	Unplanned hydrocarbon release	Environmental Performance Outcomes (EPO)	Measurement Criteria (MC)
1	Key Ecological Features	No increase in status of the regional pressures as a direct result of the planned activity.	Ancient Coastline	No increased acidification	×	×	×	×	×	×	×	×	×	×	×	×	×	×	Not required	
			Continental Slope Demersal Fish Communities	No changes in sea temperatures	×	×	×	×	×	×	×	×	×	×	×	×	×	×	Not required	
				No increased acidification	×	×	×	×	×	×	×	×	×	×	×	×	×	×	Not required	
				No physical habitat modification	×	×	×	×	×	×	×	×	✓	✓	×	×	×	✓	No physical modification to the Continental Slope Demersal Fish Communities	Daily reports show no anchoring occurred or objects lost overboard.
				No bycatch	×	×	×	×	×	×	×	×	×	×	×	×	×	×	Not required	
			Ashmore Reef and Cartier Island and Surrounding Commonwealth Waters	No sea level rise	×	×	×	×	×	×	×	×	×	×	×	×	×	×	Not required	
				No changes in sea temperatures	×	×	×	×	×	×	×	×	×	×	×	×	×	×	Not required	
				No increased acidification	×	×	×	×	×	×	×	×	×	×	×	×	×	×	Not required	
				No marine debris	×	×	×	×	×	×	×	×	×	✓	✓	×	×	×	No planned disposal of garbage at sea.	Garbage records show receipt of garbage in port.
				No physical habitat modification	×	×	×	×	×	×	×	×	✓	✓	✓	×	×	✓	No physical modification to Ashmore Reef or Cartier Island.	
				No extraction of living resources	×	×	×	×	×	×	×	×	×	×	×	×	×	×	Not required	
				No oil pollution (oil rigs)	×	×	×	×	×	×	×	×	×	×	×	×	×	×	Not required	
				No invasive species	×	×	×	×	×	×	×	✓	×	×	×	×	×	×	No invasive marine species established at any sensitive location attributable to the activity.	Implementation of IMS MC (4.1-4.7)
			Carbonate Bank and Terrace System of the Sahul Shelf	No changes in sea temperatures	×	×	×	×	×	×	×	×	×	×	×	×	×	×	Not required	
				No increased acidification	×	×	×	×	×	×	×	×	×	×	×	×	×	×	Not required	
				No extraction of living resources	×	×	×	×	×	×	×	×	×	×	×	×	×	×	Not required	
			Seringapatam Reef and Commonwealth waters in the Scott Reef Complex	No sea level rise	×	×	×	×	×	×	×	×	×	×	×	×	×	×	Not required	
				No changes in sea temperatures	×	×	×	×	×	×	×	×	×	×	×	×	×	×	Not required	
				No increased acidification	×	×	×	×	×	×	×	×	×	×	×	×	×	×	Not required	
				No marine debris	×	×	×	×	×	×	×	×	×	✓	✓	×	×	×	No planned disposal of garbage at sea.	Garbage records show receipt of garbage in port.
				No physical habitat modification	×	×	×	×	×	×	×	×	✓	✓	✓	×	×	✓	Anchoring is prohibited unless required for the safety of life at sea	Daily reports show no anchoring occurred or objects lost overboard.
				No extraction of living resources	×	×	×	×	×	×	×	×	×	×	×	×	×	×	Not required	
				No oil pollution (oil rigs)	×	×	×	×	×	×	×	×	×	×	×	×	×	×	Not required	
				No invasive species	×	×	×	×	×	×	×	✓	×	×	×	×	×	×	No invasive marine species established at any sensitive location attributable to the activity.	Implementation of IMS MC (4.1-4.7)
2	Physical Environment	No long-term effect on the existing physical environment or geomorphic features.	Commonwealth marine environment	No long-term effect on the existing physical environment or geomorphic features.	×	×	×	×	×	×	×	×	×	×	×	×	×	×	Not required	
3	Benthic Communities	No unrecoverable or long-term effects on benthic communities from impacts and risk associated with the activity.	Heywood Shoal	No unrecoverable or long-term effects on benthic communities from impacts and risk associated with the activity.	×	×	×	×	×	✓	×	×	✓	✓	✓	×	×	✓	Benthic communities continue to utilise Heywood shoal after the conclusion of the survey.	Sail Plan and MC 9
			Eugene McDermott Shoal	No unrecoverable or long-term effects on benthic communities from impacts and risk associated with the activity.	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	Habitat value of the value/sensitivity will be maintained.	Sail Plan and MC 9
			Goeree Shoal	No unrecoverable or long-term effects on benthic communities from impacts and risk associated with the activity.	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	Habitat value of the value/sensitivity will be maintained.	Sail Plan and MC 9
			Vulcan Shoal	No unrecoverable or long-term effects on benthic communities from impacts and risk associated with the activity.	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	Habitat value of the value/sensitivity will be maintained.	Sail Plan and MC 9
			Barracouta Shoals	No unrecoverable or long-term effects on benthic communities from impacts and risk associated with the activity.	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	Habitat value of the value/sensitivity will be maintained.	Sail Plan and MC 9
			Echuca Shoal	No unrecoverable or long-term effects on benthic communities from impacts and risk associated with the activity.	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	Habitat value of the value/sensitivity will be maintained.	Sail Plan and MC 9
4	Listed Threatened and Migratory Species	No substantial adverse effect on a population of listed threatened or migratory species, including its lifecycle (e.g. breeding, feeding, migration behaviour or life expectancy) and spatial distribution.	Marine Mammals	No displacement of foraging, aggregating, calving/breeding, or migrating cetaceans from identified BIA's	×	×	×	×	×	✓	×	×	✓	✓	✓	×	×	✓	Manage survey activities within BIA to ensure that biologically important behaviours can continue.	Sail Plan and MFO MC 2
				No alteration to critical habitat	×	×	×	×	×	✓	×	×	✓	✓	✓	×	×	✓	Manage survey activities within BIA to ensure that biologically important behaviours can continue.	Sail Plan and MC 9 and MFO MC 2
				No injury to any marine mammal	×	×	×	×	×	✓	×	×	✓	✓	✓	×	×	✓	No death or injury to listed threatened and migratory species resulting from the seismic survey.	MFO MC 2
			Marine Reptiles, Birds and Sharks and Rays	Ensure marine turtles are not displaced from identified habitat critical to their survival.	×	×	×	✓	×	✓	×	×	✓	✓	✓	×	×	✓	Cause no behavioural distrubance within the Green Turtle internesting BIA.	Sail Plan and MC 9.1.
				No affect to biologically important behaviours.	×	×	×	✓	×	✓	×	×	✓	✓	✓	×	×	✓	Manage survey activities within BIA to ensure that biologically important behaviours can continue.	Sail Plan and MC 9.1.
				No population level effects.	×	×	×	✓	×	✓	×	×	✓	✓	✓	×	×	✓	No death or injury to listed threatened and migratory species resulting from the seismic survey.	No reported death or injury to listed threatened and migratory species in MFO reports.
			Fish and Invertebrates	No fish/invertebrate mortality or PTS effects	×	×	×	×	×	✓	×	×	✓	✓	✓	×	×	✓	Activity to be carried out in accordance with the sail plan to avoid PTS or mortal affects to fish and invertebrates.	Sail Plan and MC 9.1.
				Non-peak spawning effects are short-term, localised, and recoverable	×	×	×	×	×	✓	×	×	✓	✓	✓	×	×	✓	Activity to be carried out in accordance with the sail plan to avoid key indicator fish species peak spawning timings.	Adoption of the sail line plan as a control measure and its required performance standards
5	Offshore Reefs and Island	No unrecoverable or long-term effects on offshore reefs and islands from impacts and risk associated with the activity, in accordance with any IUCN classification	Cartier Island	No disturbance to the habitats, ecosystems, and native species of the AMP.	×	×	×	×	×	×	×	✓	×	×	×	×	×	✓	No disturbance to the habitats, ecosystems, and native species of the AMP.	Sail Plan and MC 9.1.
			Ashmore Reef	No disturbance to the habitats, ecosystems, and native species of the AMP.	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	No disturbance to the habitats, ecosystems, and native species of the AMP.	Sail Plan and MC 9.1.
			Browse Island	See Item 4 - Marine reptiles	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	Habitat value of the value/sensitivity will be maintained.	Implementation of the OSMP in the event of a spill
6	Australian Marine Parks	Protect and maintain biological diversity in accordance with the conservation objectives of the	Category IA Marine Park (Cartier and Ashmore)	No disturbance to the habitats, ecosystems, and native species of the AMP.	×	×	×	×	×	✓	×	×	×	×	×	×	×	✓	No disturbance to the habitats, ecosystems, and native species of the AMP.	Sail Plan and MC 9.1.

6	Australian Marine Parks	accordance with the conservation objectives of the IUCN Protected Area category.	Category VI Marine Park (Kimberley)	No effect to the biological diversity or sustainable use of the natural ecosystem of the AMP.	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	Habitat value of the value/sensitivity will be maintained.	Implementation of the OSMP in the event of a spill
7	Commercial/Traditional Fisheries	No effect to the sustainability of the fish population and the sustainability of the fisheries in the Gascoyne and North Coast fishing marine bioregions.	Social and economic features of each fishery within the ensonfied area of the survey	No increased threat to the sustainability of the fishery.	×	×	×	×	×	✓	×	×	×	×	×	×	×	✓	No increased threat to the sustainability of the fishery.	Sail Plan and MC 9.1.
		No interference with fishing to a greater extent than is necessary for the exercise of right conferred by the titles granted to carry out exploration activities.	Northern Demersal Scalefish Fishery	The overall spatial access to the productive areas of fishing within the overall licence area does not result in quantifiable reduction in catch effort as a result of the survey	✓	×	×	×	×	×	×	×	×	×	×	×	×	✓	The overall spatial access to the productive areas of fishing within the overall fishing licence area does not result in quantifiable reduction in catch effort as a result of the survey.	Adoption of relevant MC such as sail line plan (MC 9.1) and communications procedure (MC 1.2 and 1.3).
8	Tourism and Recreational Activities	No injury to humans using the water by diving.	None identified	-	×	×	×	×	×	×	×	×	×	×	×	×	×	×	Not required	
9	Military and Defence Activities	No interference with defence activities as directed by the Dept. of Defence.	None identified	-	×	×	×	×	×	×	×	×	×	×	×	×	×	×	Not required	
10	Ports and Commercial Shipping	No interference with navigation to a greater extent than is necessary for the exercise of right conferred by the titles granted to carry out exploration activities.	Osbourne Passage	No collisions with other commercial vessels	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	No collisions or near-misses during the survey.	No reports of collisions or near-misses for the duration of the survey.
				No alterations to a greater extent than is necessary of preferred shipping routes because of the survey	✓	×	×	×	×	×	×	×	×	×	×	×	×	✓	No complaints given to the Factory 3D seismic vessel during the course of the activity by the commerical shipping industry as a result of the activity.	Adoption of relevant MC (MC 1.1, 1.4-1.6)
11	Offshore Exploration and Production	No interference with other titleholders to a greater extent than is necessary for the exercise of right conferred by the titles granted to carry out exploration activities.	None identified	-	×	×	×	×	×	×	×	×	×	×	×	×	×	×	Not required	

Relevant Environmental Impacts and Risks

Control Measures (System, Item of Equipment, Person, Procedure)			Planned Events							Unplanned Events							Environmental Performance			Consultation	ALARP Assessment		
ID	**Title**	**Detail**	Physical Presence	Discharges of deck and bilge water	Discharges of treated sewage, grey-water and putrescible waste	Light Emissions	Atmospheric Emissions	Acoustic Emissions (Seismic)	Acoustic Emissions (Non-seismic)	Invasive Marine Species	Unplanned Seabed Disturbance	Unplanned loss of solid waste or dropped objects	Unplanned loss of survey equipment	Unplanned loss of chemicals or hazardous liquid waste	Unplanned collisions (marine species)	Unplanned hydrocarbon release	**Ref**	**Environmental Performance Standards (EPS)** Grey text indicates that this performance standard has not been adopted and will not be applied for this activity.	**Measurement Criteria (MC)**	**Measure adopted because of the consultation?**	**Adopted**	**Rejected**	**Reasons for rejection or consideration of improved performance of control measures that have been adopted.**
1	Communications procedure	The purpose of the communications procedure is to ensure that relevant persons are informed about the progress of the activity at the frequency requested during preparation of the EP. There are various people involved in ensuring that the communications procedure is followed with the overall responsibility for ensuring the performance residing with the Environment Advisor.	✓					✓			✓				✓	✓	1.1	Relevant persons who requested notification of commencement of the survey will be provided that notification 4 weeks prior to the survey (includes DMIRS, AMSA (RCC), AHO, DAWR, Mareterram and NDSF as requested during consultation)	Communications records	✓	✓		Updates on a more regular basis are considered burdensome on relevant persons and could dilute the important messages that do need to be received and understood.
																	1.2	Relevant persons who requested a 72-hour look ahead for acquistion will be provided this notification daily for the duration of the survey.	Communications records	✓	✓		
																	1.3	An agreed cooperation and interaction protocol plan will be in place for commercial fishers prior to the commencement of the activity. If not agreed prior to the survey the interactions will be governed by maritime law.	Communications records	✓	✓		
																	1.4	Notification to AMSA JRCC 48 hours prior to the commencement of the activity	Communications records	✓	✓		
																	1.5	'Notice to Mariners' issued via RAN Australian Hydrographic Service (AHS) prior to the commencement of the survey.	Log of transmission of Notice To Marines broadcast	✓	✓		
																	1.6	AMSA will be notified in the event of equipment loss to provide a warning to shipping vessels in the area, if necessary.	Communications records		✓		
																	1.7	Appoint a Fisheries Liaison Officer (FLO) to carry out specific consultation with commercial and recreational fishers in accordance with this procedure.	Communication records			×	Not requested by fishers during consultation. Only one fishery likely to have benefit. The procedure and on-water communication is known to be effective at reducing interference to other marine users so this option is not expected to reduce impact and risks further than already lowered to.
2	Marine Fauna Observers (MFOs)	The purpose of the MFOs is to provide environmental expertise to the vessel crew to ensure that Shell's Environmental Performance Outcomes are achieved. They do this by implementing EBPC Act Policy Statement 2.1, the Australian National Guidelines for Whale and Dolphin Watching 2017, WA Fisheries Publication No 112 (2013), and the adaptive management procedure for protected species.	✓					✓	✓						✓		2.1	Two MFOs with at least two previous surveys experience will be resident on the seismic vessel at all times covering all day-time operations. Shell will review the CV's of the MFO's to determine compentence as part of the subcontractor selection.	MFO CVs, MFO daily reports, bridge log		✓		Consideration will be given to the MFO's previous experience including items such as compliance/knowledge and application of relevant controls within EPBC policy statement 2.1, whale and general marine fauna identification relevant for the activity,
																	2.2	Additional MFO with at least two previous surveys experience will be used from spotter aircraft for marine mammal observation with suitable communications tools with project vessels	MFO daily reports			×	No overlap with critical habitat means spotter aircraft will be ineffective. Logistically impractical due to distance offshore and range of helicopters. High adoption costs and increase life safety risks.
																	2.3	Complete pre-start observations for traditional Indonesian fishing vessels and predict interaction probability	Sighting recorded in bridge logs or MFO daily report		✓		
																	2.4	Ensure implementation of all EPBC Act Policy 2.1 Statement Part A measures as required; observation zone (3km), low-power zone (2km) and shut-down zone (500m), use of softs starts. In addition, this requirement will apply to whales sharks as well as 'whales' defined within EPBC policy statement 2.1 Part A.	MFO daily reports, bridge log confirms MFO attendance	✓	✓		Shell could implement larger precautionary zones however observations become unreliable beyond 3km. Increased shut-downs/power-downs would extend the duration of the survey and potentially increase the quantum of impact on the population. It is not considered practicable to implement an observation powerdown zone of 8 km (which is distance of the modelled behavioural impact to species like pygmy blue whales) based on the distance MFOs are able to observe from the vessel. The limit of accurate observations is 3 km (DEWHA 2008), especially given the sea state and visibility conditions in the northwest WA. In addition, for the key whale family in the OA, baleen whales, the predicted PTS SEL24H for LF would be exceeded within 1.73 km from the acoustic source, and therefore less than the lower power zone distance of 2 km (Table 6 11). Therefore, with the precaution zones implemented as per EPBC Act Policy Statement 2.1, mysticetes will not be exposed to underwater sound levels likely to cause PTS. Whale sharks will be included in the application of the EPBC policy statement 2.1 which apply for the survey. DPIRD requested the addopted of soft starts, which are outlined in EPBC policy statement 2.1 part A. Consideration of application of EPBC policy statement 2.1 to marine turtles was considered. It was deemed not practicable as there are clear limitations in applying EPBC policy statement 2.1 to marine turtles also, i.e. challenging to observe turtles at 500m/1km/2km/3km. Considering the evidence suggests turtles are not that sensitive to sound either, supports not applying such a stringent standard managing impacts to marine turtles. Instead Shell is proposing to adopt a receptor specific control
																	2.5	Ensure no night time acquisition if there are three or more sightings of whales or whale sharks within the preceding 24 hours within the power-down/shut-down zone and recommence at daylight (PS 2.1 Part B)	MFO daily reports, bridge log		✓		Shell could shut-down for a specified period (i.e. 24 hours) but at daylight the MFOs will return to the bridge and therefore the shut-down provides no additional protection to these species.
																	2.6	Relocate the survey to >10km from last sighting in the event of three consective days with >3 shut-downs/power-downs in each day.	MFO daily report		✓		Greater than 10km relocation would be beyond the distance of behavioural disturbance to marine fauna.
																	2.7	Cease all night time surveying if there are three consecutive days on which there are three or more whale-instigated shut down/power down situations (PS 2.1 Part B)	MFO daily report			×	This performance standard has the potential to undermine the financial viability of the survey. Would extend the duration of the survey and potentially increase the quantum of impact on the population.
																	2.8	Avoid approaching whale sharks and maintain distance beyond 250m.	MFO daily report			×	Application of EPBC policy statement 2.1 part A to whale sharks meets the intent of this control.
																	2.9	Work with the vessel master to implement the observation, low-power, and shut-down zones	Copies of induction records for MFO's and the vessel master		✓		
																	2.10	Document all marine fauna interactions in the prescibed format	MFO daily report		✓		
																	2.11	Report all marine fauna interactions to the Department of Environment with two months of survey completion	Copies of the reports		✓		
																	2.12	Report marine fauna collisions via the online National Ship Strike Database as per the National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna.	Copies of the reports		✓		
																	2.13	Use of PAM (passive acoustic monitoring) and associated procedures for Night-time / Low Visibility Conditions -	MFO daily reports			×	Unproven and ineffective technology only relevant to whale species not expected to be encountered. High adoption cost.
																	2.14	Part B. Additional Management Procedures (see EPBC Policy Act Statement 2.1) - increased pre-watch period of 45 minutes.	MFO daily reports			×	Given the shallow water of the OA, long duration diving times of cetaceans is unlikely, therefore making the standard pre-watch period adequate for the survey duration.
																	2.15	Apply a siesmic source shutdown zone of 200m from the vessel for marine turtles.	MFO daily reports		✓		Given the predicted range of mortal impacts to marine turtles is 190m, a 200m shutdown radius from the vessel is considered to be more than enough to protect marine turtles from mortal impacts. No further reasonable controls are considered credible to consider applying to marine turtles.
																	2.16	Undertaking soft start procedures as per EPBC policy statement 2.1 Part A for turtles during surveys irrespective of location and time of year of the survey.	MFO daily reports		✓		This control is aimed at avoiding mortal impacts to marine turtles (and other marine species) when the air guns are started up during the seismic survey. It is also suggested as apart of the Recovery Plan for Marine Turtles in Australia (2017). Considering of applying more stringent standards to this survey have been considered, such as EPBC policy statement 2.1 to turtles, however this approach is considered overly conservative in the instance of the Factory 3D survey as there have never been any reported or documented cases of marine turtle injury or mortality from a seismic survey.

