

AURORA MC3D MARINE SEISMIC SURVEY ENVIRONMENT PLAN: PUBLIC SUMMARY

This summary of the Environment Plan for the PGS Aurora MC3D marine seismic survey, which will be acquired within the southern Browse Basin offshore from Western Australia (WA), has been submitted to the WA Department of Mines and Petroleum (DMP), to comply with sub-regulations 11(7) and 11(8) of the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009.

INTRODUCTION

Petroleum Geo-Services (PGS) proposes to undertake a multi-client, three-dimensional (3D) marine seismic survey (Aurora MC3D MSS), within the southern Browse Basin offshore from Western Australia (WA) (**Figure 1**). The Aurora MC3D MSS will be comprised of a maximum of 7,600 square kilometres (km²) of 3D seismic acquisition in a total of 11 Exploration Permit Areas, and one Retention Lease Area in the southern Browse Basin.

COORDINATES OF THE PROPOSED ACTIVITY

The Aurora MC3D MSS will cover parts of Exploration Permits WA-281-P, WA-285-P, WA-332-P, WA-411-P, WA-413-P, WA-414-P, WA-424-P, WA-425-P, WA-429-P, WA-431-P, WA-432-P, and Retention Lease WA-37-R. Seismic acquisition will take place in an operational area that covers approximately 18,850 km² overlapping these exploration permits and retention lease (**Figure 1**). Seismic acquisition within the operational area will be comprised of approximately 7,600 km² within a core survey area, the exact location of which is still to be determined. Boundary coordinates for the operational area are provided in **Table 1** below.

Table 1: Aurora MC3D MSS operational area - boundary coordinates

Latitude (S)			Longitude (E)		
Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
14	14	12.93	123	29	05.53
13	53	51.00	123	29	05.53
13	53	51.00	122	44	04.56
14	11	39.48	122	25	23.07
15	10	51.63	122	25	17.20
15	10	51.63	122	39	57.95
15	00	32.14	122	51	07.32
15	00	26.45	123	40	03.17
14	38	13.72	124	03	21.51
14	38	57.21	124	04	01.76
14	34	58.09	124	08	19.99
14	31	24.14	124	04	59.49
14	14	18.62	124	04	54.57

Datum: GDA94

The Aurora MC3D operational area is situated a minimum distance of approximately 95 km from the mainland coastline of the west Kimberley, at High Bluff in Brunswick Bay (to the south-east). The operational area is located in Commonwealth waters, approximately 50 km due north of Adele Island, and 47 km east of South Scott Reef, as depicted in **Figure 1**. At the closest point, the north-eastern boundary of the operational area is located approximately 5.5 km (three nautical miles) west of Browse Island. No seismic acquisition or vessel movements will take place in WA State waters surrounding Browse Island, as the

survey lines will be orientated north-south within the operational area.

The eastern edge of the operational area is located approximately 95 km from the core humpback whale calving area in Camden Sound, to the south. In respect of the newly-declared marine reserves in WA State waters off the Kimberley coast, at the closest point the operational area is located approximately 60 km north-west of the north-west boundary of the Camden Sound Marine Park, and approximately 50 km north-west of the boundary of the North Kimberley Marine Park.

Water depths in the operational area range from approximately 50-410 m, with shallowest water depths situated in the south-east part of the polygon, and the deepest areas in the north-west (**Figure 2**).

