



Kraken 3D Marine Seismic Survey Summary Environment Plan

Karoon Gas Controlled Document

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1 Introduction

Karoon Gas (Browse Basin) Australia Pty Ltd ('Karoon') is proposing to undertake the Kraken Marine Seismic Survey (MSS) in the Commonwealth waters of the Browse Basin, Western Australia (WA) in Exploration Permit Areas WA-314-P, WA-302-P and adjacent non-permit areas.

The purpose of the surveys is to better delineate hydrocarbon prospects in the area and accurately define possible drilling locations for future exploration activities.

Karoon, as nominated Environmental Operator for this petroleum activity within WA-314-P and under access authority WA-41-AA for ingress into WA-302-P and adjacent non-permit areas, has prepared an Environment Plan (EP) for this activity in accordance with the requirements of the *Offshore Petroleum & Greenhouse Gas (Environment) Regulations 2009*. The EP has been reviewed and accepted by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

This EP summary document has been prepared to comply with the requirements of Regulation 11(7) and (8) of the referenced *Offshore Petroleum & Greenhouse Gas (Environment) Regulations 2009*.

2 Activity Location

The Kraken MSS activity, shown on a regional basis in **Figure 2-1**, will be undertaken within WA-314-P, WA-302-P and adjacent non-permit areas (Browse Basin). Activity within the WA-302-P and adjacent non-permit areas will be undertaken in accordance with access authority WA-41-AA.

Within the Kraken MSS 'vessel working area'¹ of approximately 1109km² (refer **Table 2-1** for coordinates and **Figure 2-2**) seismic data acquisition will be acquired over an area of 318km² (refer **Table 2-2** for coordinates).

The Kraken MSS area is located approximately 345km northwest of the Kimberley coastline (WA), 270km south of Rote Island (Indonesia), 30km north-west of Seringapatam Reef and 50km north of Scott Reef North in water depths of 900-2000m.

¹ Defined as the operational boundary of the Environment Plan.

Figure 2-1: Regional Location of the Kraken MSS

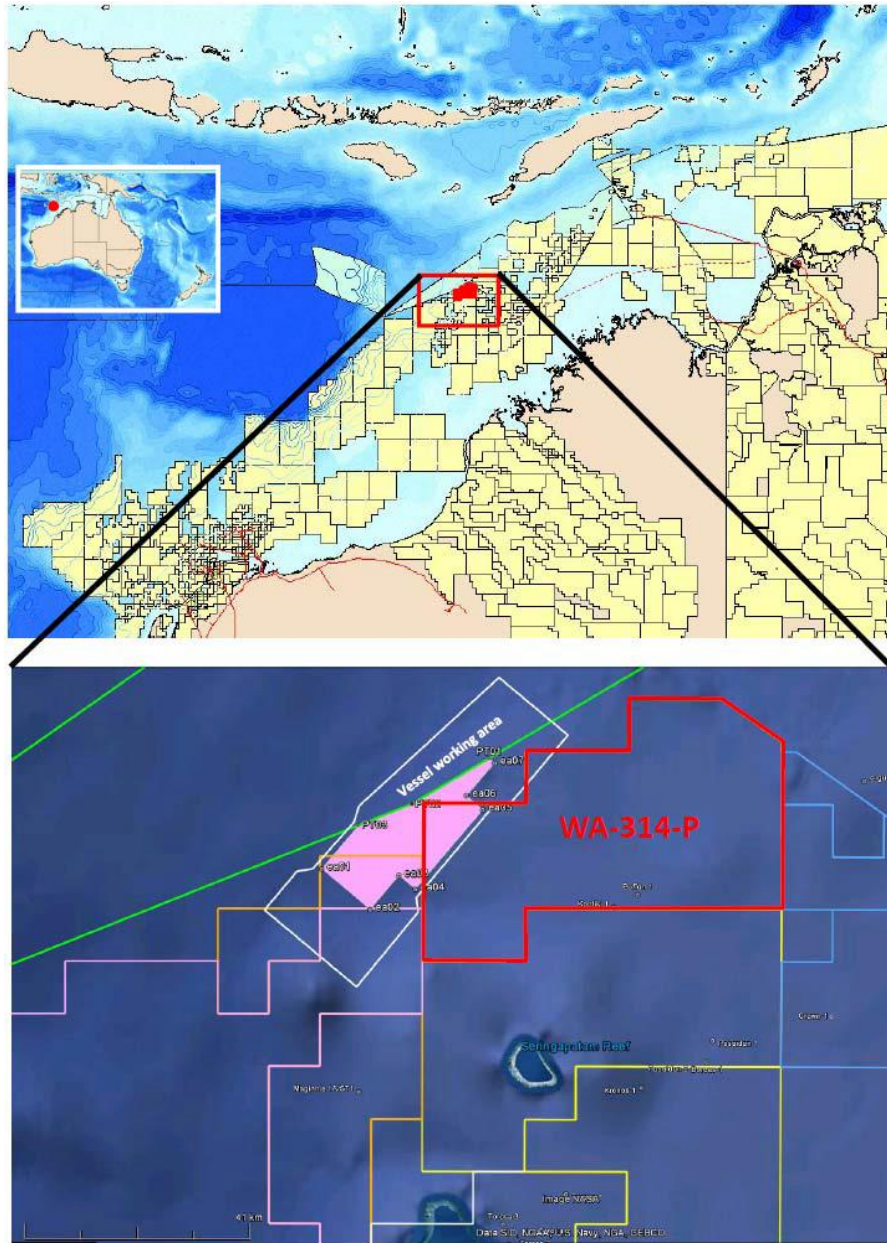


Table 2-1 Kraken MSS 'Vessel Working Areas'

Location Point	Latitude			Longitude		
	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
<i>Kraken MSS Vessel Working Area</i>						
KWA01	13	11	36.54	121	47	49.63
KWA02	13	15	09.50	121	43	52.07
KWA03	13	16	42.34	121	43	22.22
KWA04	13	21	08.49	121	39	21.36
KWA05	13	21	23.16	121	37	48.42
KWA06	13	25	03.78	121	34	39.25
KWA07	13	32	22.73	121	43	39.68
KWA08	13	25	15.33	121	49	39.11
KWA09	13	23	52.19	121	49	28.54

Location Point	Latitude			Longitude		
	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
KWA10	13	15	24.46	121	56	44.83
KWA11	13	15	14.32	121	58	19.56
KWA12	13	08	22.87	122	04	12.73
KWA13	13	02	54.35	121	57	28.69