Control Measures (System, Item of Equipment, Person, Procedure)			Planned Events							Unplanned Events							Environmental Performance			Consultation	ALARP Assessment		
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																	2.17	Apply low power zone for marine turtles as per EPBC policy statement 2.1	MFO daily reports			×	Applying this standard is consdiered overly conservative considering there is no seismic array discharged within any turtle BIA. A 1 or 2km low power zone for marine turtles considered overly conservative as they are likely to move away whilst the array is being discharged. The cost of applying this control is the same as a shut down (~$80,000 per event) as the seismic data can not be used in processing, gaps would likely need to be filled with follow re-runs of lines, therefore extending the survey also. No turtles are predicted to be injured or killed as a result of the Factory 3D survey.
3	Project vessels	The activity includes one support vessel (for equipment and crew transfers), one chase vessel (for safe navigation) and the acquisition vessel. As per the requirements of the implementation strategy the vessels will be staffed with qualified and experience crew at all times and will be required to complete an environment induction.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	3.1	Vessels will not travel at speeds greater than 6 knots within a 300m of a sighted whale, whale shark, or turtle and will maintain 100m separation from these species. Vessels will not approach closer than 50m of a dolphin (with the exception of animals bow riding).	Bridge log		✓		
																	3.2	Project vessels will be equipped with suitable and functioning navigation aids, automatic identification system (AIS) and competent crew maintaining 24-hour visual, and radio and electronic surveillance	Pre-mobilisation inpsection report		✓		
																	3.3	At least one of the chase or support vessel will be present at all times during the seismic survey. The support vessel will undertake equipment and crew transfers and assist, if it is safe to do so, recovery of lost equipment or unplanned lost garbage.	Bridge logs, support vessel logs		✓		Shell has considered transfering equipment by helicopter however this is expected to increase survey timing which increases environmental risk. Increased emissions and threats to birds also result in no benefit from this improved control measure.
																	3.4	Additional chase and/or support vessels will be utilised to provide further protection for other marine users at time of high vessel traffic.	Bridge logs, support vessel logs			×	Increases complexity in simultaneous operations which increases risks. More vessels on the water means greater distrubance to fishers and marine fauna. High adoption cost.
																	3.5	Shell will implement the use of the support / chase vessel to manage the proximity of the seismic vessel to any traditional fishing vessels that may be transiting the OA.	Bridge logs, support vessel logs		✓		
																	3.6	Support and/or chase vessels will accompany the seismic vessel during surveying to patrol and maintain a clear zone ahead of the vessel including scouting for and communication with commercial, recreational, shipping, petroleum service and traditional Indonesian fishing vessels	Bridge logs, support vessel logs		✓		
																	3.7	All project vessels will all have a Ballast Water and Sediment Management Plan, a Ballast Water Record Book, a Shipboard Oil Pollution Emergency Plan (SOPEP), an Ozone-Deplieting Substances Record Book, a Garbage Management Plan, appropriate to the Class of the vessel	Relevant record book or management plan		✓		
																	3.8	Ballast water exchanges will be done in open waters	Ballast water record book		✓		
																	3.9	Contracted vessels will have water separation systems such that bilge discharges overboard will not exceed 15 ppm and an oily water record book to record discharges	Oily water record book		✓		
																	3.10	Contracted vessels will collect and store deck drainage, bilge water, sewage, grey-water or putrecible waste for subsequent transport to mainland and disposal onshore	Record of transfer ashore			×	Duration of survey means multiple offloading at high cost. No increase in overall environmental protection.
																	3.11	Contracted vessels fitted with shrouded lights to prevent light spill or directional lighting.	Pre-mobilisation inpsection report			×	Given distance to nearest nesting beach (9 km to Cartier Island) and that no defined nesting BIAs for any species directly overlaps the OA, costs for implementing this control outweigh benefits. Also increased risk of collision with other vessels.
4	IMS Risk Assessment Procedure	This procedure assures Shell's adherence to the International Convention for the Control and Management of Ship's Ballast Water and Sediments 2004 and the Australian Ballast Water Management Requirements (DAWR, June 2016). This procedure identifies the pre-voyage actions that are required per vessel (e.g. dry-docking, antifouling, hull cleaning) and ensures that Shell apply DPIRD's vessel check tool to all vessels, and all immersible equipment will be cleaned to 'low risk' of introducing invasive marine species.								✓							4.1	Shell will undertake an IMS risk assessment prior to mobilisation into Australian waters.	Completed risk assessment		✓		
																	4.2	The Shell IMS Risk Assessment Procedure is consistent with DPIRD's vessel check tool.	Annual review of the procedure to confirm consistency with the tool		✓		
																	4.3	DPIRD vessel check tool will be applied to vessels, and all immersible equipment (inc. streamers and anchors) clean to 'low risk' of introducing invasive marine species.	Vessel maintenance records, streamer deployment plans and records of inspections	✓	✓		
																	4.4	For vessels coming from international waters, Shell will undertake an IMS risk assessment prior to mobilisation into Australian waters. The assessment identifies the pre-voyage actions that are required per vessel (e.g. dry-docking, antifouling, hull cleaning).	Completed risk assessment		✓		
																	4.5	Inspection, maintenance and cleaning of in water equipment prior to deployment and during retrieval throughout the activity.	Vessel maintenance logs		✓		
																	4.6	Project vessels will be docked and an in-water hull inspection performed before departure to the OA	Inspection report			×	Additional movements of vessels as part of the petroleum activity are undesirable and increase IMS risks unnecessarily. Moderate cost of adoption.
																	4.7	Project vessels will be dry-docked for cleaning if the in-water inspection identifies the precence of IMS	Vessel dry-dock logs, inspection report			×	Increases in environmental protection are outweighed by the significant increase in project cost from adoption.
5	Marine Assurance System	The marine assurance system is administered by Shell's Marine team and, amongst other requirements, ensures compliance of contract vessels with MARPOL, COLREGS, and Marine Orders 21, 30, 70,71,72, 91, 95, 96, 97, 98.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	5.1	Ensure that contracted vessels have anti-foulant systems that are maintained and in compliance with the International Convention on the Control of Harmful Anti-Fouling Systems on Ships	Copy of the antifoulant certificate/declaration		✓		
																	5.2	OVID-style inspections will be undertaken of project vessels, including a check for valid and in date International Oil Pollution Prevention (IOPP) and International Sewage Pollution Prevention (ISPP) International Air Pollution Prevention (IAPP) Certificate Certificates, as part of the contracting process.	Pre-mobilisation inspection report, (sighting of the IOPP, ISPP, and IAPP certificates.)		✓		
																	5.3	Ensures that the sulphur content of fuel used by project vessels will comply with Regulation 14 of MARPOL Annex VI (as appropriate to vessel class) in order to control SOx and particulate matter emissions.	Bunkering records/receipts, vessel contract		✓		
																	5.4	If any project vessels, including the seismic vessel and any spill response vessels, has an overseas 'last port of call', a Pre-Arrival Report will confirm that the vessel meets ballast and quarantine requirements.	Completed pre-arrival report, vessel track logs, Ballast Water Record Book		✓		
																	5.5	Ensures that spill kits will be available on project vessels.	Pre-mobilisation inpsection report		✓		
																	5.6	Ensures that vessels will use approved navigation systems and depth sounders.	Pre-mobilisation inpsection report		✓		
																	5.7	Preventative maintenance of anchoring equipment completed as scheduled.	Pre-mobilisation inpsection report		✓		
																	5.8	Checks that project vessels have a preventative maintenance system and that maintainence is regularly completed as scheduled.	Pre-mobilisation inpsection report		✓		

Control Measures (System, Item of Equipment, Person, Procedure)			Planned Events							Unplanned Events							Environmental Performance			Consultation	ALARP Assessment		
ID	Title	Detail	Physical Presence	Discharges of deck and bilge water	Discharges of treated sewage, grey-water and putrescible waste	Light Emissions	Atmospheric Emissions	Acoustic Emissions (Seismic)	Acoustic Emissions (Non-seismic)	Invasive Marine Species	Unplanned Seabed Disturbance	Unplanned loss of solid waste or dropped objects	Unplanned loss of survey equipment	Unplanned loss of chemicals or hazardous liquid waste	Unplanned collisions (marine species)	Unplanned hydrocarbon release	Ref	**Environmental Performance Standards (EPS)** Grey text indicates that this performance standard has not been adopted and will not be applied for this activity.	Measurement Criteria (MC)	Measure adopted because of the consultations?	Adopted	Rejected	Reasons for rejection **or** consideration of improved performance of control measures that have been adopted.
																	5.9	Ensures that lifting equipment that contains hydraulic fluid will be maintained in accordance with a functioning maintenance management system	Vessel maintenance logs		✓		
																	5.10	Requires pre-mobilisation audits of all contracted vessels.	Pre-mobilisation inpsection report		✓		
6	Oil Pollution Emergency Plan	The purpose of the OPEP is to guide Shell in how to respond to a hydrocarbon spill in a manner consistent with the national system for oil pollution preparedness and response. The response arrangements to meet the EPS's associated with the OPEP are provided in the implementation strategy.															6.1	The OPEP and OSMP will be part of the EP submission and assessed and accepted by NOPSEMA	Letter of acceptance from NOPSEMA		✓		
																	6.2	Shell will implement a monitor and evaluate strategy to determine the fate and ecological consequences of a Level 2 & 3 spill in accordance with the Shell Australia Oil Spill Monitoring Plan (HSE_PRE_000496)	Daily logs from monitoring personnel, monitoring records from flights and vessels		✓		
																	6.3	Shell will implement a shoreline cleanup strategy to remove bulk and stranded oil from shorelines identified as suitable for cleanup as an outcome of SCAT assessments and in accordance with the OPEP Shoreline Response Guide	SCAT assessment records, shoreline cleanup records		✓		
																✓	6.4	Shell will implement a protection and deflection strategy at identified sensitive areas to prevent hydrocarbons entering sensitive or pristine habitats in accordance with plans recommended as an outcome of SCAT assessments.	SCAT assessment records			×	Strategy has low effectiveness in the environments proximate to this survey. They would be difficult to implement safely due to strong currents and would likely cause more damage to the reef systems.
																	6.5	Shell will implement a contain and recover strategy to contain, collect, separate and reprocess liquid hydrocarbon through suitable vessel configurations.	Daily logs from vessels			×	Only diesel will be used for this activity which spreads too thin in the open ocean to be able to be collected. The fate of diesel in the marine environment is likely to be <7 days on the surface and <6 weeks before natural microbial breakdown removes any trace of spilt hydrocarbons.
																	6.6	Shell will implement a chemical dispersant strategy to enhance the natural processes of water colum microbial breakdown by increasing the surface area of hydrocarbon available to be degraded.	Daily logs from vessels			×	High evaporation of diesel and rapid spreading mean that adding chemical dispersants would be ineffective and increase environmental harm.
																	6.7	Shell will implement an oiled wildlife response strategy to protect listed and migratory species in consultation with the WA DBCA and in accordance with the WA Oiled Wildlife Response Plan.	Wildlife response records		✓		
7	Oil spill response equipment and personnel and associated emergency management procedure	Shell maintains access to large stockpiles of equipment and a local, national and international pool of dedicated oil spill response personnel. Shell is a member of AMOSC, OSRL, and the GRSN. Shell also has MOU's in place with other titleholders should support be required. The emergency management procedure is document HSE_GEN_010996.															7.1	Oil spill response equipment is located in Fremantle, Geelong (AMOSC), Singapore, and Southampton (OSRL), is maintained and ready for deployment to WA on a 24/7 availability basis in accordance with an agreed Service Level Agreement (or equivalent).	Master services contracts, service level agreements		✓		
																✓	7.2	AMOSC and OSRL will be audited annually by one of their members to ensure that the Service Level Agreement can be met	Annual audit report		✓		
																	7.3	Memoranda of Understanding are in place with other titleholders through the AMOSPLAN	AMOSPLAN		✓		
																	7.4	Shell has access to trained oil spill responders in Perth and will staff an Incident management team in the event of an incident	Staff emergency roster		✓		It is not feasible or of any benefit to locate responders closer to site given the remoteness offshore and the fate of diesel in the marine environment.
																	7.5	Shell will maintain the minimum personnel numbers prescribed in HSE_GEN_010996	Training records		✓		These numbers of personnel are considered the minimum requirement for all Shell's offshore activities. This capability well exceeds the need in relation to this activity.
8	Vessel bunkering procedure	The purpose of this procedure is to ensure that good practice and industry standards are applied in the event that bunkering operations are required. It is Shell's preference that bunkering during the activity does not occur but vessel availability will dictate if this is achieveable. The performance standards are crafted to accomodate both scenarios.															8.1	Should the contracted vessel be of sufficient tank capacity be available then there will be no offshore refueling/bunkering as part of the petroleum activity.	Bunkering records/receipts, vessel contract		✓		Shell's preference will be for a vessel of sufficient capacity to avoid refueling at sea.
																✓	8.2	Should the contracted vessel have insufficient fuel capacity and need to refuel the contracted vessel will have a vessel bunkering procedure.	Bunkering procedure		✓		
																	8.3	Contracted vessels will have dry-break couplings, inspected and certified bunkering hoses, and this equipment will be maintained.	Pre-mobilisation inpsection report, maintenance records		✓		
																	8.4	Bunkering operations will commence during daylight hours with continual monitoring of hoses and tank levels from both vessels.	Bunkering record book, completed checklist		✓		
																	8.5	Bunkering operations will only commence in port	Bunkering record book			×	Recovering streamers and return to port increases survey duration, increases life safety risk, and increases impacts to other marine users. High adoption cost.
9	Sail line plan	The sail line plan is the key control measure for ensuring that activity is carried out by the contract to the specifications of Shell Australia. It includes spatial and technical data consistent with the EP describing the operational area, the full-fold and corresponding full-power area for operation of the seismic source and exclusion zones. The sail line plan includes all the specifications of the acoustic source and streamer configuration.															9.1	The sail plan will contain information for the seismic contractor on the operational area, the full power zone, the accoustic source exclusion zones (Ref. Figure 2-2), soft start zone (Ref. Figure 2-2), water depth exclusions zones, depth contours, and distances related to environment management control measures. These areas will be the minimum extent that the survey needs to cover to be financially and geophysically viable	Sail line plan		✓		If Shell were to decrease the extent of the survey any further the geophysical objectives of the survey could not be met as we need to tie into existing data points and cover the title work commitments.
																	9.2	The sail plan will contain sail line pre-plots for acquistion and instruction on how and when these sail lines will be optimised and updated throughout the survey due to operational and environmental constraints and considerations. The optimisation process will ensure the minimum duration possible for the survey to minimise costs and environmental harm. Therefore this includes night-time operations (subject to MFO reports)	Sail line plan		✓		Any increase to survey duration financally impacts Shell and increases environmental exposure so our interests are aligned to minimise the survey duration.
																	9.3	Alternative acquisition timing to minimise impact from acoustic emissions.	Sail line plan			×	Information from commercial fisheries and DPIRD during consultation indicated that September - May were peak spawning times for key commercial species and peak commercial fishing periods were from June - November. An assessment of all sensitives affected by this activity (see the sensitivities timing table), including Whales, Turtles, commercial fish spawning etc. indicate that alternative times of year will not achieve a reduction in overall impacts of the activity on the environment. The months where the least impact to commercial fishing occurs from the seismic acquisition is December to May. In addition to this, the only months where the activity would not impact peak spawning periods for goldband snapper or red emperor would be the months from June – August. Since the peak spawning periods and peak fishing periods cover the entire year, it is not possible to avoid seismic acquisition for both periods. On this basis, and considering other environmental priorities that have been considered, it is Shell's intention to preferentially carry out the survey between the November – February window proposed in the EP. This would minimise impacts to commercial fishing and other environmental receptors. It is also important to note with this that Shell cannot guarantee the survey timing will occur from November - February as there are numerous factors which could result in pushing the survey to occur sometime in the second window from April – September.
																	9.4	The sail plan will be split across multiple time windows to allow for environmental recovery.	Sail line plan			×	No permenant or irreversible environmental harm is predicted from the impact assessment meaning there is no environmental benefit from this control measure performing in this way. Extreme adoption costs.