Figure 1: Aurora MC3D MSS – location map

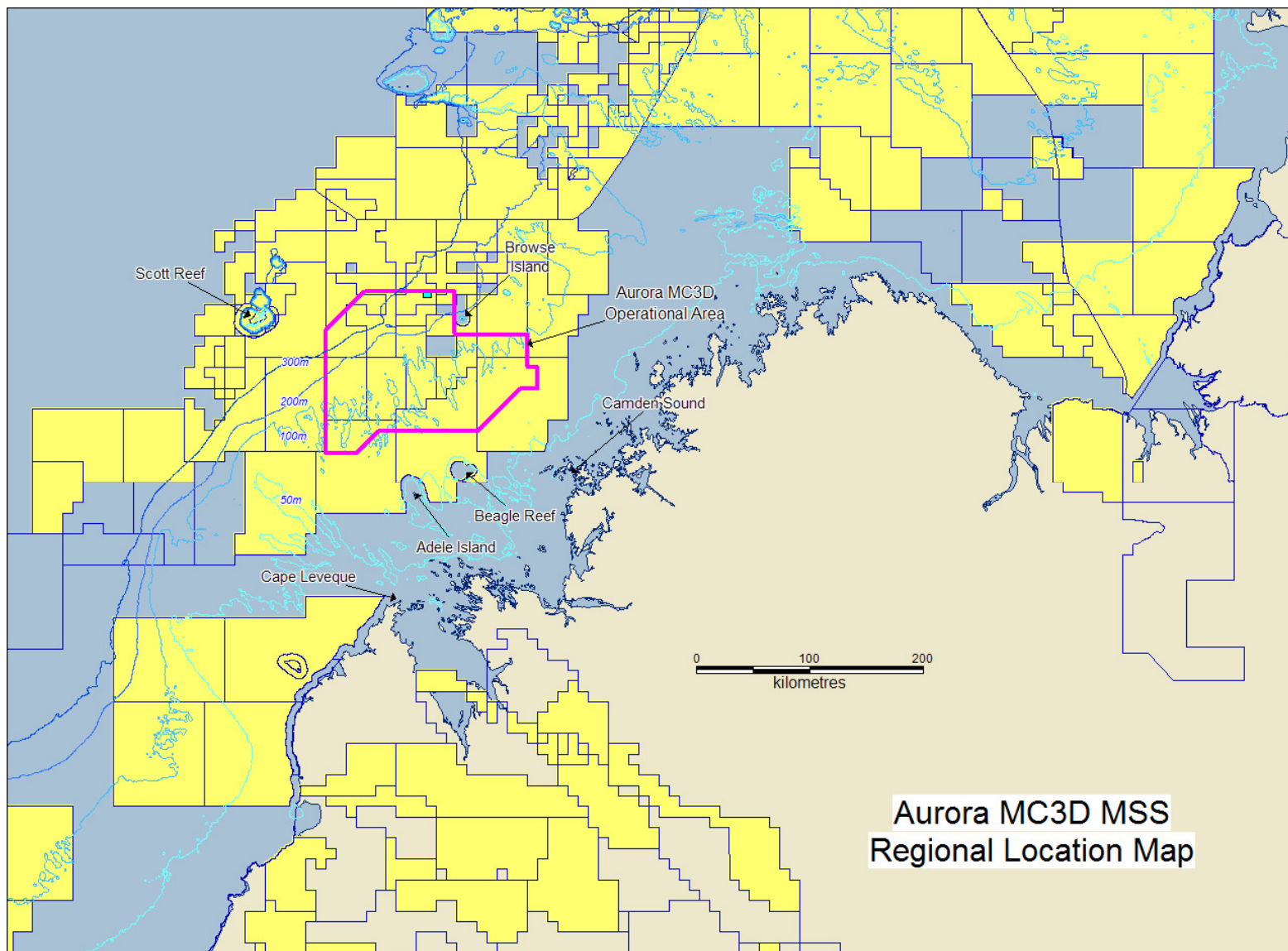