Table 2-2 Kraken 3D MSS 'Survey' Area

Location Point	Latitude			Longitude		
	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
<i>Kraken Survey Area</i>						
PT01	13	10	34.67	121	56	33.77
PT02	13	14	56.52	121	49	03.15
PT03	13	16	58.36	121	43	49.81
EA01	13	21	07.41	121	40	13.56
EA02	13	25	01.44	121	44	58.96
EA03	13	21	45.27	121	47	47.19
EA04	13	23	05.27	121	49	22.63
EA05	13	15	29.98	121	55	56.61
EA06	13	14	08.82	121	54	22.78
EA07	13	11	01.49	121	57	06.30

Figure 2-2: Kraken MSS Coordinates



3 Seismic Program Activity Description

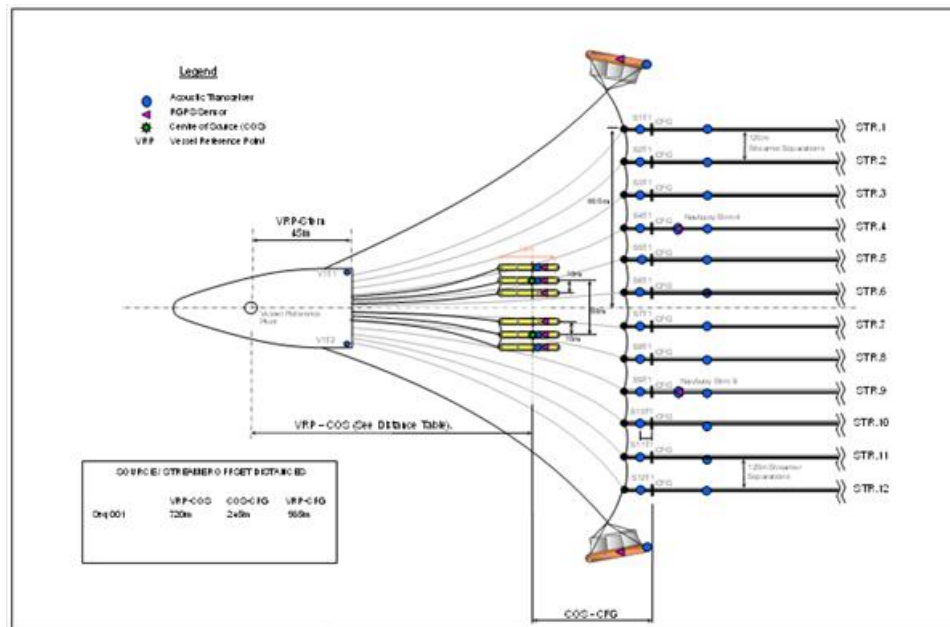
The Kraken MSS program will acquire seismic data between 1st August 2013 and 31st August 2013 with the activity expected to take up to 20 days. The precise commencement and completion dates are dependent on vessel schedule and weather conditions. Seismic acquisition will be undertaken 24 hours per day, seven days per week.

The activity will be undertaken by an experienced seismic contractor utilising a purpose-built seismic vessel, towing seismic equipment along a series of pre-determined seismic lines within the 318km² survey acquisition area. The vessel will, while acquiring seismic, travel at an average speed of approximately 8–9 km/h (4–4.5 knots). As the vessel travels along the survey lines, a series of acoustic pulses activated at 18.75m or 25m intervals (approximately every 11 seconds) will be directed down through the water column into the seabed via two source arrays. Reflected sound wave are then detected by sensitive hydrophones, arranged along a number of cables (streamers) towed behind the survey vessel. Data collected by the hydrophones is stored in on-board computers for processing and analysis, allowing the structure of the underlying geological strata to be mapped and potential hydrocarbon reservoir targets to be identified.

The seismic equipment will comprise of a dual source array, of volume between 2400-4000in³ operating at pressures of 2000psi and towed at approximately 6-9m water depth. Reflected sound waves will be collected by up to fourteen (14) hydrophone collectors ('streamers') of length up to 6100m, each separated by approximately 100m, towed at a depth of approximately 8-50m depth behind the seismic vessel. These hydrophone streamers will be solid streamers (with small amounts of liquid).

A typical towing diagram of a 3D MSS vessel is provided in **Figure 3-1**.

Figure 3-1: Typical 3D MSS Towing Diagram



The MSS vessel will traverse the survey areas along defined transects (or seismic lines) approximately 400-800m apart (dependent on number of streamers and streamer separation). The Kraken MSS will run in a northeast-southwest direction.

There will be two vessels supporting survey activities and at least one vessel will be present with the MSS vessel during survey operations. These support vessels will be sourced from Australian waters where possible but may mobilise from international ports. The main function of these vessels is to escort the MSS vessel; to scout ahead of the MSS vessel for marine hazards; to maintain a safe distance between the towed array and other

vessels; to manage interactions with shipping and fishing activities; and to act in an emergency-response capacity. A support vessel will periodically deploy from the survey area to obtain supplies.

Additionally, the seismic vessel and streamers will display appropriate navigational safety measures such as day shapes, lights and reflective tail buoys to indicate that the vessel is in tow and restricted in its ability to manoeuvre. A visual and radar watch will be maintained on the bridge at all times by trained and competent crew (STCW95) and in addition, Automated Radar Plotting Aids (ARPA) will be utilised on both the MSS and support vessel to monitor for vessels in the area.

The vessels will operate under an approved Shipboard Oil Prevention Emergency Plan (SOPEP) which details actions to be taken in the event of a shipboard emergency or oil spill in accordance with MARPOL 73/78 Annex I requirements.

Seismic operations will utilise the Port of Darwin where possible, otherwise the Port of Broome or Dampier as a supply port. Refuelling of vessels at sea is planned during the survey, however this will occur within the operational area at least 12nm from any reef structure. Crew changes will preferably occur during port calls however helicopter transfer of personnel is also possible. Helicopter transfer, if required, will occur during daylight hours from Darwin via Troughton Island. There will be no helicopter refuelling on-board the seismic vessel.