Control Measures (System, Item of Equipment, Person, Procedure)			Planned Events							Unplanned Events							Environmental Performance			Consultation	ALARP Assessment		
ID	**Title**	**Detail**	Physical Presence	Discharges of deck and bilge water	Discharges of treated sewage, grey-water and putrescible waste	Light Emissions	Atmospheric Emissions	Acoustic Emissions (Seismic)	Acoustic Emissions (Non-seismic)	Invasive Marine Species	Unplanned Seabed Distrurbance	Unplanned loss of solid waste or dropped objects	Unplanned loss of survey equipment	Unplanned loss of chemicals or hazardous liquid waste	Unplanned collisions (marine species)	Unplanned hydrocarbon release	**Ref**	**Environmental Performance Standards (EPS)** Grey text indicates that this performance standard has not been adopted and will not be applied for this activity.	**Measurement Criteria (MC)**	**Measure adopted because of the consultations?**	**Adopted**	**Rejected**	**Reasons for rejection <u>or</u> consideration of improved performance of control measures that have been adopted.**
			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	9.5	The sail line plan will be provided to the seismic contractor for agreement prior to the survey and all variations to the plan will be agreed and recorded in writing between Shell and the seismic contractor.	Sail line plan and variation instuctions		✓		
																	9.6	Acoustic source size will not exceed 3,480 in3 and will utilise two or three independent source arrays to generate acoustic pulses by alternatively discharging compressed air into the water column at ~6–7 seconds intervals, ('flip-flop' or 'flip-flop-flap').	Sail line plan		✓		`
																	9.7	Streamer will be solid, rather and fluid filled streamers equipped with pressure-activated self-inflating buoys, and turtle guards. Control devices will be positioned along the streamers to maintain the position of the streamers at the required depth and cables will be towed at a depth that will not allow them to be closer than 10 m from the seabed.	Sail line plan		✓		
																	9.8	Data acquisition will be undertaken in a northwest to southeast and southeast to northwest line orientation as modelled.	Vessel track from AIS		✓		An alternative acquisition line plan of northeast/southwest orientation was considered. Although potentially giving more flexibility to accommodate the avoidance of the adjacent pygmy blue whale BIA by prioritising line sequences, it cannot be attempted due the presence of shoals to the northeast of the OA, which restricts the space needed for line turns. Consequently, acquisition in the northeast/southwest orientation would be detrimental to the volume of the acquired data to the extent that the sub-surface structures would not be adequately imaged, and the survey objective would not be achieved. In conclusion, geophysical and geological constraints are the predominant drivers in the survey design. Within the OA the only viable line orientation is northwest/southeast due to the proximity of shoals, which has the benefit of placing 'quieter' line turns in the pygmy blue whale BIA. The adopted racetrack progression will ensure maximum efficiency in line turns when towing 8,100 m of streamers and hence reducing the overall time that data acquisition will take and reducing overall exposure of the activity to the environment.
																	9.9	Shell will not acquire adjacent lines within 24 hours of acquisition, and any additional lines acquired within 24 hours will be >5 km from the line being acquired.	Vessel track from AIS	✓	✓		
																	9.10	There will be no operation of the acoustic source outside of the Operational Area	Vessel track from AIS		✓		
																	9.11	Operation of the acoustic source array will only occur in water depths >70 m.	Vessel track and bathymetry overlays	✓	✓		
																	9.12	Within 4 km of Heywood Shoal, Shell will not acquire adjacent lines within 24 hours of acquisition, and any additional lines acquired within 24 hours will be >5 km from the line being acquired.	Vessel track from AIS	✓	✓		
																	9.13	40 km separation between the survey and other operating seismic vessels of concurrent / simultaneous surveys in the region of the OA during data acquisition.	Vessel track from AIS		✓		In the event that the timing of any proposed seismic survey coincides with another survey in the area, the survey vessel will ensure a minimum distance of 40 km is maintained between them during full seismic acquisition to: •minimise potential cumulative impacts on marine fauna; and •minimise noise interference that may affect seismic data quality.
																	9.14	Surveys planned to occur inside important internesting turtle habitat should be scheduled outside the nesting season.				×	This control is not applicable to the proposed survey as none of the survey area or any potential dishcarge or air guns will occur within the internesting turtle habitat (BIA).
																	9.15	Continuous line acquisition will not occur during the survey.	Daily reports		✓		A detailed understanding of predicted impacts at nearby values and sensitivities could not be made with information currently available for continuous line acquisition to occur. It has therefore been ruled out on this basis.
																	9.16	Maintenance airgun tests in water will be minimised and will not exceed 50% source power.	Daily reports		✓		This control will minimise airgun discharge within the OA to ALARP.
10	Project Company Site Representatives	Shell will have a company site representative (CSR) and a Navigation Specialist. Their jobs are to ensure execution of the agreed scope of work and associated contract. The CSR performs regular checks/inspections. The purpose of these regular checks is to make sure that the specified controls are in place to manage environmental risks, and that they remain working, will contribute to continually reducing the risks to ALARP.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10.1	Oversight of the project and implementation of EPO's and EPS's within the EP.	Bridge logs, POB record		✓		
																	10.2	Verify that the project vessels are performing as per the agreed contract and executing the seismic in accordance with the agreed (and varied) sail line plan.	Daily reports		✓		
																	10.3	Conduct daily informal HSE checks of vessel operations to ensure that the EP commitments are implemented.	Daily reports		✓		
																	10.4	Attend the daily operational meeting and tool box talks recording any environment matters discussed.	Daily reports		✓		
																	10.5	Record details of any environmental incidents that have occurred in the previous 24 hours.	Daily reports		✓		
11	Compensation process for direct economic losses from survey activities	The purpose of this process is to provide a process for when, how, and for what compensation may be due to a fisher directly affected by seismic acquisition activities provided for in this EP.	✓					✓									11.1	Shell Australia will prepare a compensation process (or equivalent) for consultation with potentially affected fishers once Shell Australia approval is obtained.	Ongoing consultation records	✓	✓		
																	11.2	As part of the preparation process Shell will share, in full, the predictions of social and economic impacts to fishers arising from the interference based on the information available (in the EP) about the fisheries.	Ongoing consultation records	✓	✓		
																	11.3	The compensation process will require a fisher to provide evidence for claimed losses that enables a calculation of how much compensation may be due.	Compensation process (or equivalent)	✓	✓		
																	11.4	Direct losses that may be compensated are limited to: 1) Accidental damage or loss of deployed fishing equipment casues by the presence of the seismic vessel (either repair or replace); 2) Displacement for increased transit times which result in increased fuel and crewing costs from moving fishing locations, 3) Reduced catch per unit effort if survey acquisition timing directly overlaps a previously fished area, within the fishing season, demonstrated by the reported data in previous 5 years.	Compensation process (or equivalent)	✓	✓		Indirect losses are not predicted from this activity and thus are not reasonable to consider within this compensation process. .

Appendix B OPEP

Factory 3D Marine Seismic Survey

Oil Pollution Emergency Plan (OPEP)

Department	HSE
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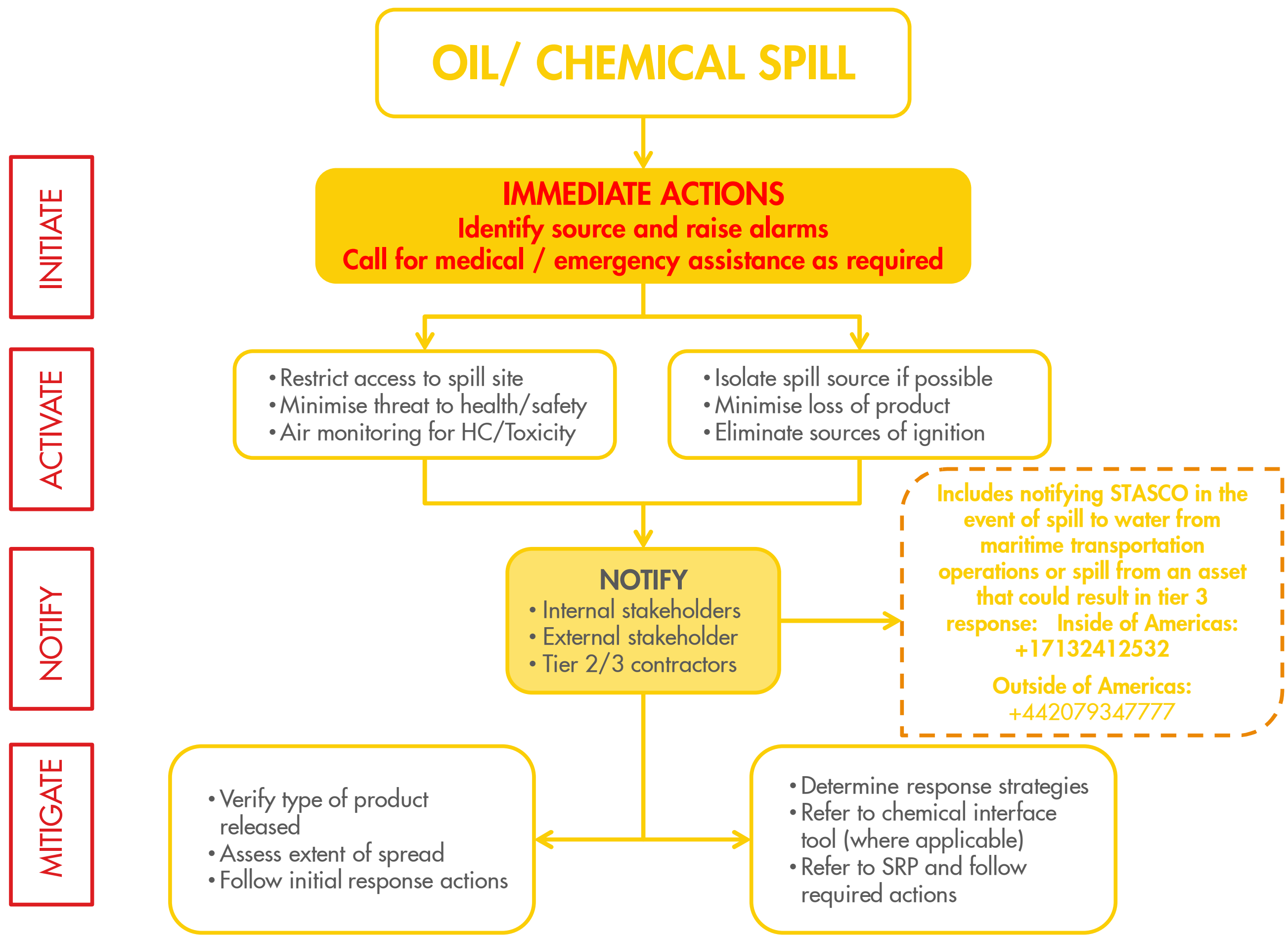
REVISION HISTORY					
Ver.	**Change Description**	**Date**	**Originator**	**Reviewed by**	**Approved by**
1	Version 1	15/3/2019			

Initial Response Flowchart



Please note that this is a generic notification process and each site should refer to its own specific initial action plan and role-specific checklists/action requirements.

Initial (First Strike) Actions

Table A has been developed to guide response personnel through the key steps of this OPEP during a level 1(Tier1) Level 2 (Tier 2) or Level 3 (Tier 3) spill.

An overview of initial (first strike) actions for **vessel spills** are in **Table A**.

Vessels Spills: Australian Maritime Safety Authority (AMSA) is the control agency in commonwealth waters and will remain so unless agreed with other agencies in different jurisdictions; Shell undertake first strike actions and support AMSA in accordance with the MOU. Seek early engagement with AMSA liaison officer.

Information to support the initial (first strike) response requirements is included in the rest of this Oil Pollution Emergency Plan (OPEP).

Definitions for 'Responsible role' persons in Table A are as follows;

- ERT – Emergency Response Team (Vessel based)
- IMT (W) – Incident Management Team (West; Perth Based)
- VM – Vessel Master
- CSR - Shell Company Site Representative

Table A Vessel Spill - Initial (First Strike) Actions

	Responsible Role		**Spill from Vessel (AMSA Control Agency)**		
Item	**IMT (IMT Leader)**	**VM**	**Initial (First Strike) Actions**	**Information Resources/ Contact Information**	**Comments**
1.		x	Stop the spill	Vessel shipboard oil pollution emergency plan (SOPEP)	
2.		x	Vessel Master alert the Shell IMT and Contractor IMT		
3.		x	Initiate Monitor and Evaluate: Gain and maintain situational awareness. Deploy satellite tracking buoy as close to spill source as possible	See Monitor and Evaluate (Section 18.1)	
4.		x	Classify the Level of spill	Refer to Section 3	
5.		x	Verbally notify AMSA Rescue Coordination Centre (RCC)	24 hr AMSA Ph: 1800 641 792 Notification to AMSA RCC. AMSA is the Control Agency and will respond in accordance with its Marine Pollution Response Plan (National Plan 2017). ERT, IMT (W), and Seismic Contractor IMT will provide support as directed by AMSA.	
6.	x		Shell to Activate IMT (W; Refer to weekly contact list HSE_GEN_011648 for IMT Leader 24-hour coverage.)	Ph: +61 (0)420 909 376: IMT Leader to liaise closely with AMSA Incident Commander regarding response.	
7.	x		Establish coordination with Seismic Contractor IMT.	Communicaiton protocols to be established during survey planning phase and included in Operaitonal Plans.	Both Shell IMT and Contractor IMT to support Control Agency (AMSA)
8.		x	Prepare Pollution Report (POLREP), submit it to AMSA and give copy to IMT (W)		Contractor and Shell IMT to verify completion
9.	x		Verbally notify NOPSEMA of Level (Tier) 2 or Level (Tier) 3 spill **within 2 hours.**	Ph: **(**08) 6461 7090. Complete verbal notification within 2 hours of spill occurrence (see section 15 for external notifications/forms)	
10	x		Immediate notification to Shell STASCo on +44 20 7934 7777 in the event of; • a spill to water from maritime transportation operations; or	IMT Leader Call +44 20 7934 7777	

	Responsible Role		Spill from Vessel (AMSA Control Agency)		
Item	**IMT (IMT Leader)**	**VM**	**Initial (First Strike) Actions**	**Information Resources/ Contact Information**	**Comments**
			• any Shell related marine incident		
11	x		IMT(W) Leader to engage with appropriate Shell Business Executive who will in turn liaise with the Crisis Management Team CMT		
12	x		Initiate further Monitor and Evaluate actions: aerial, vessel, modelling, satellite, weather forecasts	Shell IMT (W) has modelling resources. To contact RPS APASA contact Australian Marine Oil Spill Centre (AMOSC) Shell IMT (W) to contact support vessels in the vicinity to be on stand-by	
13	x		Mobilise Oil Spill Monitoring Plan (OSMP) contractor	Environment Unit to contact contractor (AIMS) on +61 459 823 427 or +61 428 113 906 or +61 413 734 467 or +61 418 883 069	
14	x		Initiate incident planning for next operational period.	IMT(W) Leader to seek input and agreement from AMSA Incident Controller (IC) as the Control Agency.	

13. Introduction

This OPEP outlines preparedness and response arrangement for worst credible spill scenarios that may occur as a result of the Factory 3D Seismic. The plan also describes response arrangements, preparedness and capability, roles and responsibilities and competency associated with the response.

Shell Australia has significant operational presence in the Browse Basin due to its Prelude FLNG project, approximately 55km to the south-west of the survey area, which provides a high level of existing Emergency Response preparedness in the region which can be leveraged for this seismic exploration activity. A majority of the Emergency Response capability presented in this OPEP, including trained personnel, IMT and Command, support, and plans are provided by these existing Prelude FLNG arrangements.

13.1. Objectives

The objectives of this OPEP are to:

- provide guidance to Shell Australia such that, in the event of a spill, a rapid and effective initial (first strike) response and transition to an extended response can be implemented (if required);
- provide guidance for the initiation of the OSMP;
- meet regulations under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS (E) Regulations);
- outline oil spill response roles and responsibilities;
- integrate with the National Plan for Maritime Environment Emergencies 2017 (National Plan) and DoT State Hazard Plan – Maritime Environmental Emergencies (MEE) 2018 (formerly WA State Westplan – Marine Oil Pollution (MOP)) requirements for preparedness and response for vessel and offshore petroleum facility spills;
- meet Shell's requirements under the HSSE &SP Control Framework: Spill Preparedness and Response Manual and Specification; and
- Integrate with Shell Australia's Emergency Management Procedures (HSE_GEN_010996) and supporting Emergency Response Arrangements.

The following table provides a quick reference of information relevant to the Seismic Operation with respect to oil spill preparedness. Further information on the types and characteristics of the oil can be found in Appendix 4.

Table 13-1: Field Details, Scenario Details and Supporting Arrangements Summary

Field	Factory 3D Seismic Acquisition
Permit Area	AC/P65, WA-534-P and adjacent acreage
Basin	Northern Browse
Water Depth (MSL)	Approximately 100-300 m
Facility Operator	Seismic Contractor (TBC)
Support Vessels	1x Seismic Acquisition Vessel 2x Support vessels
Neighbouring Installation/s	Montara ~40km north-east Prelude FLNG ~55km south-west Ichthys FPSO ~70km south-west
Hydrocarbon Type/s	Marine Diesel Oil Marine Gas Oil
ITOPF Classification	Marine Diesel Oil (MDO): Group 2 – 3

<table>
<tr><td></td><td colspan="3">Marine Gas Oil (MGO): Group 2 – 3</td></tr>
<tr><td>Worst Case Scenarios/ Maximum Possible H/C Inventory</td><td colspan="3">Marine Diesel Oil (MDO): An instantaneous release of 250 m³ of marine diesel oil at the surface following a rupture of a single fuel tank.</td></tr>
<tr><td rowspan="3">Worst Case Scenarios Minimum time to shoreline [hours (days)] for ≥ 100 g/m², probability ≥ 1%</td><td colspan="2">Receptor</td><td>Minimum time (hrs.)</td></tr>
<tr><td colspan="2">Cartier Island AMP</td><td>14 hrs</td></tr>
<tr><td colspan="2">Ashmore Reef AMP</td><td>80 hrs</td></tr>
<tr><td rowspan="2">Expected waste volumes in worst case spill scenarios (for oiling ≥ 100 g/m², probability ≥ 1%)</td><td>Spill event</td><td>Worst-case credible spill size (m³)</td><td>Worst Case accumulated volume (m³) along the shoreline</td></tr>
<tr><td>Marine Diesel/Gas Oil</td><td>250</td><td>80 m³ at Cartier Island
36 m³ at Ashmore Reef
37 m³ at Browse Island
2 m³ at Scott Reef and Sandy Island</td></tr>
<tr><td>Within Environmentally Sensitive Area or Marine Protected Area?</td><td colspan="3">Browse Island, Scott Reef (Marine Park), Cartier Island (AMP) and Ashmore Reef (AMP) are both environmentally sensitive areas.
All other sensitive receptors are located greater than 60 km from the survey area and slick modelling indicates minimal impact at this range.</td></tr>
<tr><td>Supporting Contractors/ Organisations/ Other Control Agencies</td><td colspan="3">Seismic Contractor, AMOSC AMSA (Control Agency also – refer to Section 16.1), DOEE (or DBCA), AIMS, OSRL, STASCo (GRSN; Shell).</td></tr>
</table>

14. Spill Levels Classification

The following table has been adapted from the National Plan for the seismic survey. It is intended to provide guidance to the responders on the initial 'Level' classification of a spill.