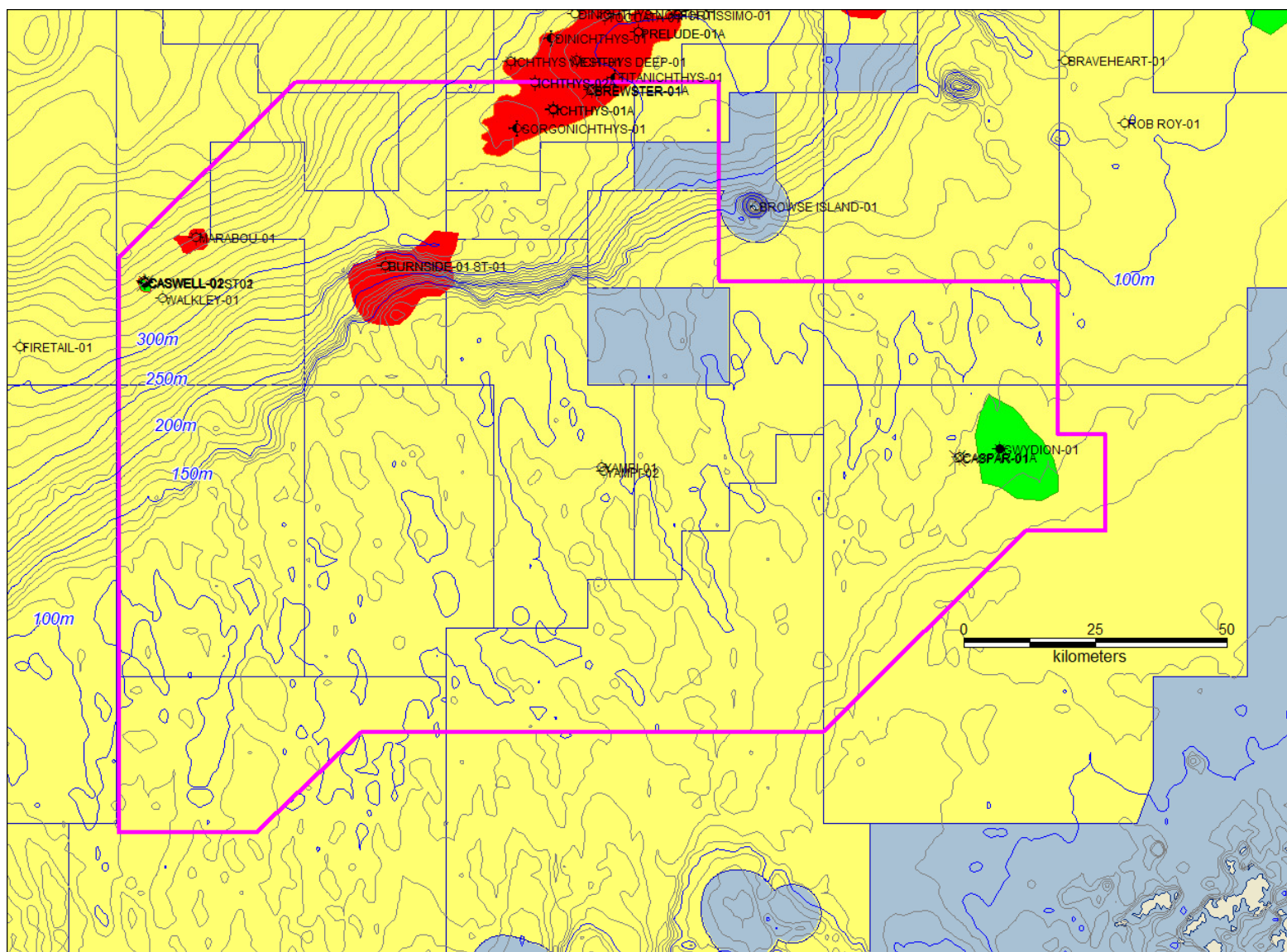