4 Receiving Environment

4.1 General

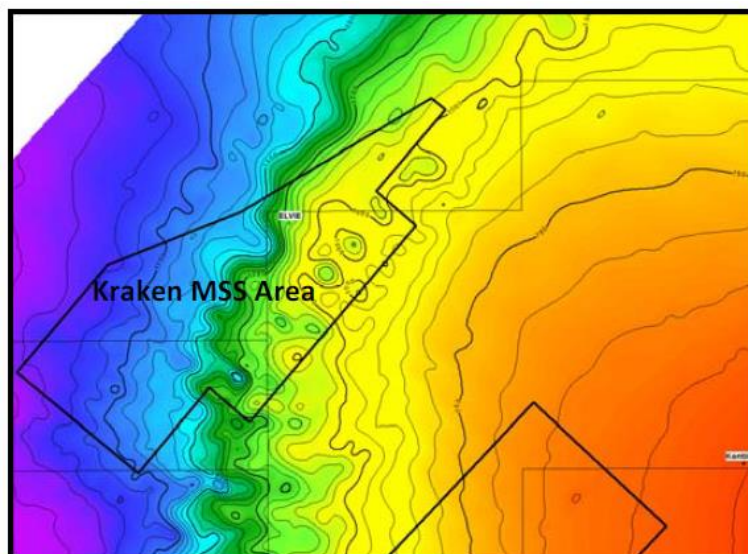
The Kraken MSS area is located in the Timor Province Bioregion (DEWHA, 2008). The shallow reefs at the shelf-break (Seringapatam and Scott Reef) are considered high in biodiversity and include important pelagic and benthic ecological communities. Scott and Seringapatam reefs represent the limit of the geographic range of many species and are the only known habitat in WA for many fish, mollusc and echinoderm species. Scott Reef also supports a genetically distinct breeding population of green turtles (Sandy Islet); is an important staging area for migratory shorebirds and is thought to contain diverse deep water coral habitats not found elsewhere in Australian waters (DEWHA, 2008). Sandy Islet, located approximately 72km south of the nearest MSS boundary, is an area of 'reserved land' (formally a 'C' Class Nature Reserve) vested in the WA Conservation Commission.

The nearest Commonwealth Marine Reserve to the Kraken MSS area is the Argo-Rowley Terrace Marine Reserve located approximately 120km west of the nearest MSS boundary; the Ashmore Reef National Nature Reserve (a RAMSAR site) located approximately 160km northeast and Cartier Island Marine Reserve located approximately 180km north-east of the nearest MSS boundary.

4.2 Bathymetry

The Kraken MSS area is located in water depths of 950-2000m over the continental slope area adjacent to Seringapatam Reef (refer **Figure 4-1**). The slope is steep adjacent to the western edges of the Scott and Seringapatam Reef systems and is incised by erosional gullies. Seabed sediments in the Kraken MSS area are expected to comprise of soft silt and clay (i.e. mud classification), with areas of sand and stiff hard and/or cemented material (Woodside, 2011).

Figure 4-1: Bathymetry of the Kraken MSS Area



4.3 Marine Fauna

Deep ocean habitats are likely to support meiofauna (e.g. nematodes), larger infauna (e.g. polychaete worms and isopods) and sparsely distributed epibenthic communities (e.g. sea-pens). Mobile benthic seafloor species such as deep-water cucumbers, crabs and polychaetes are likely to be present as well as sparse populations of benthic-pelagic fish and cephalopods (low densities) (Brewer et al 2007; cited in DEWHA, 2008).

Fish communities of the continental slope include two distinct demersal fish community types: an upper continental slope community (225-500m) and mid-continental slope community (750-1000m) (DEWHA, 2007) with no mid-upper slope biome is present. This feature is identified as a Key Ecological Feature (KEF) within the region.

The pelagic environment, in general, is depauperate with small pelagic species supporting primary and secondary consumers (e.g. sharks and tuna) (Brewer et al, 2007).

Mega fauna species such as whale sharks, whales and turtles migrate through this area. The EPBC Act 'Protected Matters Database' lists both threatened and migratory species that are protected under Commonwealth legislation and various international conventions and treaties as having a presence in the area (SEWPC, 2012a). The following species potentially have habitat in the MSS area (refer **Table 4-1**):

- Twenty-two (22) species of cetacean. Two (2) of these species have a threatened status and six (6) species have a migratory status under the EPBC Act. It is possible that the two threatened species, the Blue and Humpback whale, may be encountered during the MSS however encounter rate is expected to be low. Encounter with other migratory cetacean species is also considered low;
- Seven (7) reptile species listed as threatened with six (6) listed as migratory. Turtle species presence in the MSS area, given the water depths present, are expected to be transitory and encounter is considered low;
- Three (3) species of shark. One species has a threatened status and all species have a migratory status under the EPBC Act;
- Two (2) marine bird species are listed as migratory; and
- Twenty-nine (29) species of fish including twenty-one (21) species of pipefish and four (4) species of seahorse.

Table 4-1: EPBC listed Threatened & Migratory Species in the MSS Area (SEWPC, 2012a)

Status:

E: Endangered

V: Vulnerable

M: Migratory

Likelihood of Occurrence:

LO: Species or species habitat likely to occur in area

MO: Species or species habitat may occur within area

FMO: Foraging/Feeding may occur within area

FKO: Foraging/Feeding known to occur in area

FLO: Foraging/Feeding likely to occur in area

BO: Breeding known to occur in area

Species Type	Scientific Name	Common Name	EPBC Status	Type of Presence
Marine Mammals	<i>Balaenoptera musculus</i>	Blue Whale	E, M	MO
	<i>Megaptera novaeangliae</i>	Humpback Whale	V, M	MO
	<i>Balaenoptera bonaerensis</i>	Antarctic Minke Whale	M	MO
	<i>Balaenoptera edeni</i>	Bryde's Whale	M	MO
	<i>Orcinus orca</i>	Killer Whale	M	MO
	<i>Physeter macrocephalus</i>	Sperm Whale	M	MO
Marine Birds	<i>Calonectris leucomelas</i>	Streaked Shearwater	M	MO
	<i>Puffinus leucomelas</i>	Streaked Shearwater	M	MO
Sharks	<i>Isurus oxyrinchus</i>	Shortfin Mako	M	LO
	<i>Isurus paucus</i>	Longfin Mako	M	LO
	<i>Rhincodon typus</i>	Whale Shark	V, M	MO
Reptiles	<i>Caretta caretta</i>	Loggerhead Turtle	E, M	LO
	<i>Chelonia mydas</i>	Green Turtle	V, M	MO
	<i>Dermochelys coriacea</i>	Leatherback Turtle	E, M	MO
	<i>Eretmochelys imbricata</i>	Hawksbill Turtle	V, M	MO
	<i>Natator depressus</i>	Flat-back Turtle	V, M	MO
	<i>Aipysurus apraefrontalis</i>	Short-nosed Seasnake	CE	LO

4.4 Socio-Economic Environment

4.4.1 Commercial Shipping

AMSA has identified that the main traffic routes from North Western Australia (Dampier, Port Walcott & Port Hedland) to Roti Indonesia pass to the west of the western border of the proposed Kraken MSS area. A scout vessel to identify potential shipping threats, together with navigational warnings will be implemented prior to MSS commencement to alert commercial vessels of the activity.