Table 14-1: Spill Level Classification Guide

Characteristic	Level 1	Level 2	Level 3
Management			
Jurisdiction	Single jurisdiction (Commonwealth Waters)	Multiple jurisdictions (State/Commonwealth Waters)	Multiple jurisdictions, including international
Resources	Resourced from within the local area	Requires intra-state resources	Requires national or international resources
Type of Incident			
Type of response	First-strike	Escalated	Campaign
Duration of response	Single shift	Multiple shifts Days to weeks	Extended response Weeks to months
Resources at Risk			

Environment	Isolated impacts or with natural recovery expected within weeks	Significant impacts and recovery may take months. Remediation required	Significant area and recovery may take months. Remediation required
Public Affairs	Local and regional media coverage	National media coverage	International media coverage

15. Notification and Reporting - External

Shell IMT (W) is responsible for making most external notification and reporting except where outlined in initial (first strike) actions Table A. The following table outlines external notification and reporting requirements required for Level 2 and Level 3 incidents. Information on relevant organisation which may provide support in the event of a spill is provided in Section 5.2.

Table 15-1: Support Organisations Activation and External Notifications and Reporting

Agency or Authority	Reporting Requirements and Contact Details	Responsibility & Timing	Legislation/ Guidance	Links to Reporting Forms
Notifications				
AMSA	All hydrocarbons released from a vessel All spills in the marine environment (notwithstanding the size or amount of oil or sheen) All spills where National Plan equipment is used in a response Email: marine.pollution@transport.wa.gov.au	Immediate notification by the Vessel Master to AMSA Written Marine Pollution Report (POLREP) form submitted by the Vessel Master or Shell Representative to AMSA, 24 hours following request by ASMSA.	National Plan for Maritime Environmental Emergencies (National Plan)	Incident Reporting Requirements: https://www.amsa.gov.au/forms/incident-report AMSA POLREP: https://amsa-forms.nogginoca.com/public/polrep.html National Plan: https://www.amsa.gov.au/sites/default/files/2014-11-np-gui003-accessing-national-plan-support-arrangements.pdf
NOPSEMA	A spill associated with the activity that has caused, or has the potential to cause, moderate to significant environmental damage: Vessel loss of containment (MDO)	Notification by Shell Representative to NOPSEMA, within 2 hours Written report submitted by the Shell Asset Manager to NOPSEMA, as soon as possible, within 3 days	Offshore Petroleum and Greenhouse Gas Storage Act 2006 Offshore Petroleum Greenhouse Gas Storage (Environment) Regulations 2009	Incident Reporting requirements: https://www.nopsema.gov.au/environmental-management/notification-and-reporting/
NOPTA and DMIRS	Spill to Commonwealth Waters that is	Written report submitted by the Shell Asset Manager to	Guidance Note (N-03000-GN0926) Notification and Reporting of	Provide same written report as provided to NOPSEMA

Agency or Authority	Reporting Requirements and Contact Details	Responsibility & Timing	Legislation/ Guidance	Links to Reporting Forms
	reportable to NOPSEMA and DMIRS NOPTA email: titles@nopta.gov.au DMIRS email: webmaster@DMIRS.wa.gov.au	NOPSEMA, as soon as possible. Shell Representative to provide a copy of the report provided to NOPSEMA, to both NOPTA and DMIRS, within 7 days of the initial report being submitted to NOPSEMA	Environmental Incidents	
WA DoT	Offshore Petrolium Activity spill which enters State Waters (or with potential to impact state waters) from a vessel, unknown source or Offshore Petroleum Facility. 24-hour reporting number: (08) 9480 9924	Immediate notification by IC to the WA DoT Maritime Environmental Emergency Response (MEER) Duty Officer Written POLREP submitted by Vessel Master to DoT, as soon as practicable Written Situation Report (SITREP) submitted by the ERT or IMT (depending on level of activation), within 24 hours of being directed by DoT	DoT State Hazard Plan – Maritime Environmental Emergencies (MEE) 2018 DoT OFFSHORE PETROLEUM INDUSTRY GUIDANCE NOTE Marine Oil Pollution: Response and Consultation Arrangements https://www.transport.wa.gov.au/mediaFiles/marine/MAC_P_Westplan_MOP_OffshorePetroleumIndGuidance.pdf	DoT POLREP: http://www.transport.wa.gov.au/mediaFiles/marine/MAC-F-PollutionReport.pdf SITREP: http://www.transport.wa.gov.au/mediaFiles/marine/MAC-F-SituationReport.pdf
DoEE	Level 2 or Level 3 spills. Any spills impacting Protected Matters (i.e. Ashmore Reef National Nature Reserve). Ph: 1800 110 395 or email: compliance@environment.gov.au	ASAP (within 4 hours) The EPBC Act (Part 3 and 13) provides for the making of exemptions if in the national interest with the National Plan	EPBC Act 1999 compliance and enforcement mechanisms	Protected Matters: https://www.environment.gov.au/epbc/compliance-and-enforcement/report-a-breach
Director of National Parks	Spill to Australian Marine Park (or with potential to impact to an Australian Marine	Emergency response activities in Australian Marine Parks must	Relevant Australian Marine	

Agency or Authority	Reporting Requirements and Contact Details	Responsibility & Timing	Legislation/ Guidance	Links to Reporting Forms
	Park) from a vessel, unknown source or Offshore Petroleum Facility. Ph: (02) 6274 2220	be carried out in accordance with the management plan or with Director of National Parks approval if there is no current management plan.	Park Management Plan	
DBCA	Level 2 or Level 3 spills where potential exists for oil to enter state waters Ph: (08) 9219 9108	ASAP (within 4 hours)	WA Oiled Wildlife Response Plan	WA Oiled Wildlife Response Plan https://www.DBCA.wa.gov.au/images/documents/conservation-management/marine/wildlife/West_Australian_Oiled_Wildlife_Response_Plan_V1.1.pdf
DPIRD	Level 2 or Level 3 spills Ph: +61 4 3007 0159 Or email: environment@fish.wa.gov.au	ASAP (within 4 hours) Reporting of suspected or confirmed presence of any marine pest or disease be reported within 24 hours by email or telephone.	Key stakeholder (Fisheries)	
DWER	Level 2 or Level 3 spills Ph:1300 784 782	ASAP (within 4 hours) when considered spill could enter state waters	Environment Protection Act	
DMIRS	Level 2 or Level 3 spills Ph: + 61 419 960 621– Or Email: petroleum.environment@dmirs.wa.gov.au	ASAP; when considered spill could enter state waters	Consultation and under the OPGGS Act.	
OPICC (Offshore Petroleum Incident Coordination Committee)	Email: opicc@industry.gov.au Email/Phone (2): catherine.kesteven@industry.gov.au - 02 6243 7368 Email/Phone (3): christina.bee@industr	ASAP (within 4 hours)	Aust. Govt. agreed oversight committee for central incident coordination and oversight, chaired by the Dept. of Industry.	

Agency or Authority	Reporting Requirements and Contact Details	Responsibility & Timing	Legislation/ Guidance	Links to Reporting Forms
	y.gov.au - 02 6276 1026			

16. Incident Management System

Shell utilise the Incident Command System (ICS) IMS framework. This enables Shell to conduct a more effective response through use of a broad range of personnel resources by using globally consistent terminology.

16.1. Control Agency Interface and Responsibilities

For this activity, in the event of a spill within the operational area, AMSA will be the control agency because the activity is in commonwealth waters. The WA DOT, states that: "*The Controlling Agency remains true to the incident initial location. If a Maritime Environmental Emergency crosses over defined waters boundaries, the Controlling Agency will remain with the original nominated agency or organisation unless otherwise appointed through agreement between the HMA / Jurisdictional Authority of both waters*."

The responsibility for an oil spill is dependent on location and spill origin. The National Plan sets out the divisions of responsibility for an oil spill response (see Table 4). The National Plan defines the Control Agency as follows:

Control Agencies: the agency or company assigned by legislation, administrative arrangements or within the relevant contingency plan, to control response activities to a maritime environmental emergency. The legislative or administrative mandate should be specified in the relevant contingency plan. The Control Agency will have responsibility for appointing the Incident Controller (AMSA, 2017).

Table 16-1: Control Agency Assignments for the Seismic acquisition programme

Jurisdictional Boundary	Spill Source	Jurisdictional Authority	Control Agency		
			Level 1	Level 2	Level 3
Commonwealth Waters	Vessel	AMSA	AMSA	AMSA	AMSA
WA State Waters (3 nm from baseline; Inc. Browse Island)	Vessel	DoT	Shell Australia (titleholder)	DoT	DoT

** In accordance with DoT State Hazard Plan – Maritime MEE: In the event of a Level (Tier) 2/3 oil spill incident resulting from an Offshore Petroleum activity in Commonwealth waters that impacts State waters, the role of Controlling Agency will be performed by DoT for response activities in State waters. In such instances a DoT liaison officer should be requested to be mobilised to the Shell IMT ASAP. The initial response for all spills in State waters will be conducted by Shell in accordance with the WA DoT Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (IGN).*

<u>AMSA</u>

"*For all other marine pollution incidents in Commonwealth waters, including those from ships and offshore petroleum activities that are not related to offshore petroleum facilities, AMSA has Control Agency responsibility*" (AMSA 2017).

In the instance that AMSA is the Control Agency, Shell has committed, under Clause 7 of a memorandum of understanding (MoU) between Shell and AMSA, that Shell: "*agrees to provide all available support to AMSA and AMSA's performance of its Combat (Control) Agency responsibilities*".

For instances where Shell, as the control agency, requests assistance of AMSA through the MOU, Shell will request an AMSA liaison officer be mobilised to the IMT as soon as possible. In the interim period, until AMSA have assembled their IMT, Shell (IMT Leader) will liaise closely with the AMSA liaison officer and or the AMSA incident controller to inform them of first strike actions being taken.

General

Other key general interface issues between Shell and AMSA include external communications and information sharing are discussed below.

External communications; A joint communications team between Shell and AMSA will sought to be established to align external communications.

Information sharing; Information sharing in the early stages of a response between Shell and AMSA (as relevant) will be through the most efficient means possible which will likely be either telephone conversations, emails or face to face. Documentation of such communications will be held in incident logs wherever possible. This includes sharing of key information such as initial SIMA's.

16.2. Support Organisations Activation

Shell has numerous agreements in place with support organisations involved in the storage, maintenance and mobilisation of level 2 and level 3 spill response resources. Support organisations which Shell Australia can call on in the event of a Level 2 or Level 3 spill are outlined below. Information on support organisations equipment capability is outlined in Appendix 2. The IMT is responsible for making support team activations as outlined in the initial (first strike) response tables A and B.

- **Australian Marine Oil Spill Centre (AMOSC): Typically level 2 and 3 response.** Shell is a participating company member of AMOSC, established by the Australian Institute of Petroleum (AIP). AMOSC has extensive spill response equipment located throughout Australia (see Appendix 2). In the event that the oil spill response requires the call-out of AMOSC and the AMOSPlan, the request from Shell will be made directly to AMOSC by the GM HSE, IMT Leader or Shell Australia Emergency Manager.
- **Australian Marine Safety Authority (AMSA)**: **Typically level 2 and 3 response.** AMSA is established under the Australian Maritime Safety Authority Act 1990 with responsibilities for maritime safety and combat of pollution in the marine environment or other environmental damage caused by shipping. AMSA manages the National Plan and associated arrangements on behalf of the Australian Government. AMSA will coordinate the resources of the National Plan for Maritime Environmental Emergencies on the formal request of the appointed Incident Controller. Notification of AMSA will be through Joint Rescue and Coordination Centre Australia (JRCC – Operated by AMSA) on ph: 1800 641 792.
- **Shell Global Response Support Network (GRSN): Typically level 3 response.** Shell has a global Level 3 response network, Global Response Support Network (GRSN). The GRSN is activated through the Shell Tanker and Shipping Company (STASCo)/ Shell Oil Spill Expertise Centre (OSEC; +44 207 934 7777- STASCo). The GRSN can supply necessary trained personnel from Australia and throughout the world to provide incident management, field command and supervision of response teams.
- **Oil Spill Response Ltd (OSRL): Typically level 3 response.** Shell is a participating member of the internationally based Oil Spill Response Ltd (OSRL) and can access their support directly. Shell Australia can contact ORSL via STASCo and receive free technical support for the first 48hrs but OSRL mobilization for Shell only comes from preapproved individuals within Shell Oil Spill Expertise Centre (OSEC; +44 207 934 7777-CASCO/STASCo). For OSRL advice over the phone; call +65 6266 1566.
- **Department of Biodiversity, Conservation and Attractions (DBCA): Typically level 2 and 3 response.** Shell will directly contact DBCA as outlined in the Western Australia Oiled Wildlife Response Plan requesting support to implement oiled wildlife response as outlined in Section 18.4. DBCA can be contacted 24/7 on Ph: (08) 9219 9108 by the IMT Leader.
- **Australian Institute of Marine Science (AIMS): Level 2 and 3 response** AIMS provide Shell with operational and scientific monitoring resources and expertise in the event of a Level 2 or 3 oil spill. AIMS can be activated by calling any of the following numbers; +61 459 823 427, +61 428 113 906, +61 413 734 467, +61 418 883 069.

- **Offshore Petroleum Incident Coordination Committee (OPICC):** The Australian Government has agreed that in responding to offshore petroleum incidents originating in Australian Government waters, a central incident coordination committee be convened and chaired by the **Department of Industry, Innovation and Science**. The purpose of OPICC is to effectively coordinate the Australian Government efforts and resources, and communicate to the public and affected stakeholders all matters relevant to a significant offshore petroleum incident that originates in Commonwealth waters. E: opicc@industry.gov.au

16.3. Interface with Other Plans

The Seismic Vessel Shipboard Oil Pollution Emergency Plan (SOERP) and Emergency Response Plan (ERP) provides procedural guidance on the roles, responsibilities, actions, reporting requirements, emergency management processes and facilities that are in place to manage all emergencies, including oil spills. This OPEP supplements the vessel SOPEP/ERP to include Shell arrangments and procedures and focused on implementation of an effective oil spill response. These additional documents are available on the Shell intranet as controlled documents, however pertinent content is included below on the organisation, command structure and capability for completeness of this OPEP.

- **Shell Australia Oil Spill Monitoring Plan HSE_PRE_000496:** This plan describes the operational and scientific monitoring that would be undertaken in the event of either Level 2 or 3 spills.
- **Shell Australia Incident Management Team (IMT; West) Emergency Response Plan HSE_GEN_011209:** Describes roles and responsibilities of the level 2 IMT(W) in response to an all hazards emergency.
- **Weekly Contact List Work Instruction HSE_GEN_011648:** This work instruction contains all relevant contact and communications information for the weekly Shell Australia Incident Management Team (West) roster to enable effective communication amongst the response personnel and external stakeholders. It is updated and kept live at all times. This is done on a weekly basis in line with the weekly IMT (W) handover.
- **Rolling Ex Plan:** Is a document which is stored in Share Point, in the Oil Spill Response folder.
- **Shell Australia Crisis Management Manual and Instruction;** Relating to this OPEP, the Crisis Management Team will provide for expanded external and media communications ability during a spill event.
- **Shell Australia Emergency Management Procedure HSE_GEN_010996:** This plan describes the process the SA Emergancy Management process in detail. Including the IMT structure and how it feeds into the CMT.
- **Browse Island Incident Management Guide** This Plan aims to specifically outline detailed tactics planning to allow an effective/pre-planned response at Browse Island along with other offshore island or remote locations (for all remote locations this document shall be used and inferred, due to a high number of islands and remote beachs accessible only from sea it is not possible to plan for each island, the concept from this plan will be inferred for each island, IMT members will need to work closely with the environment unit and ESC to develop specific SIMA’ s and understand the senistivities of each location in the intial response planning) in the event they are impacted from a spill.

Shell interfaces with the following key external plans:

- **Vessels’ Shipboard Oil Pollution Emergency Plan (SOPEP) Plans:** These plans contain details about the ship, roles and responsibilities in the event of a spill and spill response equipment on board. MARPOL 73/78 requires that every oil tanker of 150 tonnes gross tonnage and above, and every ship of 400 gross tonnes and above carry a shipboard oil pollution emergency plan (SOPEP) approved by the Administration. It is the same Shipboard Marine Pollution Plan that is required under the OPRC Convention. Shipboard Marine Pollution Plans also include noxious liquid substances and should more correctly be called “Shipboard Marine Pollution Emergency Plan”. The plans must be prepared in accordance with vessel class and flag state requirements and guidelines as laid down by the International Maritime Organisation (IMO).

- **National Plan:** The National Plan for Maritime Environmental Emergencies (2017) has been developed by the Commonwealth and State governments and is administered by the Australian Maritime Safety Authority (AMSA). It defines the efforts and resources of the Commonwealth and State Governments and the oil and shipping industry to combat oil spills in the marine environment.
- **State Hazard Plan and DoT Industry Guidance Note:** State Hazard Plan Maritime Environmental Emergencies (MEE; 2018) supports the National Plan for Western Australia waters, and is administered by the Department of Transport (DoT) Western Australian Hazard Management Agency, as detailed in the Emergency Management Regulations 2006. The plan details the arrangements between State Government agencies, industry and AMSA where relevant to combat marine oil pollution within WA. It prescribes responsibilities and procedures and provides a basis for coordination of resources for responding to spills. Further details of detail of DoT expectation relating to Shell's role in a offshore petroleum activity State water response is outlined within the DoT Industry Guidance Note (Sep 2018).
- **Western Australian Oiled Wildlife Response Plan:** Owned and administered by the Western Australia Department of Biodiversity, Conservation and Attractions (DBCA), this Plan sets out the minimum standard required for an oiled wildlife response (OWR) in Western Australia in both Commonwealth (upon request by Shell or DOEE) and State waters.
- **AMOSPlan:** This plan is managed by the AMOSC and will be activated by Shell when the response to an oil spill incident is regarded by Shell to be requiring resources beyond those of Shell. The plan coordinates the participation of the oil industry in the National Plan. AMOSC's role includes the:
  - provision of oil spill response personnel and equipment;
  - provision of oil spill training services at the training centre in Geelong; and
  - administration of the oil industry mutual aid arrangements where industry oil spill response resources are available to other operators and to the National Plan.