4.4.2 Commercial Fishing

The Kraken MSS area lies within the following commercial fishing management areas:

- Western-Australian state-managed:
 - Western Australian Tropical Shark Fishery (no reported fishing effort during 2009/10 and WA Department of Fisheries has confirmed no fishing effort occurs within the MSS area); and
 - North Coast Demersal Scale-fish Fishery (not identified by WA Department of Fisheries as being active in the MSS area).
- Commonwealth-managed:
 - North-west Slope Trawl Fishery (consultation has identified that this fishery will not be present during the Kraken MSS);
 - Western Tuna and Billfish Fishery (predominant fishing activity occurs south of Carnarvon. No reported fishing activity has occurred in the Kraken MSS area between 2005-11); and
 - Skipjack Tuna and Southern Bluefin Tuna Fishery (AFMA data indicates both these fisheries are not active in the MSS area).

Encounter with commercial fishing activities is not expected.

4.4.3 Recreational Fishing

Recreational fishing occurs within the region. Consultation feedback (tourism groups, charter boat operators and RecFishwest) has indicated that recreational fishing charter trips to Scott Reef operate each year. Time spent at the reef on visits is typically five days. While this area has the potential to provide significant opportunities for pelagic sport fishing, the distance from the Western Australian coastline limits the number of charter operators prepared to operate in the Scott Reef area (Woodside, 2011).

4.4.4 Indonesian Fishermen

Indonesian fishermen, under a Memorandum of Understanding (MOU) between Australia and Indonesia, are permitted to fish via traditional fishing methods (and non-motorised sailing vessels) at Ashmore Reef, Cartier Island, Browse Island, Seringapatam and Scott Reef (Heyward et al, 1997). The fishermen's focus is trepang (sea cucumber) and trochus; collected by reef-walking at low tide or shallow diving; and shark (Heyward et al, 1997) obtained by longlines. Seasonal factors affect the presence of Indonesian Fishermen in Australian Waters. During the west monsoon from January to April, winds and waves limit fishing. Fishing in the area occurs during the east Monsoon (May to June) and again from September to December. July and August are times of strong winds and most fishermen curtail fishing during this period (Fox & Sen, 2002).

4.4.5 Oil & Gas Development

The Browse basin contains significant amounts of contingent gas resources. A significant amount of gas reserves have been discovered or are under development in adjacent areas. These include:

- ConocoPhillips and Karoon are developing the Poseidon Field located in permits WA-314-P, WA-315-P & WA-398-P which lies approximately 30km east of the Kraken MSS area;
- The Ichthys field in WA-284-P is located approximately 200km ESE from the Kraken MSS area;
- The Prelude Field in WA-371-P is located approximately 200km east of the Kraken MSS area; and
- The Browse LNG Development which consists of the Torosa, Brecknock and Calliance fields lie adjacent to the MSS area. The Torosa Field lies approximately 25km south of the Kraken MSS area.

4.4.6 Commonwealth Heritage

4.4.6.1 **Natural Environment**

Commonwealth heritage places lying in proximity to the Kraken MSS area include Seringapatam Reef (& surrounds) and Scott Reef (& surrounds).

Seringapatam Reef is a shelf atoll consisting of an emergent reef, an enclosed lagoon and surrounding oceanic waters extending to the 50m bathymetric contour (SEWPC, 2012b). The annular reef structure is approximately 8km by 9.4km which is slightly broader on the western side (1.5km) than the eastern side (1.2km). The enclosed lagoon varies in depth to 20-30m and is connected to the ocean by a narrow passage at the north-east. The reef crest includes a well-developed boulder zone, beyond which the reef slopes gently seaward to a reef front which then drops away steeply to deep water (SEWPC, 2012b). There is very scarce coral coverage on the reef flats and the reef crest adjacent to the wave zone (Heyward et al, 2010; Heyward et al, 2012). Key groups of taxa within that zone are the massive non-Acroporas, particularly *porites* species (McKinney, 2009).

Seringapatam Reef has been included on the Commonwealth Heritage list due to its unique physical and biological characteristics. It is characterised by environmental conditions which are rare for shelf atolls including clear, deep oceanic water. Seringapatam Reef has biogeographic significance given the presence of species which are at or close to their biogeographic range; a high representation of species not found in WA coastal waters; significant diversity of fauna (corals, molluscs, crustacean species, echinoderms and fish); and recognition as the most highly developed zonation of any coral reef community in Australian (SEWPC, 2012b) resulting from strong wave action on outer slopes and a wide tidal range (~4.5m in spring neaps).

Seringapatam Reef contains small areas of seagrass (lagoon area) and is a staging area for marine birds including the wedge-tailed shearwater (*Puffinus Pacificus*), brown booby (*Sula Leucogaster*), lesser frigate bird (*Fregata Ariel*), common noddy (*Anous Stolidus*) and sooty tern (*Sterna Fuscata*). Marine fauna at Seringapatam Reef includes several species of sea snake and while turtle foraging at Seringapatam Reef does occur, the reef does not carry a significant population of turtles.

Scott Reef is a large shelf atoll consisting of an emergent reef, partially enclosed lagoons and includes the surrounding oceanic waters extending to the 50m bathymetric contour (SEWPC, 2012c). This includes the North Reef, an annular reef (16.3km long by 14.4km wide) with a deep enclosed lagoon (~21m deep) connected to the ocean by passages in the SE and SW; and South Reef, a crescent shaped reef (17km across by 27km apart) that subtends the North Reef with a partially enclosed deep (~55m) lagoon. A deep (400-700m) channel separates the North and South Reef. A small island, Sandy Islet, lies between North and South Scott Reef. The Islet measures 690m long by 110m wide.

Scott Reef has been included on the Commonwealth Heritage list as the Reef has biogeographic significance given the presence of species which are at or close to their biogeographic range; the reef provides habitat to a number of endemic species (fish, molluscs, echinoderms and seagrass) and has significant habitat diversity (SEWPC,

2012c). As per Seringapatam Reef, Scott Reef is characterised by environmental conditions rare for shelf atolls including deep oceanic waters and large tidal ranges.

A diverse assemblage of hard coral species have been recorded in the shallow and deep water environments at Scott Reef. Two hundred and ninety five species have been recorded from the shallow water environments (<30m) and 51 species from the deep-water habitats (>30m). No coral species are endemic to Scott reef with all coral taxa widespread Indo-Pacific species having clear affinities with coral assemblages at Ashmore Reef and the Indonesian provinces to the north (Woodside, 2011). Two short and distinct periods of coral spawning have been identified for Scott Reef – March /April and October/November and recruitment of coral species within Scott Reef is largely local (Woodside, 2011). Coral spawning periods at Seringapatam Reef are expected to be similar.

Seagrass communities at Scott Reef occur at the reef edge, lagoon edge and shallow lagoon. Seagrasses recorded in less than 15m of water depth cover a total of 23Ha out of 10,873Ha at North Scott Reef and 77Ha out of 14,400Ha at Scott Reef South (Woodside, 2011). Scott Reef is a staging area for marine birds similar to Seringapatam Reef. Other fauna includes five species of sea-snake; significant coralline fauna; molluscs; crustacean species; echinoderms; fish and provides habitat for Green Turtles, a genetically distinct group from the species which inhabits WA coastal areas (SEWPC, 2012c). The fish species at Scott Reef are diverse in both shallow and deep waters. Of the 898 fish species recorded at Scott Reef, 621 species were recorded in the 0-20m water depth range and 277 species in the 30-70m depth range (Woodside, 2011).

4.4.6.2 Cultural

Review of the National Shipwreck database indicates that no shipwrecks lie within the Kraken MSS area. The closest registers shipwrecks are the *Yarra* (1884) located approximately 40km south at Scott Reef and the *Ann Millicent* (1888) located approximately 190km NE at Cartier Island.

5 Major Environmental Hazards and Controls

In accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* R14(3) & R14(3A), an environmental hazard identification and risk assessment has been undertaken to evaluate the potential sources of environmental impact associated with the Kraken MSS activity. This included an assessment of risks arising from operational activities, unplanned events (non-routine/accident) and incident response activities and can be grouped into the following broad categories:

- Mobilisation of the seismic and support vessels to the proposed survey area:
 - Introduction of invasive marine species (IMS) from ballast water discharge or biofouling.
- Physical presence of the Seismic Vessel:
 - Disruption to commercial fishing activities and commercial shipping; and
 - Lighting impacts due to 24 hour activities.
- Seismic acquisition:
 - Discharge of acoustic source sound pulses in the proposed survey area;
 - Sound from operation of vessels; and
 - Sound from operation of helicopters.
- General vessel operations:
 - Routine waste discharges from the seismic and support vessels (oily water, sewage, food-scrap); and
 - Air emissions (combustion and ozone depleting substances).
- Non-Routine (accidental) events:
 - Oil spill from vessel fuel tank rupture;
 - Chemical/oil spill through deck drain system;
 - Oil spill during refuelling at sea;
 - Solid non-biodegradable/hazardous waste overboard incident;
 - Seismic streamer loss in the marine environment;
 - Seismic streamer liquid leak in the marine environment; and
 - Vessel collision with a cetacean.

Implemented control measures identified in **Table 5-1** ensure that the environmental risk associated with these hazards is as low as reasonably practicable (ALARP). Control measures are taken into consideration in calculating the residual risk associated with the activity of impact reflected in **Table 5-1**.



Table 5-1: Kraken MSS Aspects, Potential Environmental Impacts and Controls

Aspect	Possible Impacts	Control/Mitigation Measures	Residual Risk
<i>Mobilisation</i>			
Vessel Entry to Timor Sea Waters (Introduction of IMS)	Alteration of local ecosystem by IMS through Ballast Water Discharges	<p><u>Prevention Controls:</u> MSS vessels to undergo Ballast water Exchange prior to entry to Australian waters in accordance with DAFF <i>Guidelines on Ballast Water Management</i> (2011); During MSS activity no ballast water exchange occurs within 12nm from the outer boundaries of Scott and Seringapatam Reefs; Support vessel sourced locally from within Australian Waters (wherever possible); Vessels to submit QPAR form to AQIS and ballast water logs 96hrs prior to arrival into Australian Port.</p> <p><u>Mitigation:</u> Water depth of area is 950-2000m (light-limited) limiting the success of IMS colonisation.</p>	Low
	Alteration of local ecosystem by IMS through Vessel Bio-fouling	<p><u>Prevention Controls:</u> Vessels entering Timor Sea waters will be 'clean' of biofouling in accordance with the <i>National Biofouling Management Guidance for the Petroleum Production and Exploration Industry</i> (2009) and as defined by the <i>Western Australian Marine Pest Management Guidelines</i> (WA DoF, 2013); 'Clean' as defined by the WA Department of Fisheries (DoF) refers to vessels which have been assessed for IMS risk and with corrective actions implemented are deemed 'low risk'. Vessels mobilising from the same IMCRA meso-scale bioregion are deemed low-risk; Support vessel sourced locally from within Australian Waters (wherever possible); All infield equipment, when retrieved to the MSS vessel, will be inspected and cleaned as necessary to remove biofouling.</p> <p><u>Mitigation:</u> Water depth of area is 950-2000m (light-limited) limiting the success of IMS colonisation.</p>	Low
<i>Presence of Vessel in Permit Areas</i>			
Presence of Vessel Activities	Interference with Commercial/Recreational Fishing Activities (Spatial Conflicts)	<p><u>Prevention Controls:</u> Stakeholder consultation with fisheries to advise of activity, understand issues and identify practicable controls to reduce impacts; Notifications to relevant marine users prior to survey commencement and on survey completion; Vessel activity reports to AMSA RCC who will issue shipping notifications to minimise potential for marine activity conflicts; Notice to Mariners issued by AHO for activity; Support/chase vessel available to advise fishermen of seismic presence.</p> <p><u>Mitigation:</u> Limited duration of MSS activity (20 days). No commercial fishing activity reported within the Kraken MSS area. Recreational fishing advice indicates earliest presence during September.</p>	Low



Aspect	Possible Impacts	Control/Mitigation Measures	Residual Risk
	Interference with Indonesian Fishermen in transit across MSS area (spatial conflict)	<p><u>Prevention Controls:</u> Support/chase vessel available to advise fishermen of seismic presence. Bahasa speaking representative on-board to communicate with Indonesian fishermen (as required); Vessel activity reports to AMSA RCC who will issue notifications to minimise potential for marine activity conflicts; Notice to Mariners issued by AHO for activity.</p> <p><u>Mitigation:</u> Limited duration of MSS activity (20 days). Indonesian fishermen presence possible but more likely in May-June and September-December</p>	Low
	Interference with Commercial Shipping (Diversion)	<p><u>Prevention Controls:</u> Stakeholder consultation with commercial shipping to advise of activity, identify any issues and controls to minimise impacts; Support/chase vessel available to advise & deter of third party presence; Bridge manned 24/7 by STCW95 competent crew to identify third party vessel presence via vessel radar, radio, ARPA and AIS; Vessel activity reports to AMSA RCC; Notice to Mariners issued by AHO for activity.</p> <p><u>Mitigation:</u> Seismic program in Kraken MSS area is short in duration (20days). Commercial vessels within Kraken MSS area expected to be low</p>	Low
Vessel Lighting	Light-spill interfering with behaviour of marine fauna and birds	<p><u>Prevention Controls:</u> Vessel lighting is the minimum required for compliance with navigation safety and workplace safety requirements; In-sea inspection activities during night hours are minimised as far as possible; Pre-mobilisation audit identifies opportunities to eliminate deck light spill with corrective actions implemented prior to mobilisation.</p> <p><u>Mitigation:</u> Survey area not located within, or in close proximity to known light-sensitive fauna aggregation areas (e.g. turtle breeding beaches) and survey is outside turtle nesting season; Survey duration is limited (approx. 20days) and vessel is constantly moving.</p>	Low
<i>Survey Operations</i>			