16.4. Organisation

The Shell spill response organisation is structured in line with the internationally recognised ICS system. The response organisation which will operate for a spill response is completely scalable suited to the nature and scale of the incident. A Level (Tier) 1 incident may have only a few responders whilst a Level (Tier) 3 spill may have hundreds or possibly thousands of personnel across multiple support organisations. The scalability of the response organisation includes support organisations which are outlined in more detail in Shell Australia Incident Management Team (IMT; West) Emergency Response Plan (HSE_GEN_011209) and summarised below.

Escalated Response (In Country)

As part of its emergency management arrangements Shell Australia has as membership of the Australian Marine Oil Spill Company (AMOSC), access to both AMOSC OSR advice and equipment (AMOSC and National Plan (AMSA) stockpiled OSR equipment). Further to this, access is also provided to the AMOSC managed industry based OSR Core Group to which Shell Australia also provides resources. Further access is also granted on request via AMOSC to pre-agreed O & G industry mutual aid.

International Escalation

Where the incident grows to beyond in country resources to manage, or when the business does not have the resources to manage the incident, the Global Response Support Network (GRSN) may be activated by mutual agreement through existing emergency management arrangements, which includes notification of STASCo Casualty Notification +44 (0) 207 937 7777 (also for all Marine events) The business may delegate the incident management to the GRSN for effective management of such incidents. These arrangements are documented in STASCO's Spill Response Plan.

When an oil or hydrocarbon spill incident threatens Shell's reputation in country, both the Incident Management Team (IMT (W)) and the Crisis Management Team (CMT) will be activated, in accordance with Shell Australia's emergency management arrangements. It is important that from the outset, the interfaces between the teams are identified and that the teams work alongside and in support of each other. The Country Chair is responsible for managing Shell's reputation in country

The business having an incident is accountable for the incident management. Shell Australia through its' emergency management arrangements has plans in place (relevant ERP, OPEP & Environment Plans) to manage oil and hydrocarbon spills to water.

16.4.1. Command Structure

Shell Australia Incident Management Team (IMT; West) Emergency Response Plan (HSE_GEN_011209) describes roles and responsibilities of the level 2 IMT(W) in response to an all hazards emergency.

The key organisations which make the response team(s) up are the affected facility Emergency Response Team (ERT), which will be a Contractor organisation, and the IMT (W) The following figure outlines the ERT & IMT (W) organisations which are scalable to the nature and scale of the response i.e. one person can take on multiple roles where circumstances permit. The mobilisation of the ERT is at the directive of the Vessel Master or delegate. The mobilisation of the IMT (W) will occur by the Facility Incident Commander (IC) contacting the on-duty IMT (W) Leader who will then mobilise the IMT (W) as the situation warrants. The ICC for Shell will be held in the Shell ICC, level 4 and Shell House if an escalation is required arrangements are in place to escalate and move the ICC to the Recency Hyatt Hotel.

Interface between the IMT and Crisis Management Team (CMT) are outlined in the Business Unit Executive Roles in the SA Weekly Contact List (HSE_GEN_011648). The affected facility business executive will have been notified by the IMT (W) Leader and will in turn notify the Shell Australia CMT leader.

16.4.2. Key Roles and Responsibilities

There are various key roles and responsibilities in the initial (first strike) actions stage of a spill response that are key to an effective and efficient response (Figure 1 – Command Structure). The IMT(W) Leader determines the size and nature of the activated response organisation in consideration of the Level of the incident (Level 1, 2 or 3), nature of the incident (i.e. MEDEVAC vs Hydrocarbon Release), scale of response, and utilising the principle of 'prudent over-reaction'.

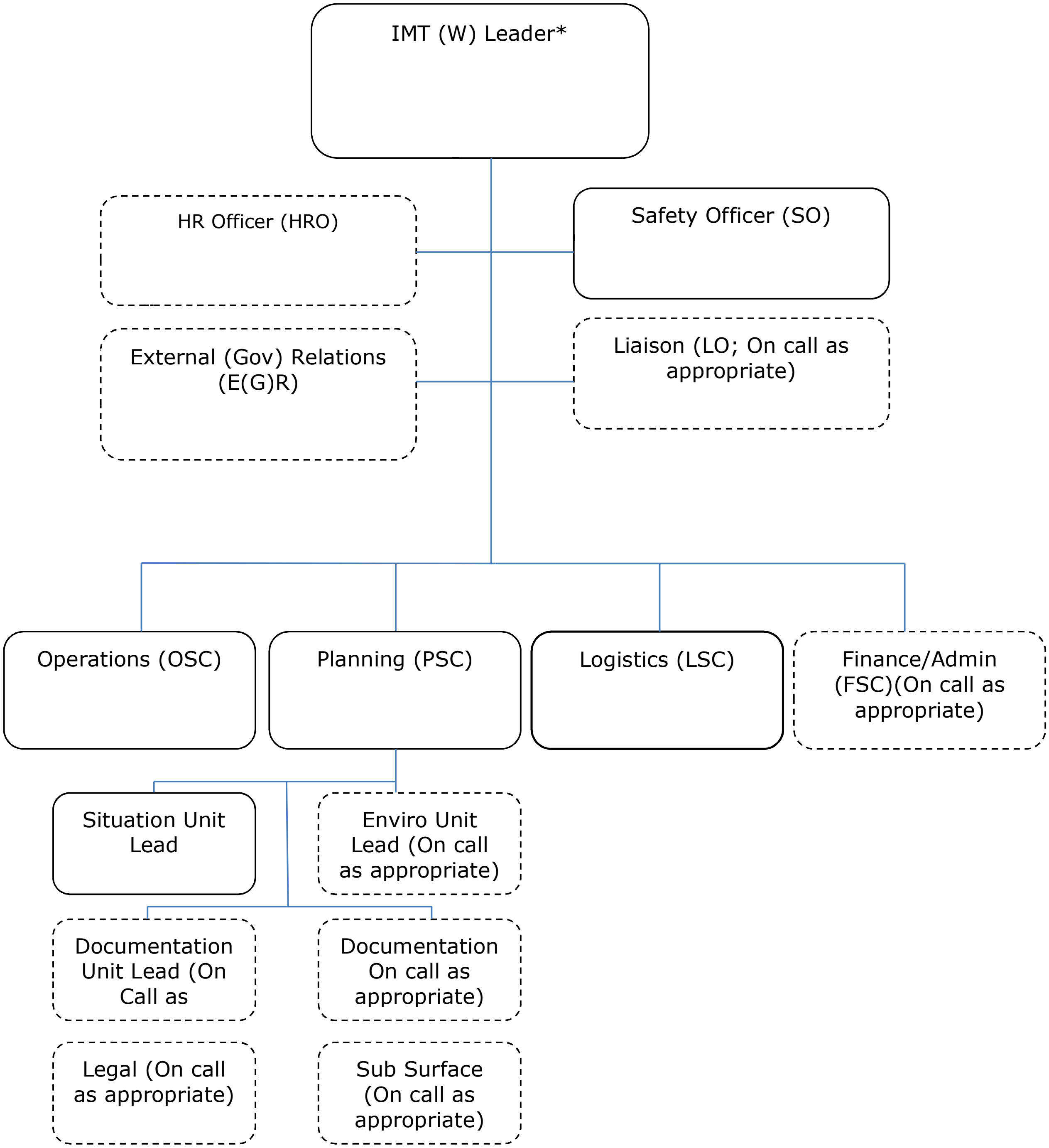


Figure 16-1: Incident Management Team (West; IMT (W)) Structure

* In level (tier) 2 and 3 spills where DoT is activated as the Control Agency for state waters response, the IMT (W) will be managed through coordinated command (DoT owns decisions in state waters, Shell in Commonwealth waters)

Table 16-2: Key Initial (first strike) Actions

Key Roles	Responsibilities: Key Initial (First Strike) Actions	Complete
ERT (Vessel Master)	Classify the level of spill	□
	Initiate Monitor and Evaluate: Gain situational awareness. Deploy satellite tracking buoy as close to the spill source as possible.	□
	Notify IMT (W)	□
	Notify NOPSEMA within 2 hours	□
IMT Leader	Ensure all first strike actions carried out per OPEP.	□
	Vessel Spills: Seek verbal or written confirmation on IAP actions from Control Agency (AMSA IC or liaison officer until AMSA IC is in place) until AMSA forward mobilise to Perth incident management centre.	□
	Offshore petroleum Facility Spill entering WA state waters: Seek verbal or written confirmation on state water IAP actions from Control Agency (DoT IC). This requirement does not apply for vessel based spills.	□
	Mobilise AMOSC, DoT and DBCA (and AMSA, STASCo (GRSN) and OSRL as required)	□
	Notify key stakeholders, request liaison officers (AMSA and/or DoT) imbedded in IMT and keep informed as appropriate.	□
	Initiate further Monitor and Evaluate actions: aerial, vessel, modelling, satellite and weather forecasts.	□
Operations Section Chief (OSC)	Initiate and execute field oil spill response strategies as relevant to the spill (e.g. source control)	□
Planning Section Chief (PSC)	Mobilise Environment Unit	□
	Facilitate Development of IAP for next operational period	□
Logistic Section Chief (LSC)	Locate and commence mobilisation of required resouces to staging areas.	□
E(G)R	Follow E(G)R Emergency Response/Crisis plans and associated supporting tools.	□
Environment Unit (SME in IMT (W) structure)	Mobilise OSMP contractor	□
	Identify protection priorities	□
	Validate strategic SIMA to generate the initial operational SIMA.	□
Situation Unit	Modelling (internal and external)	□
Safety Officer	Make all external notifications per section 15.	□
	Ensure all facets of the current and future operations and IAPs are correctly risk assessed	□

Key Roles	Responsibilities: Key Initial (First Strike) Actions	Complete
Finance (& Admin)	The Finance (& Admin) Section Chief is responsible for all financial, administrative and cost analysis aspects of an emergency and for supervising members of the Finance/Admin Section. (Refer to IMT (W) Finance (& Admin) Section Work Instruction (HSE_GEN_011727).	☐

17. Strategic Spill Impact Mitigation Assessment (SIMA)

The strategic SIMA was developed based on the risk evaluation, ALARP and acceptability assessments for all the emergency events outlined within the Bratwurst-1 Drilling Campaign EP.

An Operational SIMA will be conducted in an extended response using the strategic SIMA as the initial basis. If required, a more detailed SIMA will be conducted following the SIMA process outlined within the IMT (W) ERP (HSE_GEN_011209) – Environment Unit Lead Duty Card (10). As always documented justificaitons for decisions made is important as this process forms the basis for what spill response strategies will be implemented through each operational period of an IAP. The SIMA will consider relevant receptors when conducting the SIMA. This will include consideration of relevant information outlined in Marine Park Management Plans or Threatened Species Recovery Plans as relevant to the spill. These plans will help inform the proposed response options for implementation and that any impacts from these are acceptable in the context of the impacts to the specific values and sensitivities.

Following implementation of the initial (first strike) response, it is always important to provide documented justification of reasoning for decisions being made in a response, hence the table below outlines reasons why or why not they planned to be used during the Initial (First Strike) Actions.

Table 17-1: Strategic SIMA: Strategy applicability to credible worst case scenarios used for planning initial (first strike) response

Strategy Applicability	**Vessel collision – MDO or MGO (~up to 250 m^3)**
1. Monitor and Evaluate	**Planned (First Strike)** - Monitor and Evaluate is applicable and helpful in all spill events. This strategy has several sub strategies (personnel surveillance through to aerial surveillance) and is scalable according to spill nature and scale. SIMA will always support the implementation 'Monitor and Evaluate' given the clear benefits in maintaining situational awareness throughout the duration of a spill event and little or no environmental impact associated with its implementation. This strategy intentionally duplicates some tools outlined in the Oil Spill Monitoring Strategy.
2. Natural Recovery	**Planned (First Strike)** - Natural recovery is the most effective response to reduce the spill volume through natural weathering and fate processes.
3. Chemical Dispersant	**Not planned** - Diesel evaporates and spreads rapidly and will likely be too thin to enable effective use of chemical dispersants.
4. Contain and Recover	**Not planned** - Diesel spreads too quickly and it will be too thin to corral, it will mostly degrade naturally. There is no net environmental benefit.
5. In-situ Burning	**Not planned** - Diesel spreads too quickly and it will be too thin to corral to enable in-situ burning.
6. Protect and Deflect	**Not planned -** The 'Protect and Deflect' strategy is unlikely to work in the deep water, open ocean environment immediately surrounding the emergent sensitivities (reefs). Access to the shallow intertidal area on top of emergent sensitivities is likely to be very difficult/not safe. Potential boats are too small to be safely able to use set up booms and anchors to protect the island. Even if the boats could carry the anchors, anchor and boom placement in the shallow intertidal area is likely to cause more direct damage reefs. Strong tides and currents are also a limiting factor for any shoreline deflection boom deployment along coastlines or islands.
7. Shoreline clean up	**Planned –** Given the worst-case scenario (250m^3 of MDO) it is considered unlikely that shoreline impact requiring shoreline clean-up will occur due to the volume and lack of persistence of the spilled oil. However, in the unlikely event of shoreline contact, shoreline clean up could be carried out at contacted shorelines such as Cartier Island and Browse Island (Key Ecological Receptors). Preparations for shoreline response should be made as soon as predictions indicate a possible shoreline impact.
8. Oiled Wildlife	**Planned -** Oiled wildlife unlikely to occur, but in the event oiled wildlife are detected during a response, oil wildlife response may be carried out if deemed appropriate in consultation with DBCA, AMOSC, DOEE and/or AMSA under the mutual aid agreement.
9. Oil Spill Monitoring Plan	**Planned (First Strike) –** In the event of a level 2 or level 3 spill, the oil spill monitoring plan will be enacted. Some key operational monitoring techniques are also covered under the monitor and evaluation strategy (OM1, OM3 and OM8) as well.

18. Response Strategies

The response strategies implemented as a part of a spill response are outlined for each worst credible spill scenario in the Strategic SIMA (Section 17, Table 17-1). This section provides an overview of each of the available (planned) response strategies which includes;

- Overview
- Objective
- Commencement and Termination Criteria; and
- Capability (including personnel, equipment and logistics)

The relevant (planned) strategies available to Shell Australia for the worst-case credible spill scenario (250m^3 MDO) include:

- Monitor and Evaluate;
- Natural Recovery;
- Shore-line Clean up;
- Oiled Wildlife Response;
- Oil Spill Monitoring Plan.

Other oil spill strategies are possible but are not deemed appropriate for the expected oil spill scenarios for this seismic survey. These additional strategies may be considered dependant on the specifics of a developing incident, but are not Planned responses for this OPEP:

- Chemical Dispersant (not effective on Marine Diesel Oil);
- Contain and Recover;
- In-situ burning;
- Protect and Deflect;

The implementation of response strategies will be subject to their ability to be executed safely and effectively. Constraints on the execution of response strategies applicable on the day may include but not be limited to; time of day, weather conditions and seasons, actual properties of the oil and seasons, safety and compliance with SOLAS 1974. Where timeframes are given for the implementation of response strategies, this is always subject to suitable conditions to safely implement the strategy.

18.1. Monitor and Evaluate

18.1.1. Objective

The objective of the monitor and evaluate strategy is to acquire and maintain situational awareness at all times throughout the duration of a spill event to inform decision making throughout the response through to response termination. This strategy will also determine the effectiveness of response strategies. This strategy will be implemented continuously for all types of spills.

18.1.2. Overview

As there is an insignificant environmental impact associated with the monitor and evaluate strategy, a SIMA will always support the implementation of the strategy given the clear benefit of maintaining situational awareness throughout the duration of a spill event. The strategy is also covered under the oil spill monitoring strategy (Section 18.5 and the OSMP (HSE_PRE_000496) primarily through the use of Operational Monitoring (OM); OM1, OM3 and OM8.

18.1.3. Commencement and Termination Criteria

This strategy will commence for every spill to water as soon as the spill occurs. This may range from very simplistic visual observation only through to more involved monitor and evaluate tactics.

Termination of the strategy will cease:

- For visible oil observation when the spill is no longer visible to observers.
- Agreement is reached with relevant regulators (i.e. AMSA) and stakeholders to terminate the incident response.

18.1.4. Capability

There are several tools available for the monitor and evaluate strategy. The entire strategy is also covered by implementation of several of the operational monitoring guidelines (OM's) outlined in the Oil Spill Monitoring Plan (OSMP). Specifically, the relevant OM's for implementing monitor and evaluate are outlined below in Table 18-1.

Surface oil Observation

Tracking Buoys

Oil Spill tracking buoys will be provided to the seismic and/or support vessels to be deployed in the instance of a vessel-based spill. Deployment should be co-ordinated through the SA IMT (W) Geomatics team.

Satellite Imagery

There are several options available to SA IMT (W) in terms of satellite imagery:

- Rapid Response Satellite Imagery (LANCE / MODIS via NASA):
- Priority Tasking of RADAR Imagery (Radarsat, COSMO-SkyMed, TerraSARX, Sentinel)
- High resolution Optical Satellite Imagery Baseline; and
- Other "non-emergency" acquisitions of various other sensor platforms.

Access to this service will be co-ordinated by the Shell Geomatics team.

Observation from / Support Vessels

The support vessels can be used to follow spills and aid surveillance to provide situational awareness intelligence to the ERT and IMT (W).

Modelling

IMT (W) has access to in-house deterministic spill modelling (surface spills only), this will be run by the Geomatics team (within Situation Unit) who are trained in using this software. IMT (W) will utilise the Automated Data Inquiry for Oil Spills (ADIOS2) empirical oil weathering and fate model developed by the National Oceanic and Atmospheric Administration (NOAA) in the event of a major spill, which is a publicly available program. Comparisons of fate curves from OilMap and ADIOS2 should occur.

AMOSC has in place a call off contract with APASA to perform independent hydrocarbon modelling in the event of a spill, which will be **available within 2 hours of notification**. These services include the use of OilMap, OilMap Deep and plume modelling products. APASA is contract to IMT (W) to provide the remainder of modelling services not provided through AMOSC.

Metocean Data

Numerous data sets of metocean data are accessible from the Bureau of Meteorology and APASA (Environmental Data Service, ECOP and Coastmap). Access to these services will be co-ordinated by the IMT (W) Situation unit. The Prelude FLNG also has a weather station which measures wave, current and wind real-time.

Aerial Surveillance

Aircraft can only operate in favourable flying conditions. IMT (W) may consider the use of drones for various monitoring purposes during a response if it were considered feasible and necessary. Aerial surveillance will be carried out using in the first instance:

- already contracted helicopters or chartered planes from Broome, Perth or Karratha. These will be accessed via ad hoc call off contracts in place with Corporate Aircraft Charter (CAC) for fixed wing aircraft and CHC or Bristow for helicopters (Refer to Appendix 1 for Contact Details); and
- AMSA upon request may provide the Dornier aircraft for aerial surveillance (accessed through the National Plan). However, the Dornier aircraft is used for search and rescue as well as border protection operations, the timeframe and availability of this aircraft is unable to be accurately defined.

It is important that oil slicks are tracked in the field so that information can be obtained to facilitate modelling or manual calculation of spill trajectory and behaviour, and so that the accuracy of these calculations can be verified. Ideally slick area, type, thickness and volume, and trajectory are tracked by aerial surveillance (refer to Appendix 3). The pilot, or other observer if present, should maintain a log of observations. The Oil Spill Tracking Log (refer to Appendix 3) can be used for this.

Note: It is ideal that the pilot, or a passenger of the aircraft, is trained in the description and interpretation of oil on the sea. AMOSC can provide a trained observer (Geelong, 24 hours mobilisation time). Should these resources be unavailable for any reason, trained aerial observers are available in several jurisdictions via the AMSA National Response Team (via the National Plan), through mutual aid arrangements from operators with trained staff (e.g. Chevron) and through OSRL who has trained aerial observers to call upon. If no trained observers are available in a timely fashion, refer to Appendix 3 for information as to how to estimate a slick volume via the Bonn Agreement Oil Appearance Code. Observation should be undertaken via this method by an untrained observer, until a trained observer can be allocated to this task.

Table 18-1: Monitor and Evaluate Commencement and Termination and Capability Summary

Sub strategy/ Tools	Level (Tier) 1 Use?	Level (Tier) 2 Use?	Level (Tier) 3 Use?	Commencement Criteria	Termination Criteria	Resources	Mobilisation time
Tracking buoys (OM3)	No	Yes	Yes	Level (Tier) 2 spills	When buoys no longer accurately locate spills. The buoys are not designed to be recovered.	Tracking buoys on Seismic Vessel and/or support vessel. Additional tracking buoys can be accessed through industry stockpile in Broome and AMOSC.	Immediately, as support vessel location allows. Deployment of tracker buoys is better prior to last light as this allows better tracking of spill during dark without wasting the buoys. Only other use should be to confirm hydrodynamic models. Deployment of buoys should be under advice from Geomatics / Metocean.
Satellite imagery (OM3)	No	Yes	Yes	Level (Tier) 2 spills	Termination of spill response.	Contracts in place with providers: NASA (public domain), MDA, eGEOS, K-SAT, Spatial Energy).	2.5 – 48 hrs depending on imagery.
Observation from facilities or vessels (OM3)	Yes	Yes	Yes	Any spills	Termination of spill response.	Support vessels	Immediately, though support vessel prioritisation and location may affect availability.
Hydrocarbon modelling (OM1)	No	Yes	Yes	Level (Tier) 2 spills	Termination of spill response.	In-house capabilities and AMOSC (RPS APASA). Specialist modelling also available through RPS APASA contract held by Shell Australia.	In-house within 2 hrs, AMOSC within 2 hrs of call-out.
Aerial Surveillance (OM3)	No	Yes	Yes	Level (Tier) 2 spills	Termination of spill response.	Already contracted helicopters to Shell. Fixed wing planes - AMSA.	Immediate notification and mobilisation expected within 48 hrs for contracted resources, mobilisation time 24 hrs for trained observer.

18.2. Natural Recovery

Natural recovery is a no impact response. There are no commencement and termination criteria, nor resources or capability required to implement it apart from supporting strategies such as monitor and evaluate and oil spill monitoring.

Oil on the ocean disperses and breaks up via several processes. Natural processes acting on the oil such as evaporation, dissolution, dispersion into the water column, biodegradation and photo oxidisation reduce the volume of oil over time. Evaporation can be the most important mechanism to reduce the volume of oil; especially in the short term. In general, about 54.8% of the hydrocarbon mass from a subsurface spill should evaporate within the first 12 hours; a further 22.8% should evaporate within the first 24 hours; and a further 14.6% should evaporate over several days (APASA, 2018).

Stochastic oil spill modelling indicates that surface spills are expected to remain offshore, away from sensitive marine resources.

Natural recovery by allowing the oil to weather naturally will be a large part of the response given the inventory of light oils (diesels, aviation fuels and condensates), and the warm water temperatures at the activity location.

18.3. Shoreline Clean-up

Based on a 100 g/m^2 threshold, determined from stochastic modelling, probability for accumulation of oil on shorelines is predicted to be low. In the low likelihood of shoreline impact to Cartier Island, Browse Island, Scott Reef or Ashmore Reef volumes are predicted to be small and highy weathered. Therefore, shoreline clean-up strategy is a planned response in the event shoreline impact is predicted.

In the instance of shoreline impact, the activation of this shoreline clean-up strategy will be determined in consultation with AMSA.

18.3.1. Objective

Shoreline clean-up is used to assess the extent and severity of shoreline oiling and apply clean-up tactics to remove as much oil as possible.

18.3.2. Overview

Shoreline clean-up occurs after impact but aims to reduce the overall adverse impacts from a spill through the removal of oil from contaminated shorelines to prevent its remobilisation and/or cross-contamination (e.g. foraging fauna).

Shoreline clean-up and treatment is an iterative process, requiring systematic surveying of impacted areas before, during, and after clean-up. Shoreline surveys must be conducted systematically because they are a crucial component of effective decision-making. Repeated surveys are needed to monitor the effectiveness and effects of ongoing treatment methods (i.e. changes in shoreline oiling conditions, as well as natural recovery), so that the need for changes in methodology, additional treatment, or constraints can be evaluated.

Tactics may be used alone or in combination to clean up oiled shorelines, including:

- Shoreline Assessment – uses the Shoreline Clean-up Assessment Technique (SCAT), also known as, Oiled Shoreline Assessment (OSA) process (refer to OSMP) to evaluate shoreline segments, establish clean-up priorities, and identify suitable tactics. Typically, this should be the first step in any shoreline clean-up response.
- Natural Recovery – oiled shorelines are left untreated and the oil naturally degrades over time
- Manual and Mechanical Removal – removes oil and contaminated materials using machinery, hand tools, or a combination of both
- Washing, Flooding, and Flushing – uses water, steam, or sand to flush oil from impacted shoreline areas

- Sediment reworking and Surf washing – uses various methods to accelerate natural degradation of oil by manipulating the sediment.

Considerations for selecting and applying shoreline clean-up tactics are included in the **Section 3.4** and **7.5**.

Environment Unit Lead Work Instruction

Shoreline Response Guide

Shell Australia

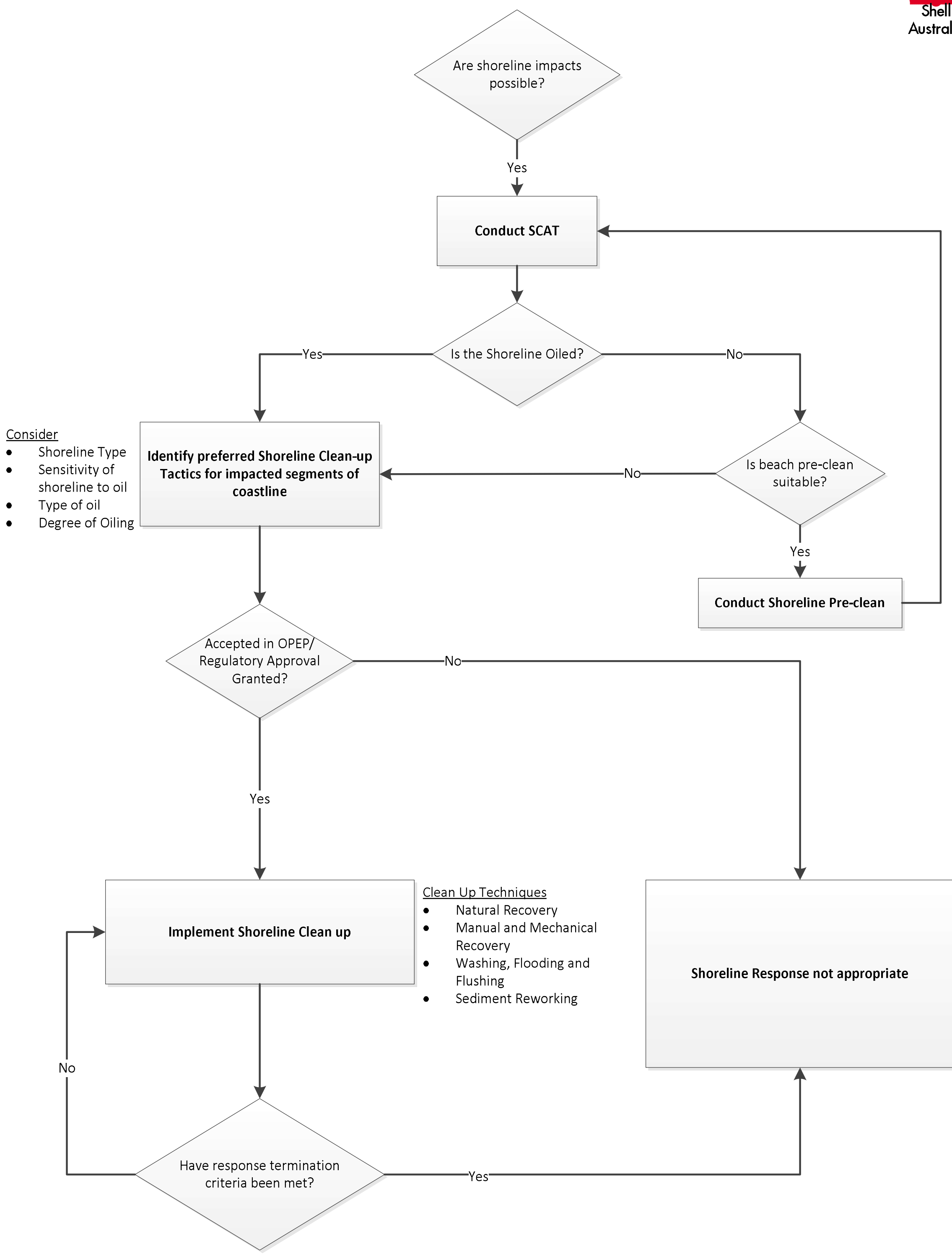


Figure 18-1: Shell Shoreline Response Guide

18.3.3. Commencement and Termination Criteria

Shoreline Clean-up has the following commencement criteria;

- Level (Tier) 2 or 3 spills where shoreline will potentially be impacted; and
- Approval required by WA DoT IC when required.

Termination of this strategy will cease:

- For state jurisdiction in consultation with WA DoT (when required).
- For Commonwealth jurisdiction in consultation with AMSA and Director of National Parks (when required)

18.3.4. Capability

Table 18-2: Shoreline Clean-up Commencement and Termination and Capability Summary

Sub strategy/ Tools	Level 1 Use?	Level 2 Use?	Level 3 Use?	Commencement Criteria	Termination Criteria	Resources	Approx. Mobilisation time
Shoreline Clean-up	No	Yes	Yes	Level (Tier) 2 Level 3 spills which are predicted to impact a shoreline. For state jurisdiction in consultation with WA DoT (when required). For Commonwealth jurisdiction in consultation with AMSA (when required)	For state jurisdiction in consultation with WA DoT (when required). For Commonwealth jurisdiction in consultation with AMSA and Director of National Parks (when required)	Prelude FLNG (or other vessel) can act as a staging and accommodation facility. Shoreline clean-up will be carried out as outlined in the Browse Island Incident Management Guide outlined in the Prelude OPEP. Approximately 10 personnel with handheld equipment such as shovels and bulk bags. Helicopter call-off contract in place to mobilise people, equipment and waste to remote shorelines from staging/accommodation facilities.	Given the logistical and safety limitations with shoreline response in the Browse basin, implementation of the response will take approximately 1 week to occur from decision being made to commence.

18.4. Oiled Wildlife response

18.4.1. Objective

The objective of an oiled wildlife response is to reduce damage to fauna threatened by a spill occurring.

The likelihood of significant numbers of oiled wildlife is low, given the potential maximum spill volume, open water conditions, and low persistence of Diesel as thick slicks. However, if oiled wildlife is encountered then this strategy may be implemented, in consultation with DBCA (WA), AMOSC and DoTEE (Commonwealth).

18.4.2. Overview

Surface oil in significant concentrations can cause high mortality to birds and reptiles contacting oil on the ocean surface or on affected coastlines. Whale and dolphins, by contrast, have been found to have low mortality rates from direct contact with floating oil (French McCay and Rowe, 2004).

A lower threshold of floating oil of 1 g/m^2 is likely to be an indicator of where there is a visual presence of an oil slick (rainbow sheen), however, there is little potential for impact to surface dwelling fauna at this concentration. Estimates for the minimal thickness of floating oil that might result in harm to seabirds through ingestion from preening of contaminated feathers, has been estimated by different researchers at approximately 10 g/m^2 (French, 2000) to 25 g/m^2 (Koops et al. 2004).

For vessel based spills in the vicinity of the survey area, large numbers of oiled wildlife are not expected given the low density of birds and reptiles in the area. At sea, reptiles including turtles are vulnerable to the effects of hydrocarbon spills at all life stages as they are frequently contacting the sea surface for resting or feeding. However, reptiles and turtles are unlikely to be feeding out in the deep water in areas where there is likely to be oil at thicknesses greater than 10 g/m^2 (e.g. survey results from the Centre for Whale Research recorded only 8 turtles and 21 sea snakes over a total survey area of 8,126 km^2 (Jenner, Jenner & Pirzl, cited in INPEX, 2010). Cartier Island supports a large population of nesting green turtles (86 km north-west of the Operational Area), and Ashmore Reef is a designated Ramsar wetland of international significance (135 km north-west). Summer is the most sensitive time period for exposure, however heavy oiling is not expected on the shoreline.

Seabirds are particularly vulnerable to hydrocarbon spills owing to high potential for contact with the sea surface where they feed, rest or moult. Feeding by seabirds recorded in the region involves snatching prey items from or below the water surface by paddling or aerial diving, and these birds also rest on the ocean surface. Migrating and residential shorebirds by contrast are less susceptible to severe oiling and associated physical effects as they confine feeding to shorelines (Sholz et al. cited in WEL, 2011) and they do not land on the water surface.

Important seabird rookeries are also located at Ashmore Reef and Cartier Island. Stochastic modelling did predict floating oil reaching these receptors and seabird BIAs in proximity seismic survey area. Ecological impact from floating oil has been estimated to occur at 10 g/m^2 as this level has been observed to mortally impact birds and other wildlife associated with the water surface (French et al. 1996, French 2000).

Mass mortalities are not expected to occur in the event of a spill. Nonetheless, in areas where concentrations of surface oil are above 10 g/m^2 (indicated to be within the immediate vicinity of the spill event location), there is potential for oiling of seabirds. The most sensitive time periods are likely to be October to November and March to April when migratory birds are active. However, given spreading and weathering behaviour of condensate, it is not expected that there will be thick slicks (i.e. > 10 g/m^2) over an extended time period.

If oiled birds or non–avian wildlife were to be observed at sea, on-water collection should be considered for the effective capture of oiled animals before they become so debilitated that their chance of survival is severely affected (IPIECA, 2004).

Animals would be collected using nets or cages (if possible) off the vessels, stored on a vessel and returned to shore for treatment. Onboard treatment may be considered if deemed more appropriate at the time of the spill. This would be outlined in the incident action plan at the time in consultation with DBCA.

Alternatively, hazing may be necessary to remove birds or other fauna from the impacted zone and given the activity (aerial and vessel) likely to be occurring in the area, fauna is likely to practice avoidance of the zone in any case.

18.4.3. Capability

Personnel

Experienced personnel will be critical to ensuring that decisions are taken such that any oiled wildlife response brings a net benefit to the affected fauna rather than causing additional damage.

Capture techniques will vary according to species but in most cases two people will be required for a successful capture. In general, the oil may have rendered birds flightless but only reduced their ability to dive and avoid being caught. Most mammals and birds will still be able to run or swim. A significantly weakened animal may move slowly and be fairly easy to catch; others may need to be trapped in a net or cornered for capture by hand. Chasing oiled casualties unnecessarily will add to the animals' stress and reduce their ability to recover and should be considered only as a last resort (IPIECA, 2004).

For collected animals, trained personnel will be required for appropriate animal sorting and decision making to guide the triage process. The physical condition of live animals which are admitted to the facilities may range from much weakened and completely oiled individuals to strong and lively ones which are only partly covered with oil. The process of triage enables the responder to prioritize and to select those animals that may have the best chance of surviving further treatment and, after their rehabilitation, a return to the wild to re-join the breeding population (IPIECA, 2004).

As the condition of each animal improves, and if cleaning is deemed to be an appropriate action, this should be undertaken using trained and experienced cleaners (IPIECA, 2004).

Transporting sick animals' long distances is stressful and can be detrimental if not carried out in the appropriate way. Trained resources will assess the wildlife and determine if transport back to shore is necessary and beneficial. If wildlife is captured and brought back to shore, a transport plan will be set up to detail container guidelines, species space requirements including numbers per container, ventilation and temperature control, as well as treatment protocols prior to transport (IPIECA, 2004).

Experienced animal management staff is crucial to appropriately monitor the animals in care. The maintenance of a good environment suitable (e.g. appropriate diet, quiet, ventilation) for the species and their recovery is critical throughout to achieve a successful recovery of these animals. Evaluation for release should be as rigorous as the initial intake examination, and each animal's recovery documented. Criteria commonly utilized include healed injuries, haematological parameters, body condition and fitness, waterproofing, and behaviour (IPIECA, 2004).