Aspect	Possible Impacts	Control/Mitigation Measures	Residual Risk
Operation of Seismic Sources	Damage to &/or behavioural changes to marine fauna (Cetaceans)	<p><u>Prevention Controls:</u> All field personnel provided with an induction which includes the environmental sensitivities associated with the Kraken MSS area; Lowest size source is selected which achieves seismic objectives for the MSS; Implement & comply with requirements of the DEWHA Industry Guidelines <i>Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales (2008)</i> (includes 30minute prestart watch, 35min soft-start, 3km precautionary zone, 2km low power zone & power-down procedures, 500m shutdown zone & shut-down procedures; controls for start-up during periods of low visibility); Low visibility controls as determined by EPBC Referral 2013/6730; The acoustic source will be powered down to the lowest practicable settings on line turns; Two MMOs available on-board the vessel during survey with continuous monitoring during daylight hours while acoustic source is operational; and All vessel crews inducted/trained in cetacean observation as part of induction process to assist in identifying cetaceans & sighting data provided to SEWPC/NOPSEMA.</p> <p><u>Mitigation:</u> Cetacean/reptiles species will avoid area if sound disturbance is too high; MSS area not recognised as containing critical habitat for species and encounter will be transient; MSS duration limited (20 days).</p>	Low
	Damage/ behavioural changes to shark species (long-term)	<p><u>Mitigation:</u> Shark species appear unaffected by acoustic array sound; Vessel is constantly moving (i.e. not situated in one stationary area).</p>	Low
	Damage/ behavioural change (displacement) to fish species (long-term)	<p><u>Prevention Controls:</u> Implement & comply with requirements of the DEWHA Industry Guidelines <i>Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales (2008)</i> (provides for soft-start procedures which will alert and disperse fish)</p> <p><u>Mitigation:</u> No lethal effects have been observed for adult fish exposed to seismic arrays; Effects of seismic transitory except for fish eggs/larvae at very close range; Fish species sensitive to noise will temporarily disperse in high sound areas; Vessel is constantly moving (i.e. not situated in one stationary area).</p>	Low



Aspect	Possible Impacts	Control/Mitigation Measures	Residual Risk
Propulsion of all Vessels	Sound Pollution & Behavioural Disturbance to Cetaceans/Reptiles	<p><u>Prevention Controls:</u> Vessel propulsion equipment is routinely maintained to reduce sound levels emitted; All vessel interaction with cetaceans must be consistent with proximity distances and low speeds contained in the EPBC Regulations 2000 (Chapter 8) for vessels where streamers are not deployed. MSS vessel shall not exceed 6knots in the MSS area; MMOs on-board the MSS vessel and support/chase vessel crews will keep watch for cetaceans; Requirements will be included in the environmental induction for the survey.</p> <p><u>Mitigation:</u> Sound levels emitted from vessels are below levels which cause significant damage to marine fauna; Small area of impact given the rapid dissipation of sound in the marine environment; Marine species will avoid area if noise disturbance is too high; and Survey duration limited (20days).</p>	Low
Helicopter Use (Supply/Crew Change)	Sound Pollution & Disturbance to Cetaceans	<p><u>Prevention Controls:</u> Comply with proximity distances as required for cetaceans in Part 8 of the EPBC Regulations 2000. Crew changes to preferentially occur at port calls; Helicopter propulsions systems undergo regular preventative maintenance and inspection; MMOs to maintain watch on interactions and verify compliance.</p> <p><u>Mitigation:</u> Small area of impact given the rapid dissipation of sound in the marine environment; Marine Fauna will avoid area if sound disturbance is too high; Very short duration of disturbance (helicopters at low altitude for small period of time).</p>	Low
<i>Standard Vessel Discharges</i>			



Aspect	Possible Impacts	Control/Mitigation Measures	Residual Risk
<p>Oily water discharges from equipment spaces (All Vessels)</p>	<p>Reduction in water quality (organics & toxics) with impacts to marine fauna</p>	<p><u>Prevention Controls:</u> Discharge to comply with MARPOL Annex I requirements. Treated bilge water shall be discharged at locations greater than 3nm from the outer boundaries of Scott and Seringapatam Reefs; For vessels with an oil-water separation system is installed and discharging to the environment: - Oily water passes through an oil/water separator and treated to an oil-in-water content <15ppm prior to discharge; - Oily water is discharged via an approved Oil-in-water (OIW) meter as per MARPOL 73/78 Annex I and on detection of an OIW concentration greater than 15ppm shall automatically shut-in or divert on-board for further treatment or on-board storage; - Oil Detection Monitoring Equipment (ODME) is regularly calibrated and certified; - Equipment routinely maintained (Preventative/Planned Maintenance System); - Oily water will only be discharges while the vessels are <i>en-route</i>; - Separated oil store in dedicated tank for onshore disposal or incineration. For vessels without an oil-water separation system: - Oily water residues are retained on-board for onshore disposal. <u>Mitigation:</u> Low volumes discharged and rapid dilution/dispersion in Timor Sea waters. Seismic survey is for a limited duration only (20days).</p>	<p>Low</p>
<p>Grey water/sewage disposal (All vessels)</p>	<p>Reduction in water quality (organics & visual amenity) with impacts to marine fauna</p>	<p><u>Prevention Controls:</u> Discharge to comply with MARPOL 73/78 Annex IV requirements. Treated sewage will be discharged at distances greater than 3nm from the outer boundary of Scott and Seringapatam Reef; For vessels with a STP: - Have a current ISPP (or equivalent for class). - STP reduces BOD /organic loadings and disinfected prior to discharge at distances >3nm. - STP routinely maintained and inspected (Vessel’s Preventative/Planned Maintenance System); - POB strictly controlled on vessel; and - On breakdown of equipment discharge directed on-board for storage until equipment operational or discharged to onshore facility. For vessels without a STP: - Untreated sewage discharged at a distance of more than 12nm from Scott or Seringapatam Reef whilst proceeding <i>en-route</i> at 4knots. <u>Mitigation:</u> Low volume of sewage generated with small numbers of personnel on board; High dispersal/dilution in Timor Sea marine environment; Seismic survey is for a limited duration only (20days).</p>	<p>Low</p>