Trained personnel will be acquired through AMOSC and the Core Group, AMSA and the National Plan arrangements, Mutual Aid Agreements and/or OSRL, which allows access to national and international oiled wildlife expertise. Shell would supply untrained resources through man-hire arrangements or from within Shell (Local staff or Shell's GRSN).

Assistance will be requested from Department of Biodiversity, Conservation and Attractions (DBCA) for impacts within state waters and response is to be done in accordance to DBCA's Western Australian Oiled Wildlife Response Plan (WAOWRP) and associated Pilbara Region Oiled Wildlife Response Plan (PROWRP) in both state and Commonwealth waters. Shell must provide early notification to DBCA in State waters and DoTEE in Commonwealth waters of a spill event potentially impacting wildlife to allow preparation for the potential for oiled wildlife prior to the spill reaching wildlife sesitivities.

Equipment

Shell has access to oiled wildlife kit held by AMOSC in Perth. These kits comprise one OW container, if required, with a wash facility that provides capacity to clean around 150 oiled wildlife units. This number of oiled wildlife is not expected, given the modelling predictions. Additional OWR equipment is also available for deployment from either Broome or Darwin for vessel deployment to potential offshore response.

It is worth noting that AMSA also has 7 kits available at various locations, with Dampier, Como and Darwin being the closest locations, which would also be accessible and additionally, OSRL has kits.

It is anticipated that one kit (with capacity for at least 50 oiled wildlife units) would be more than adequate, though the incident action plan would detail requirements once impacts are known or more accurately able to be predicted.

Vessels

Given low expected numbers oiled wildlife, one vessel is deemed adequate. This vessel will be accessed via Marine Brokers.

Should the oiled wildlife treatment be set up on board rather than onshore, the vessel needs to have adequate deck space to house the oiled wildlife equipment and be able to provide continuous hot water at constant pressure and temperature. The vessel must have the ability to properly contain and dispose of contaminated wastewater. Most Support Vessels are likely to be appropriate as they have mud and other tanks for water storage and oil-water systems for treating water.

Table 18-3: Oiled Wildlife Resources and Applicability

Resource Equipment	Number required	Specification	Primary Resource location	Agreement in Place	Mobilisation time
Vessel	1	Storage capacity for 50 oiled fauna and potentially oiled wildlife kit and auxiliaries.	Vessels will be accessed from support vessels already on contract, or Shell's marine broker arrangements (vessels of opportunity).	Shell has arrangements in place with marine broker to identify available vessels quickly. Shell is a participating member of AMOSC with access to Mutual aid arrangements.	Marine broker and Mutual Aid vessels availability and mobilisation time dependent.
Personnel	2 trained plus 8 untrained	People trained in oiled wildlife handling and cleaning.	AMOSC, AMSA, Core Group (Australia Wide). OSRL and International expertise.	Shell is a participating member of AMOSC with access to Mutual aid arrangements. AMSA MoU and OSRL contracts.	Core Group members can be available within 3 days.
Equipment	1	Depending on kit size, anticipate sizing for 50 oiled fauna units would be more than adequate.	Fremantle.	Shell is a participating member of AMOSC with access Mutual aid arrangements.	34 hours from Fremantle to Broome + 30 hours by vessel (+ mobilisation times).

18.4.4. Commencement and Termination Criteria

In the event that oiled wildlife is reported or predicted to be impacted, an oiled wildlife response will be initiated. Termination of the strategy will cease when:

- Oiling of wildlife has not been observed over a 48hr period.
- Oiled wildlife have been successfully rehabilitated
- Agreement is reached with relevant regulators and stakeholders to terminate the incident response.

18.5. <u>Oil Spill Monitoring</u>

Refer to the Oil Spill Monitoring Plan (OSMP; HSE_PRE_000496) for full details of the Oil Spill Monitoring Response, but overall capabilities are described below.

18.5.1. Objective

The objective of post-spill environmental monitoring is to determine the fate and ecological consequences of Level 2 and Level 3 spills, particularly relating to extent and effect ton water quality, to enable environmental impacts to be measured and, if impacts occur, recovery to be measured.

18.5.2. Baseline Overview

<u>Baseline data</u>

Shell has identified the existing baseline data in the Browse Basin and commissioned some additional baseline studies. Baseline data is or will be available from Barracouta Shoal East and West, Echuca, Eugene McDermott, Goeree, Heywood, Shoal 25, Vulcan and Wave Governor Bank, Browse Island, Scott Reef, Ashmore, Cartier and Seringapatam Reefs and the Rowley Shoals.

Table 18-4: Existing baseline of some of existing key features near the survey area.

Feature	Existing Baseline Information available to Shell
Ashmore Reef Cartier Island Hibernia Reef Seringapatam Reef	Benthic assessment for Ashmore, Cartier and Seringapatam Reefs undertaken for the Montara spill (Heyward et al 2010b). Eight benthic survey sites were established at Ashmore, and six each at Cartier and Seringapatam Reefs comprising replicate photo transects.
Heywood Shoal Echuca Shoal Eugene McDermott Shoals Vulcan Shoal Barracouta Shoals	Montara: Offshore Banks assessment Survey (Heyward *et al.* 2012). Nine shoals were assed including Barracouta Shoal East and West, Echuca, Eugene McDermott, Goeree, Heywood, Shoal 25, Vulcan and Wave Governor Bank using a combination of multibeam echo sounder, towed video, baited remote underwater video and sediment hydrocarbons. Temporal sampling was completed at Vulcan and Barracouta Shoals. Additionally, as part of the Browse Basin OSMP, Echuca and Heyward shoals are re-surveyed annually commencing March/April 2014 and sediment and water hydrocarbon baselines will be collected as part of this work.
Browse Island	Extensive studies in support of EIS for Prelude/Ichthys/Browse EIS as summarised in Browse Basin OSMP (HSE_PRE_000496). As part of the Applied Research Program (ARP), permanent coral and fish transects were established in March/April 2014 and re-sampled annually through until March 2018 with sediment and water hydrocarbon baselines collected as part of this work.
Scott Reef	Extensive studies collected as part of the Browse EIS studies including habitat descriptions of shallow and deep corals and fish datasets (Woodside 2011). Available to Shell as a JV partner in Browse.
Rowley Shoals	Permanent coral and fish transects established or re-established at Mermaid, Imperiuse and Clerke Reefs by AIMS in Oct 2013 co-funded by Woodside and Shell in support of our Outer Canning Exploration Program. Some sites sampled sporadically since 1994.

18.6. Oil Spill Monitoring Plan (OSMP)

Shell has developed the Oil Spill Monitoring Plan (OSMP; HSE_PRE_000496) to provide the situational awareness for use in planning or executing the spill response and to determine the fate and ecological consequences of a Level 2 and 3 spills to enable environmental impacts and recovery to be measured. Details on personnel resources and mobilisation times are outlined within the OSMP.

As a summary of the objectives:

- The Operational Monitoring Guidelines (OM's) are undertaken during the spill and include any physical, chemical and biological assessments which may guide operational decisions such as selecting the appropriate response and mitigation methods and / or to determine when to terminate a response activity. The design of the OMs requires judgements to be made about scope, methods, data inputs and outputs that are specific to the individual spill incident, balancing the operational needs of the response with the logistical and time constraints of gathering and processing information. There is a need for information to be collected and processed rapidly to suit response needs, with a lower level of sampling and accuracy needed than for scientific purposes. For details on commencement and termination criteria for OM's refer to Monitor and Evaluate (Section 18.1).
- The Scientific Monitoring Guidelines (SMs) can extend well beyond the termination of response operations. Scientific monitoring has objectives relating to attributing cause-effect interactions of the spill or associated response with changes to the surrounding environment. The SMs will be conducted on a wider study area, extending beyond the spill footprint, will be more systematic and quantitative and aim to account for natural or sampling variation.

18.6.1. Capability

Shell currently holds an OSMP contract with Australian Institute of Marine Science (AIMS). Shell will ensure that contractual arrangements are always in place to meet the requirements of the Shell Australia OSMP to implement an OPEP in the event of a level 2 or 3 spill event. Additionally, Shell has capability through the Shell Global Shell Response Network (GSRN), OSRL membership, AMOSC services contract, and is supplemented by AMSA and National Plan arrangements. Capabilities and timings are detailed below.

19. Environment Values and Sensitivities

The protection priorities are set according to the National Plan and the Department of Environment, which specifies the order of protection priorities and specifies individual Protected Matters. Potential impacts of hydrocarbon on each sensitivity are described in the EP.

Shoreline Habitats have been prioritised utilising the Environmental Sensitivity Index (per National Oceanographic and Atmospheric Administration (NOAA) guidelines). This system uses the Environmental Sensitivity Index (ESI) to rate how sensitive an area of shoreline would be to an oil spill, which uses a ranking scale from 1 to 10. A rank of 1 represents shorelines with the least susceptibility to damage by oiling. Examples include steep, exposed rocky cliffs and banks. The oil cannot penetrate the rock and will be washed off quickly by the waves and tides. A rank of 10 represents shorelines most likely to be damaged by oiling. Examples include protected, vegetated wetlands, such as mangrove swamps and saltwater marshes. Oil in these areas will remain for a long period of time, penetrate deeply into the substrate, and inflict damage to many kinds of plants and animals.

This ranking system has been applied in prioritising the coastal habitats resulting in the following prioritisation.

1. Known green turtle nesting sandy beaches (Ashmore and Cartier Island). While some of these beaches support higher nesting activity than others, all are given equal ranking as it is unlikely that multiple islands will be hit by any one spill scenario as

Browse Island is to the South, Scott Reef is to the West and Ashmore and Cartier Island to the North.

2. Important seabird breeding sites such as Ashmore, Cartier and Adele Islands..
3. Reef/ reef crest/ limestone platforms/ shallow subtidal exposed reef platforms supporting marine species including sea snakes, dugongs, fish and other marine invertebrate fauna. These habitats for all emergent features are of equal ranking as it is unlikely that these islands will be hit by any one spill scenario.
4. Common Habitats for all islands/ reefs/ emergent features, as ranked in order of importance below:
    a. Vegetated sandy cays;
    b. Lagoons; and
    c. Sandbanks/ sand flats;
5. Rare and Migratory oceanic species (for more detail see the EP).
6. Fisheries.

These priorities were used, in conjunction with the stochastic oil spill modelling, to devop the SIMA and response stategies (Section 5 and Section 6), and will be further considered in the planning cycle during an incident..

20. Abbreviations/Acronyms and Definitions

Abbreviation/Acronym	Definition
ADIOS	Automated Data Inquiry for Oil Spills
AMOSPlan	Australian Marine Oil Spill Plan
AMOSC	Australian Marine Oil Spill Centre
AMSA	Australian Maritime Safety Authority
AIP	Australian Institute of Petroleum
APASA	Asia-Pacific Applied Science Associates
API	American Petroleum Institute
ARAT	Asia/ Russia/Australia Team
Bbl	Barrels
BOM	Australian Bureau of Meteorology
BOP	Blow-out preventer
CG	Core Group
Control Agency	Designated agency /industry with responsibility and capacity to respond to incident. Previously known as Combat agency.
(C)CMT	(Country) Crisis Management Team
CMT	Crisis Management Team
CSR	Company Site Representative
DFAT	Commonwealth Department of Foreign Affairs and Trade
DMIRS	Western Australia Department of Mines, Industry Regulation and Safety
DNV	Det Norske Veritas
DoEE	Commonwealth Department of the Environment and Energy
DBCA	Western Australia Department of Biodiversity, Conservation and Attractions

Abbreviation/Acronym	Definition
DPIRD	Western Australia Department of Primary Industries and Regional Development
DoT	Western Australia Department of Transport
DWER	Western Australia Department of Water and Environment Regulations
IMT Leader	Incident Management Team Leader. Equivalent to an Incident Controller or Incident Commander.
EMBA	Environment that may be affected
EMEAT	Europe, Middle East & Africa Response Team
EP	Environment Plan
ER	Emergency Response
ERC	Emergency Response Coordinator
ERP	Emergency Response Plan
ERT	Emergency Response Team
ESI	Environmental Sensitivity Index
FOB	Forward Operating Base
GRSN	Shell Global Response Support Network (activated through STASCo)
HMA	Hazard Management Agency
HPHT	High Pressure High Temperature
HR	Human Resources
HSSE and SP	Health, Safety, Security, Environment and Social Performance
IAP	Incident Action Plan
IC	Incident Controller
ICC	Incident Control Centre
ICS	Incident Command System
IGA	Inter-governmental Agreement
IMO	International Maritime Organisation
IMT	Incident Management Team
IMT (W)	Incident Management Team (West)
IRC	Incident Response Centre
Level 1, Level 2 and Level 3	Tier 1, Tier 2 and Tier 3 per IPIECA definition and HSSE &SP Control Framework.
MARPOL	The International Convention for the Prevention of Pollution from Ships 1973/78
MEE	Maritime Environmental Emergency
MEECC	Maritime Environmental Emergency Coordination Centre (WA DoT)
MEER	Maritime Environmental Emergency Response (DoT)
MODIS	Moderate-resolution Imaging Spectroradiometer
MDO	Marine Diesel Oil (Diesel)
MOP	Marine Oil Pollution
MOSES	Marine Oil Spill Response Equipment System
MoU	Memorandum of Understanding
NOAA	National Oceanic and Atmospheric Administration

Abbreviation/Acronym	Definition
NOPSEMA	National Offshore Petroleum Safety and Environment
NOPTA	National Offshore Petroleum Titles Administrator
NT	Northern Territory
OIM	Offshore Installation Manager
OPEP	Oil Pollution Emergency Plan
OSEC	Shell Oil Spill Expertise Centre
OSCP	Oil Spill Contingency Plan
OSMP	Oil Spill Monitoring Plan
OSRL	Oil Spill Response Limited
OPRC	Oil Pollution Response and Cooperation
OPGGS (E)	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS (E) Regulations
POLREP	Statutory Pollution Report
ppb	parts per billion
ppm	parts per million
PT	Petroleum Titleholder (Shell Australia -in the context of this document)
RCC	Recuse Coordination Centre
SART	Shell Americas Response Team
Shell	Shell Australia Pty Ltd
SIMA	Spill Impact Mitigation Assessment
SITREP	Situational Report
SMPC	State (WA) Marine Pollution Coordinator
SOPEP / SMPEP	Shipboard Oil/Marine Pollution Emergency Plan
STASCo	Shell Tankers and Shipping Company (the group activates mobilisation of the GRSN)
WestPlan - MOP	Western Australia State Emergency Management Plan for Marine Oil Pollution
ZPI	Zone of Potential Impact

Appendix 1 – Response Contact Directory

For detailed outline of contacts see the Shell Australia IMT (W) Emergency Response Plan (HSE_GEN_011209)) and the Weekly Contact List (HSE_GEN_011648). Further detail on Shell's freight forward arrangements can be found within the Cargo Movement Work Instruction (OPS_GEN_000250).

Contact	Contact Details
Freight Forwarding Company (Shell)	DB Schenker
Marine Broker (Shell)	24/7 contact: +61 (0) 404 787 011
Aerial contractors (Shell)	CHC Broome Ops: +61 8 9194 9110/ +61 408 533 205 HNZ Primary Contact – Operations: 1300 727 469 HNZ Secondary Contact - SAR Senior Base Pilot: +61 (0) 499 992 250
Waste Contractor (Shell)	Toll Energy & Marine +61 8 9194 2200
Shire of Broome	Ph: 08 9191 3456
Weather Information	Metraweather 24-hour Ph: 1800 183 192

Appendix 2 - Oil Spill Response Resource Directory

This Appendix lists sources of oil spill response resources, including equipment, in alphabetical order. Contact details for these organisations are provided in Table 1 and the Contact Directory Appendix 7. Equipment transport times and stockpile locations are provided below in subsequent tables.

AMSA National Plan Stockpile Listings can be found here:

https://amsa-forms.nogginoca.com/public/equipment.html

A2.1 General Directory

Aircraft: Surveillance	Additional aircraft (Dornier) can be accessed through AMSA (National Plan) via AMOSC though unknown timeframe and availability as it is also contracted for search and rescue and border control operations. This is likely to be the more expensive option.
Airstrips	The primary Shell Air Support Base is at Broome International Airport with Djarindjin Airport being used as a refuelling point for aerial ops supporting OPEP operations if required.
AMOSC Broome Stockpile	Existing oils spill response stockpiles located in Broome (WA DoT, Kimberly Port Authority and AMOSC) are focused on responding to spills in the relatively sheltered waters of the Port of Broome. This equipment is of limited value in responding to a spill at the location. The following AMOSC managed equipment to be used in an initial Level 2 response whilst more substantial equipment is mobilised from further afield: • 15 m3 of Ardrox 6120 dispersant, an AFEDO Spray set and spay arms. • 400 m of Lamor offshore boom and skimmer system (12 tonnes/ hr). • 200 m of sorbent boom. • additional tracker buoys.
Equipment: Support Vessels	All support vessels have their own SOPEP/SMPEP kit and it is solely for the use of the vessel. A spill tracking buoy will be stored on each vessel and available for deployment.
Waste	Waste contractor for management of permanent waste treatment/ disposal is Rusca Bros. +61 8 8943 1900.

A2.2AMOSC Stockpiles

An up to date listing is available online and should be checked:

http://www.amosc.com.au/

AMOSC Eqt
website.msg

A2.3AMSA Stockpiles

The Marine Oil Spill Equipment Database (MOSES) maintained by AMSA is regularly updated and lists all available equipment and contacts for activation.

A3.4OSRL stockpiles

Oil Spill Response

OIL SPILL RESPONSE EQUIPMENT STATUS - EMEA, APAC & AMERICA

07/01/2019

The attached audit equipment report is to be used for guidance purposes only. Response strategies should not be based solely on this report. As with any other report, results are dependent on the quality of the parameters and data inputs used to create the report.

	EQUIPMENT DESCRIPTION	Total	Available	Spill Use	Other	Available %
Dispersant Application						
	Neatsweep dispersant boom system	3	2	0	1	67%
	Boat Spray Sets	25	19	0	6	76%
	Fluorometer	7	5	0	2	71%
	Ayles Fernie Dispersant Eduction Spray System	1	1	0	0	100%
	Dispersant Transfer System	2	2	0	0	100%
	Chemical Spray	1	1	0	0	100%
Aircraft Systems						
	ADDS Pack Dispersant Spray	4	3	0	1	75%
Inshore Boom						
	(m)	23375	22305	135	935	95%
	(ft)	76670	73160	443	3067	
Offshore Boom						
	(m)	10400	9400	0	1000	90%
	(ft)	34112	30832	0	3280	
Active Boom						
		8	8	0	0	100%
Fire Boom						
	(m)	1050	1050	0	0	100%
	(ft)	3444	3444	0	0	
Inshore Storage						
	(m^3)	2410	2337	18	55	97%
	(US Gall)	636705	617466	4755	14484	
Offshore Storage						
	(m3)	1385	1365	0	20	99%
	(US Gall)	365875	360592	0	5283	
Recovery Devices						
	Recovery - Combi	20	9	0	11	45%
	Recovery - Mechanical	19	16	0	3	84%
	Recovery - Oleophilic	80	60	3	17	75%
	Recovery - Vacuum	32	30	0	2	94%
	Recovery - Weir	48	45	0	3	94%
Power Packs & Generators						
	Generator	49	44	0	5	90%
	1 to 50Kw Power Pack	36	28	0	8	78%
	50Kw Plus Power Pack	23	23	0	0	100%
Dispersant - SLA						
	Corexit 9500 (m3)	184	175	0	9	95%
	Corexit 9527 (m3)	84	84	0	0	100%
	Finasol OSR52 (m3)	67	67	0	0	100%
	Slickgone EW (m3)	18	18	0	0	100%
	Slickgone LTSW (m3)	21	21	0	0	100%
	Slickgone NS (m3)	339	307	0	32	91%
	Total Dispersant - SLA (m3)	713	672	0	41	94%

In addition to the above equipment, OSRL also carries a number of items that are held in reserve which includes boom, recovery devices and power-packs. These items will require a greater mobilisation time than our frontline equipment.
DEFINITION
Total: This column denotes the total amount of equipment in the SLA.
Available: This column denotes the equipment that is currently available.
Spill Use: This column denotes the equipment that is being used specifically for a spill. Equipment remains in 'Spill Use' until it has returned to base, undergone maintenance and returned to Response Ready
Other: This column denotes equipment that is temporarily unavailable, e.g. in use for training purposes, undergoing maintenance, in transit, on exercises etc.
% Available: This column denotes the percentage available to clients in relation to the total
1 cubic meter -> 264.17 US Gallon : I US Gallon = 0.00378 cubic meters
1 meter -> 3.28 feet

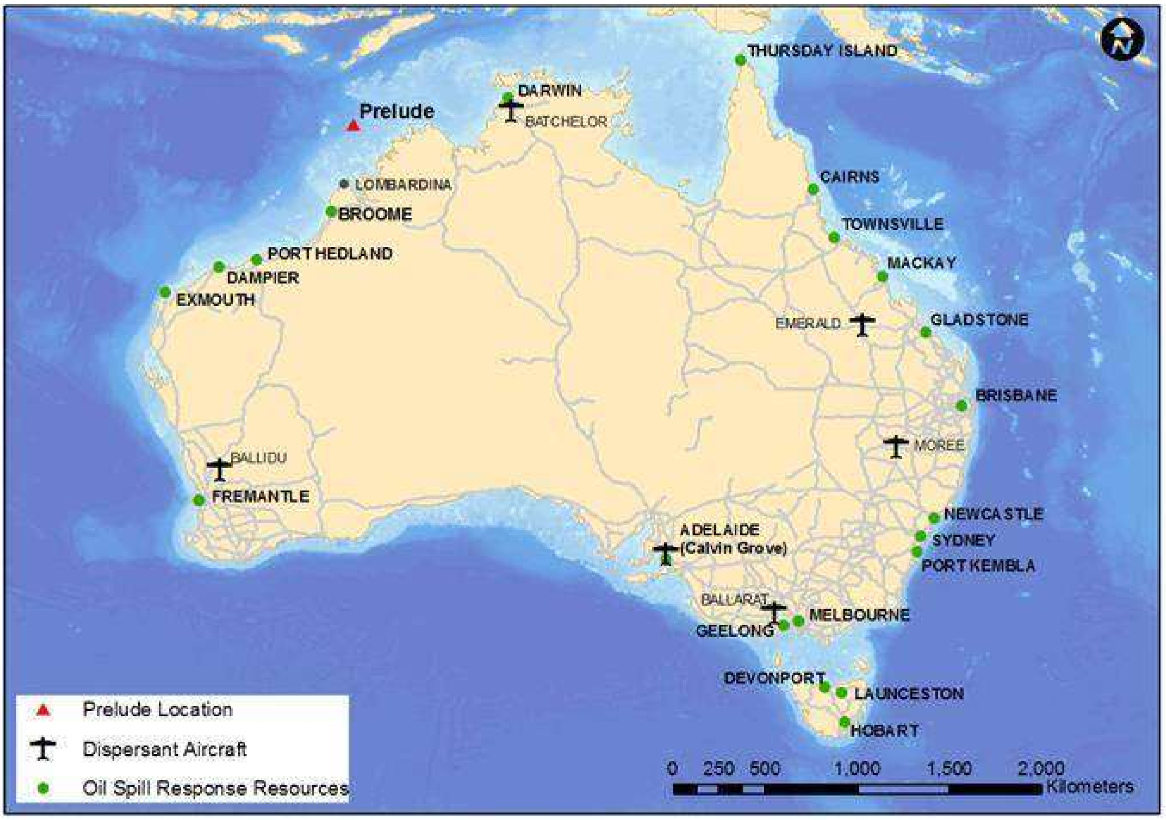
An updated list is available online and should be checked:

http://www.oilspillresponse.com/activate-us/equipment-stockpile-status-report

Activation response is as follows;

- The Duty Manager will return your call within 10 minutes.
- Boeing 727 or C130 will be available for loading within 4 hours.
- A technical advisor will be made available to you immediately and will be on first available plane.
- Time to be on scene will depend on flight times and times for equipment to clear customs etc.

A2.5Oil spill response stockpile locations



A2.6 Equipment transportation times in relationship to Factory 3D survey area

	Sea (hrs) to Survey Area	Air (hrs) to Survey Area	Air (hrs) to Broome (direct-nonstop)	Road (hrs) to Broome
Broome	24	2	NA	NA
Darwin	40	3		22
Dampier	65	4		7
Geelong	NA	15		53
Wyndam	24	2		
Lombardina	NA	1	1	8
Batchelor	NA	NA	1.2	NA
Jandakot	NA	NA	1.7	NA
Adelaide/ Calvin grove	NA	NA	3	44
Newcastle	NA	NA	NA	60
Sydney	NA	NA	4	58
Port Kembla	NA	NA	NA	58
Melbourne	NA	NA	3.4	53
Devonport	NA	NA	NA	61*
Launceston/ Bell Bay	NA	NA	NA	62*
Hobart	NA	NA	4	65*
Fremantle	NA	NA	2	24
Port Hedland	NA	NA	NA	7
Cairns	NA	NA	NA	47
Gladstone	NA	NA	NA	49
Mackay	NA	NA	NA	47
Brisbane	NA	NA	3.6	53
Townsville	NA	NA	NA	43
Exmouth	NA	NA	NA	16

**including sea transport to Melbourne*

Appendix 3 - Forms and Guidelines (External and Internal)

External Reporting Forms	Internal Guides and Reporting Forms
NOPSEMA FM0831 Reportable Environmental Incidents	Situation Awareness Template
AMSA Oil Spill Notification Report Harmful Substances (POLREP) AMSA197	Weather Information Template
AMSA Noxious Substances (POLREP) AMSA196	Estimating Spill volume and movement guide
Marine Pollution Situation Report (SITREP) AMSA	Oil Spill Tracking Log - ERT
	Oil Spill Observation Recording - Field
	Dispersant Effectiveness test and guide
	Beaufort Scale

A3.1NOPSEMA FM0831 Reportable Environmental Incidents

N-03000-FM0831-Report-of-an-Accident-I

A3.2AMSA Oil Spill Notification Report Harmful Substances (POLREP) AMSA197

AMSA Oil Spill Notification Report Ha

AMSA Oil Spill Notification Report Ha

A3.3AMSA Noxious Substances (POLREP) AMSA196

AMSA Noxious Substances (POLREP)

AMSA Noxious Substances (POLREP)

A3.4Marine Pollution Situation Report (SITREP) AMSA

SITREP Appendix9.pdf

SITREP Appendix9.pdf

Appendix 4 - Types/characteristics of oils

Figure 0-1 outlines the generally accepted oil classification system of ITOPF. The Crux condensate is a Group 1 non-persistent oil and MDO/MGO are Group 2-3 hydrocarbons

Group 1 oils

A: °API > 45 (Specific gravity < 0.8)
B: Pour point °C
C: Viscosity @ 10–20°C: less than 3 CSt
D: % boiling below 200°C: greater than 50%
E: % boiling above 370°C: between 20 and 0%

	A	B	C	D	E
Aasgard	49	-28	2 @ 10°C	58	14
Arabian Super Light	51	-39	2 @ 20°C		
Cossack	48	-18	2 @ 20°C	51	18
Curlew	47	-13	2 @ 20°C	57	17
F3 Condensate	54	<-63	1 @ 10°C	81	0
Gippsland	52	-13	1.5 @ 20°C	63	8
Hidra	52	-62	2.5 @ 10°C	60	11
Terengganu condensate	73	-36	0.5 @ 20°C	>95	0
Wollybutt	49	-53	2@ 20°C	55	4
Gasoline	58		0.5 @ 15°C	100	0
Kerosene	45	-55	2 @ 15°C	50	0
Naptha	55		0.5 @ 15°C	100	0

Group 2 oils

A: °API 35–45 (Specific gravity 0.8–0.85)
B: Pour point °C
C: Viscosity @ 10–20°C: between 4 Cst and semi-solid
D: % boiling below 200°C: between 20 and 50%
E: % boiling above 370°C: between 15 and 50%

Low pour point <6°C

	A	B	C	D	E
Arabian Extra Light	38	-30	3 @ 15°C	26	39
Azeri	37	-3	8 @ 20°C	29	46
Brent	38	-3	7 @ 10°C	37	33
Draugen	40	-15	4 @ 20°C	37	32
Dukhan	41	-49	9 @ 15°C	36	33
Liverpool Bay	45	-21	4 @ 20°C	42	28
Sokol (Sakhalin)	37	-27	4 @ 20°C	45	21
Rio Negro	35	-5	23 @ 10°C	29	41
Umm Shaif	37	-24	10 @ 10°C	34	31
Zakum	40	-24	6@ 10°C	36	33
Marine Gas oil (MGO)	37	-3	5 @ 15°C		

High pour point >5°C

	A	B	C	D	E
Amna	36	19	Semi-solid	25	30
Beatrice	38	18	32 @ 15°C	25	35
Bintulu	37	19	Semi-solid	24	34
Escravos	34	10	9 @ 15°C	35	15
Sarir	38	24	Semi-solid	24	39
Statfjord	40	6	7 @ 10°C	38	32

Note: High pour point oils only behave as Group 2 at ambient temperatures above their pour point. Below this treat as Group 4 oils.

Group 3 oils

A: °API 17.5–35 (Specific gravity 0.85–0.95)
B: Pour point °C
C: Viscosity @ 10–20°C: between 8 CSt and semi solid
D: % boiling below 200°C: between 10 and 35%
E: % boiling above 370°C: between 30 and 65%

Low pour point <6°C

	A	B	C	D	E
Alaska North Slope	28	-18	32 @ 15°C	32	41
Arabian Heavy	28	-40	55 @ 15°C	21	56
Arabian Medium	30	-21	25 @ 15°C	22	51
Arabian Light	33	-40	14 @ 15°C	25	45
Bonny Light	35	-11	25 @ 15°C	26	30
Iranian Heavy	31	-36	25 @ 15°C	24	48
Iranian Light	34	-32	15 @ 15°C	26	43
Khafji	28	-57	80 @ 15°C	21	55
Sirri	33	-12	18 @ 10°C	32	38
Thunder Horse	35	-27	10 @ 10°C	32	39
Tia Juana Light	32	-42	500 @ 15°C	24	45
Troll	33	-9	14 @ 10°C	24	35
IFO 180	18–20	10–30	1,500–3,000 @ 15°C		–

High pour point >5°C

	A	B	C	D	E
Cabinda	33	12	Semi-solid	18	56
Coco	32	21	Semi-solid	21	46
Gamba	31	23	Semi-solid	11	54
Mandji	30	9	70 @ 15°C	21	53
Minas	35	18	Semi-solid	15	58

Note: High pour point oils only behave as Group 3 at ambient temperatures above their pour point. Below this treat as Group 4 oils.

Group 4 oils

A: °API <17.5 (Specific gravity >0.95) or
B: Pour point >30°C
C: Viscosity @ 10–20°C: between 1500 CSt and semi-solid
D: % boiling below 200°C: less than 25%
E: % boiling above 370°C: greater than 30%

	A	B	C	D	E
Bachaquero 17	16	-29	5,000 @ 15°C	10	60
Boscan	10	15	Semi -solid	4	80
Cinta	33	43	Semi -solid	10	54
Handil	33	35	Semi -solid	23	33
Merey	17	-21	7,000 @ 15°C	7	70
Nile Blend	34	33	Semi-solid	13	59
Pilon	14	-3	Semi-solid	2	92
Shengli	24	21	Semi-solid	9	70
Taching	31	35	Semi-solid	12	49
Tia Juana Pesado	12	-1	Semi-solid	3	78
Widuri	33	46	Semi-solid	7	70
IFO 380	11–15	10–30	5,000–30,000 @ 15°C		

Figure 0-1: ITOPF Oil Classification Guide based on API Specific Gravity.

Marine Diesel Oil (MDO) "Diesel"

The general behaviour of diesel at sea can be summarised as follows:

- a slick of diesel will elongate rapidly in the direction of the prevailing wind and waves;
- very rapid spreading of the low viscosity diesel will take place;
- some diesel fuel oils may form an unstable emulsion at the thicker, leading edges of the slick;
- speed of physical dispersion of the surface slick increases with wind speed. Up to 95% of a slick may disperse within about 4 hours of the spill in 15 knot winds, warm air and sea conditions; and
- evaporation of diesel is likely to be enhanced due to the warmer prevailing air and sea temperatures of the Browse Basin area.

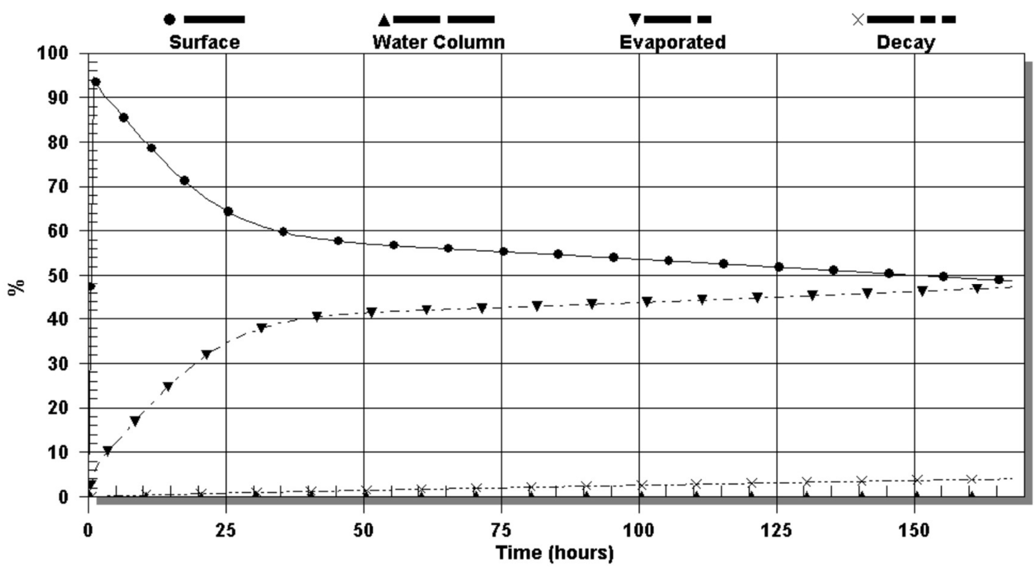


Figure 0-2: Proportional mass balance plot representing the weathering of marine diesel spilled onto the water surface as a one-off release (50 m3 over 1 hr) and subject to a constant 5 knot (2.6 m/s) wind at 27 °C water temperature and 25 °C air temperature.

Appendix 5 – Chemical Spill Response for the Marine Environment

INITIAL RESPONSE

- ❑ Take appropriate personal protective measures.
- ❑ Call for medical assistance if an injury has occurred.
- ❑ Restrict access to the spill site and adjacent area as the situation demands. Take any other steps to minimize any threat to health and safety.
- ❑ Identify/Isolate the source and minimize the loss of product.
- ❑ Eliminate possible sources of ignition in the near vicinity of the spill.
- ❑ Establish air monitoring to determine potential safety hazards, as the situation demands.
    - ❑ Take the appropriate safe guarding measures, as the situation demands
- ❑ Secure water intakes, as the situation demands.
- ❑ Notify internal/external key stakeholders.
- ❑ Verify the type of product and quantity released.
- ❑ Notify STASCO for subject matter expert consultation.
    - ❑ Outside of the Americas +44 20 7934 7777 and within the Americas +1 713 241 2532
- ❑ Follow the initial response actions detailed in the site or vessel response plan; refer to the Chemical Spill Response for the Marine Environment Interface Tool to determine or validate response strategies and tactics.
- ❑ Engage trajectory/plume modelling services to verify extent of impact.
- ❑ Provided that a safe operating environment exists and there is tactical benefit, deploy spill response equipment to prevent/mitigate spill impact (spreading of spill).
- ❑ Chemical Spill Response Contractors;
    - ❑ National Response Corporation (NRC, NRC-SRS) emergency centre contact number (worldwide service): +1-631-224-9141
    - ❑ APME ALERT-SGS 24 Emergency Response Process ALERT-SGS provides 24-hour "Level 1" Emergency Response Service in the APME (Cargo SDS Information). The number + 65 6542 9595 (or + 800 2537 8747) can be called during an emergency involving a Shell Chemical product. "Level 2" and "Level 3" services are available, but at a non-negotiated rate.
    - ❑ Braemar-Howells Available 24/7, incident response teams provide a rapid response and professional approach to dealing with oil spill incidents or hazardous (MAZMAT/HNS) spills. 24 Hour Response Line UK: 08700 73 77 66 73, INTL: +44 1646 697041