Aspect	Possible Impacts	Control/Mitigation Measures	Residual Risk
Putrescible waste (food-scrap) Discharges	Reduction in water quality (organics & visual amenity) with impacts to marine fauna	<p><u>Prevention Controls:</u> All food scrap discharges will be compliant with MARPOL 73/78 Annex V requirements: - Macerated waste to a particle size of less than 25mm discharged at distances > 3nm from the outer boundaries of Scott and Seringapatam Reefs; - Non-macerated waste at distances > 12nm the outer boundaries of Scott and Seringapatam Reefs.</p> <p>Vessels operate under a Shipboard Garbage Management Plan with placards on-board to advise of waste management requirements; Macerators have MARPOL certification and are routinely maintained and inspected (Preventative/planned Maintenance System); Personnel trained in the requirements of the Shipboard Garbage Management Plan; Breakdown of maceration equipment results in food-scrap collected in bins on-board for storage and disposal onshore until equipment operational.</p> <p><u>Mitigation:</u> Low volumes discharged and rapid dilution/dispersion in marine waters; Seismic survey is for a limited duration only (20days).</p>	Low
Air Emissions: Equipment Combustion & Incinerator Activity	Reduction in air quality (NO _x , SO _x , CO ₂) such that impacts to marine species occur & aesthetic impacts of smoke	<p><u>Prevention Controls:</u> All combustion emissions from marine utilities are in accordance with MARPOL 73/78 Annex VI (R13) requirements. MDO/MGO used to fuel survey vessels (MARPOL compliant for sulphur content) Vessels carry a current IAPP; On-board incinerator will meet the requirements of and operate in accordance with MARPOL 73/78 Annex VI (R16) requirements and waste disposed recorded in the Garbage Record Book; Regular equipment monitoring and maintenance undertaken on incinerator and combustion equipment via PMS to ensure maximum efficiencies are obtained; and Fuel monitoring undertaken to identify equipment inefficiencies.</p> <p><u>Mitigation:</u> Low volumes generated and rapid dilution/dispersion in atmosphere; Seismic survey is for a limited duration only (20days).</p>	Low
Air Emissions: Release of ODS	Reduction in Ozone Protection Layer	<p><u>Prevention Controls:</u> Vessels manage ODS systems in accordance with MARPOL 73/78 Annex VI (R12) requirements; Maintenance of closed refrigeration systems on-board the vessel undertaken by suitably qualified personnel in accordance with approved procedures; Any repair or maintenance of equipment containing ODS is recorded in the ODS Record Book</p> <p><u>Mitigation:</u> Accidental Releases are recorded in the ODS Record Book; Seismic survey is for a limited duration only (20days).</p>	Low
<i>Non-Routine Activities (Incidents)</i>			



Aspect	Possible Impacts	Control/Mitigation Measures	Residual Risk
<p>Oil spill (MDO/MGO) due to Fuel Tank Rupture (Spill volume – largest 'at risk' fuel tank is 200m³)</p>	<p>Toxic & Physiological impacts to marine biota (including Cetaceans, Turtles)</p>	<p><u>Prevention Controls:</u> Vessel selected for Kraken MSS activity meets class certification and safety audit requirements; Navigational safety equipment (AIS, navigation lighting, day shapes, ARPA and radio) is present on all vessels involved in the survey; Navigation safety equipment (ARPA, AIS, radio, Navigation lights) are maintained in accordance with Manufacturers specifications via the vessel's PMS; Notification to AMSA RCC who will issue AusCoast warnings; Notification to AHO who will issue a Notice to Mariners; Vessel operated by experienced and competent crew (STWC95) with 24/7 bridge watch; Availability of a support/chase vessel to detect third party vessels and avoid interference; Vessel interaction procedures are implemented to prevent third party impacts to vessel/streamers; Consultation with and notification to, marine stakeholders of activity; Radio communication on vessels; All field personnel undergo induction which reinforce these requirements. <u>Mitigation:</u> Availability of approved, implemented and tested SOPEP and OSCP. Activity-specific OSCP implemented and tested prior to mobilisation; <i>Note MSS is not located in an area of high vessel traffic.</i></p>	<p>Low</p>
<p>Oil/Chemical spill through deck system</p>	<p>Localised Reduction of Water Quality with possible impacts to marine fauna</p>	<p><u>Prevention Controls:</u> Chemical/oil hazards are isolated from the deck drain system (e.g. bunds, etc.); Chemicals/oils are appropriately labelled, packaged, marked and tethered in accordance with IMDG Code; Information is available to all personnel on chemical handling (e.g. MSDSs). MSDSs are to be made available for all chemicals/oils; Spill kits to be provided in appropriate locations close to high-risk spill locations; Weekly inspections of spill kits and bunded areas and high levels of housekeeping maintained on the vessels; All personnel are aware of hydrocarbon/chemical response through environmental induction; Deck spills are cleaned up immediately and prior to any deck washing; and Biodegradable detergents used on vessels for deck wash-down. <u>Mitigation:</u> Small volumes of chemicals/oils held on-board (usually in packages of limited volume); Availability of implemented and tested SOPEP; Activity-specific OSCP tested and implemented; Low volumes generated and rapid dilution/dispersion in marine environment; Seismic survey is for a limited duration only (20days).</p>	<p>Low</p>



Aspect	Possible Impacts	Control/Mitigation Measures	Residual Risk
Refuelling at Sea Fuel (MDO/MGO) transfer spill (Spill 1m ³)	Water quality and marine life impacts (estimate 1m ³)	<p><u>Prevention Controls:</u> Vessels are positioned in the Kraken MSS working area located more than 30km (16nm) from the reef system to undertaken refuelling activities; Refuelling activity is a fully supervised operation which occurs in daylight hours, good visibility and in appropriate sea-states, undertaken in accordance with approved Bunkering Procedures/Permit to Work by trained personnel with all associated equipment routinely maintained and inspected via PMS prior to use (e.g. dry-break couplings); Toolbox meetings undertaken prior to activity Tanks levels monitored to prevent overfill; Transfer area is banded; Spill kits available at location for spill clean-up.</p> <p><u>Mitigation:</u> Vessel has approved, implemented and tested SOPEP; Activity-specific OSCP implemented and tested prior to mobilisation; and Spills rapidly dispersed in the Timor Sea – no impact to shoreline expected.</p>	Low
Solid/Hazardous Waste overboard	Toxicity impacts to marine flora & fauna Alteration to Seafloor Harm to Marine Fauna by Ingestion	<p><u>Prevention Controls:</u> Vessels to operate in accordance with Garbage Management Plan and approved Waste Management & Disposal Procedures which includes identification of waste reduction measures (at source) to prevent waste generation; 'No solid non-biodegradable or hazardous waste overboard' Policy; Recyclable wastes are segregated, where possible compacted and stored on-board the vessel for onshore recycling; Waste storage areas routinely inspected; All waste clearly identified, segregated, contained (in skips or sealed drums) & labelled; Wastes incinerated where possible; All hazardous wastes are segregated and contained for onshore disposal/recycling in accordance with WA/NT legislation; All waste disposal is documented in the Garbage Record Book; Environmental induction reinforces waste management requirements.</p>	Medium
Streamer Loss	Hazard to Vessels	<p><u>Prevention Controls:</u> Streamers undergo regular inspection and maintenance system checks on bridles and harnesses for wear and damaged components with damaged components replaced as necessary; Survey operates under approved Streamer Deployment and Retrieval Procedures; For streamer operations a secondary retaining device is used to prevent loss.</p> <p><u>Mitigation:</u> The streamer contains buoyancy devices, are fitted with surface marker buoys and radar reflectors for rapid location and identification of lost equipment In the event of a streamer loss, marine stakeholders are notified.</p>	Low



Aspect	Possible Impacts	Control/Mitigation Measures	Residual Risk
Seismic Streamer Liquid Leak	Altered water quality with possible toxic impact to fauna	<p><u>Prevention Controls:</u> Solid streamers are used for the MSS (only small sections containing liquid); Streamers are fit-for-purpose; AHO issue of Notice to Mariners; Notification of activity to AMSA RCC to issue AusCoast warnings; Support/chase vessel to prevent spatial conflicts with third party vessels; Navigational safety equipment maintained and available to track third party vessels; Trained and competent crew (STCW95) and vessels maintain 24/7 watch; Approved procedures for intervention to prevent third party impacts to streamers; Environmental induction reinforces requirements.</p> <p><u>Mitigation Measures:</u> Rapid dispersion in the marine environment. Low toxicity, readily degradable, non-bioaccumulation fluid in streamer (ISOPAR). Minimal fluid content in streamer.</p>	Low
Collision with Marine Cetaceans	Damage/Death to Individual Cetacean	<p><u>Prevention Controls:</u> Comply with proximity distances as required for cetaceans in Part 8 of the EPBC Regulations 2000 for vessels not towing streamers.</p> <ul style="list-style-type: none"> • Vessel will not travel at greater than 6knots within 300m of a cetacean known to be in the area; • A vessel will not approach closer than 100m of a whale known to be in the area; • If a dolphin approaches or comes within 100m of the vessel, the vessel master must not change course or modify speed suddenly; <p>The MSS must follow these requirements when the streamers are not deployed. The support vessel must adhere to these requirements at all times; All vessel masters are responsible for ensuring these requirements are followed; and Information is included in environmental induction for the Kraken MSS.</p> <p><u>Mitigation:</u> Cetaceans deterred from high sound areas.</p>	Low

6 Summary of Management Approach

Karoon, as the 'Environmental Operator' of the Kraken MSS activity, is accountable for the environmental outcomes from the proposed MSS and will ensure the activity is managed in accordance with the accepted Kraken Environment Plan (EP). The selected seismic contractor will undertake the survey operations on Karoon's behalf and, under contractual arrangements with Karoon, will implement and comply with all environmental controls and procedures nominated in the accepted Environment Plan.

Karoon is committed to protection of the environment in all activities it undertakes. Activities are undertaken in accordance with relevant legislated standards and where legislated standards do not exist, responsible standards are adopted. Successful environmental outcomes are achieved by understanding how proposed activities interact with the environment, identifying possible and foreseeable impacts, and implementing management controls which eliminate or reduce the environmental risk to ALARP.

Environmental performance objectives have been defined for each environmental aspect. Control measures adopted to manage the environmental risk to a level which is as low as reasonably practicable (ALARP) have been assigned measurable performance standards to ensure controls are meeting their environmental outcomes. Environmental performance and control measure implementation are monitored and verified throughout the activity by the Karoon Offshore Representative.

Key elements of the implementation strategy include:

- Definition of specific roles and responsibilities as they relate to environment protection and EP implementation;
- Induction activities to educate personnel of specific environmental aspects of the MSS including the environmental sensitivities within the region, control measures which require implementation, monitoring and reporting requirements; and ongoing awareness/communication sessions to reinforce requirements and identify/resolve possible issues;
- Incident reporting and investigation of environmental incidents;
- Compliance assurance of the MSS activity and its adherence to Environment Plan requirements through auditing and inspection activities; and
- Environmental performance review at the completion of MSS activities.

Karoon adopts a philosophy of continuous improvement. Learnings from seismic performance appraisals, incident investigations and field activity reviews are documented and incorporated as improvement actions for future activities.

7 Consultation Process

In accordance with the *Offshore Petroleum and Greenhouse Gas (Environment) Regulations 2009* R(11A) and R14(9), the following stakeholders and interested parties have been identified and consulted as part of the stakeholder engagement process for the survey:

Commonwealth Department or Agency

- Australian Fisheries Management Authority (AFMA)
- Australian Maritime Safety Authority (AMSA)
- Australian Hydrographic Office (AHO)
- Department of Agriculture, Fisheries and Forests (DAFF)
- Border Protection Command
- National Offshore Petroleum Titles Administrator
- Department of Sustainability, Environment, Population and Communities (SEWPC)

Western Australian Departments or Agencies

- Department of Mines and Petroleum
- Department of Fisheries
- Department of Transport
- Department of Environment and Conservation

Fishery-interest Groups

- Western Australian Fisheries Industry Council (WAFIC)
- Commonwealth Fisheries Association (CFA)
- RecFish West
- Northern Demersal Scalefish Fishery
- North-west Slope Trawl Fishery
- Charter Boat Industry Licence Holders

Adjacent Oil and Gas Operators

- ConocoPhillips
- Shell Australia
- BHP Billiton

Scientific Interest Group

- Australian Institute of Marine Science

Feedback obtained in these consultation activities has allowed for the development of a communication and engagement strategy for each relevant stakeholder to determine the level, type, 'triggers' and schedule of on-going engagement throughout the Kraken MSS. Karoon will maintain communications with stakeholders identified in this communication and engagement strategy to ensure they are informed of relevant aspects of the survey or changes that may affect them.

8 Contact Details

Further information associated with the environmental aspects of the Kraken MSS may be obtained from Karoon Gas by contacting the following:

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