Figure 1: Aurora MC3D MSS operational area – bathymetry



DESCRIPTION OF THE PROPOSED ACTIVITY

The Aurora MC3D MSS survey is scheduled to occur in the period between late December 2010 and the end of June 2011, and is expected to be of approximately six months duration. Line orientation within the 7,600 km² core survey area will be north-south. Seismic acquisition will commence in the western part of the survey area and progress in an easterly direction.

Timing of commencement is dependent on fair sea state conditions suitable for marine seismic acquisition, the availability of the survey vessel for conducting the survey, and granting of approvals from the appropriate government bodies.

During the proposed activities, the survey vessel will traverse a series of pre-determined sail lines within the operational area at a speed of approximately 8-9 km/hr. As the vessel travels along the survey lines, a series of noise pulses (every 8-10 seconds) will be directed down through the water column and seabed. The released sound is attenuated and reflected at geological boundaries and the reflected signals are detected using sensitive microphones arranged along a number of hydrophone cables (streamers) towed behind the survey vessel. The reflected sound is then processed to provide information about the structure and composition of geological formations below the seabed in an attempt to identify hydrocarbon reservoirs.

The seismic array will comprise of a maximum of ten solid streamers (PGS's GeoStreamer technology, with pressure and velocity sensors), with a maximum length of 6 km. Streamer spacing will be 100 m, and line spacing will be 500 m. The source (airgun array) tow depth will be 6 m (+/- 1 m) and the streamer tow depth will be 15 m (+/- 1 m). The operating pressure for the airgun array will be approximately 2,000 psi. The airgun array will consist of two sub-arrays, each with a maximum volume of 4,130 cui. These sub-arrays will be fired alternately, with a shotpoint interval of 25.0 m vertical distance, and will produce source (i.e. within a few metres of the airguns) sound exposure levels (SELs) of approximately 210-220 dB re 1µPa².s at frequencies extending up to approximately 210 Hz.

PGS proposes to conduct the Aurora MC3D MSS using the purpose-built seismic survey vessel *Ramform Explorer*, which has a complement of approximately 57 crew. The *Ramform Explorer* is owned by Oslo Explorer plc and operated by Wilhelmsen Ship Management AS. The vessel has all necessary certification/registration and is fully compliant with all relevant MARPOL and SOLAS convention requirements for a vessel of this size and purpose. The *Ramform Explorer* has a Shipboard Oil Pollution Emergency Plan (SOPEP) in place, in accordance with Regulation 26 of Annex I of MARPOL 73/78.

The survey vessel will travel within the survey area at an average speed of 4.5 knots (approximately 8.3 km per hour).

A support vessel will accompany the survey vessel to maintain a safe distance between the towed array and other vessels, and to manage interactions with shipping and fishing activities, if required. The support vessel will also re-supply the survey vessel with fuel and other logistical supplies. The support vessel will have a crew of approximately 15 personnel.

During the survey, it is likely that the survey vessel will be refuelled at sea using the support vessel, either within or immediately adjacent to the operational area. At sea refuelling of the *Ramform Explorer* will only take place during daylight hours, and will not take place within a distance of 25 km from Scott Reef, Browse Island, Adele Island or Beagle Reef.

DESCRIPTION OF THE RECEIVING ENVIRONMENT

The proposed Aurora MC3D survey area lies entirely in Commonwealth marine waters in the Kimberley sub-system of the North-west Marine Region (NWMR), which extends from the southern boundary west of Broome to the northern edge of the Exmouth Plateau.

Physical Environment

South-east trade winds are prevalent from April to September, and are usually associated with fine dry weather. They produce a large swell that affects the southern side of most reefs in the area, producing consolidated crustose coralline algae and limestone substrates on the reef slope to depths characteristic of outer reefs or oceanic atolls. During April to September, the predominant direction of the ocean current is west-southwest. In the monsoon season (December to March), when winds come from the north-west or west, the direction of the ocean current reverses, becoming east-northeast. The NWMR's 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. Similarly, the Leeuwin Current is strongest in autumn, and diminishes during the North-west Monsoon (December-March).

The Kimberley system is also subject to episodic offshore cyclonic activity in the period December to April. Cyclones tend to generate offshore and move south, rarely crossing the coast until they reach the Pilbara region. They can contribute to mixing of water layers as well as play an important role in the dispersal of sediments and species

The seafloor across the NWMR is distinguished by a range of topographic features such as canyons, plateaux, terraces, ridges, reefs, and banks and shoals. The slope is relatively flat, but includes a number of large canyon heads that were probably excavated during and after continental break-up by sediment and water movements. The slope is relatively flat, but includes a number of large canyon heads that were excavated probably during and after continental break-up by sediment and water movements. There a number of reefs and islands in the Kimberley system of the NWMR adjacent to the Aurora MC3D survey area including:

- Scott Reef and Seringapatam Reef, located approximately 50 km west and 80 km WNW of the operational area, respectively. These reefs occur on the upper continental slope in water depths of 500–1,500 m.
- Adele Island, located approximately 50 km south of the operational area. Adele Island is built on a coralline platform reef, and extensive coral reefs surround the island. It is also an important seabird nesting and roosting location.
- Browse Island, located approximately 5.5 km east of the north-east boundary of the operational area. Browse Island is an important green turtle and seabird nesting site. It is surrounded by extensive coral reefs. The island is a WA Class 'C' Nature Reserve (No. 22697) vested with the Conservation Commission and managed by the WA Department of Environment and Conservation (DEC), and an IUCN Category 1A protected area.

Biological Environment

Overall, this sub-system is thought to have low productivity, largely due to the influence of the ITF and hence the chlorophyll maximum is too deep to facilitate high primary production on a regular basis. Productivity would be associated with ephemeral events, such as topographically induced water movement around geomorphic features (i.e. coral reefs, canyon heads), therefore causing some mixing of the water column. It was suggested that eddies may form on the inshore side of the emergent reefs and islands in this sub-system and therefore could be an important mechanism for mixing the water column and thereby stimulating primary production.

Repeating patterns of swirling vortices caused by the unsteady separation of flow around islands (referred to as Van Karman vortex streets) are thought to occur around the islands (on their leeward sides) of this sub-system, and may result in enhanced horizontal and vertical mixing of waters around the islands. These ephemeral but repeating events may support large populations of pelagic fish and seabirds. The islands and reefs are a key biodiversity focal point in this subregion. Associated pelagic communities provide a constant food source for cetaceans, dogtooth tuna, Spanish mackerel and pelagic sharks.

Browse Island, located approximately 5.5 km east of the north-east boundary of the operational area, is an important site for bird and turtle communities as well as a site of upwelling. Upwelling around the island is

believed to be associated with increased concentrations of tropical krill. These tropical krill aggregations may be important as there have been possible, but unconfirmed, sightings of humpback whales feeding around Browse Island.

Benthic Habitats

Generally, the granitic substrate throughout the Kimberley sub-system is hard and rough due to its erosion resistance and provides a diversity of habitats for benthic flora and fauna. Much of the outer mid-shelf is covered by a relatively featureless, sandy-mud seabed with a sparse covering of sessile organisms dominated by filter-feeding heterotrophs such as gorgonians, sponges, soft corals, echinoderms and detritus-feeding crabs and echinoderms. This is especially true of the non-trawled areas in the deeper water, and the soft-bottomed rises. However, the many limestone banks are likely to be a key ecological feature of this region. They have a harder substrate and are likely to support a more diverse range of sessile benthos such as hard and soft corals, gorgonians, encrusting sponges and macroalgae; and consequently, a more reef-associated fish and elasmobranch fauna. The mid-shelf banks of the NWMR are poorly understood. However, they are likely to support a unique and diverse invertebrate and fish fauna, with communities that change significantly with depth along their slopes.

Protected Marine Fauna

A review of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) database (Protected Matters search tool) held by the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) was conducted for the operational area polygon described by the boundary coordinates provided in **Table 1**, with the application of a 20 km buffer zone.

The 10 listed Threatened species that may occur, or relate to, the operational area are:

1. the blue whale;
2. the humpback whale;
3. the loggerhead turtle;
4. the green turtle;
5. the leatherback turtle;
6. the hawksbill turtle;
7. the olive ridley turtle;
8. the flatback turtle;
9. the green sawfish; and
10. the whale shark.

Whales and Dolphins

A number of whale species occur in and/or migrate through the NWMR, including the short-finned pilot whale, false killer whale, tropical Bryde's whale, Antarctic minke whale, killer whale, blue whale, sperm whale and humpback whale. The EPBC Act database lists 22 cetacean species that may occur in, and adjacent to, the operational area of the Aurora MC3D MSS, all of which are protected under the Act; one of which is also classified as Endangered, one as Vulnerable and seven as Migratory species.

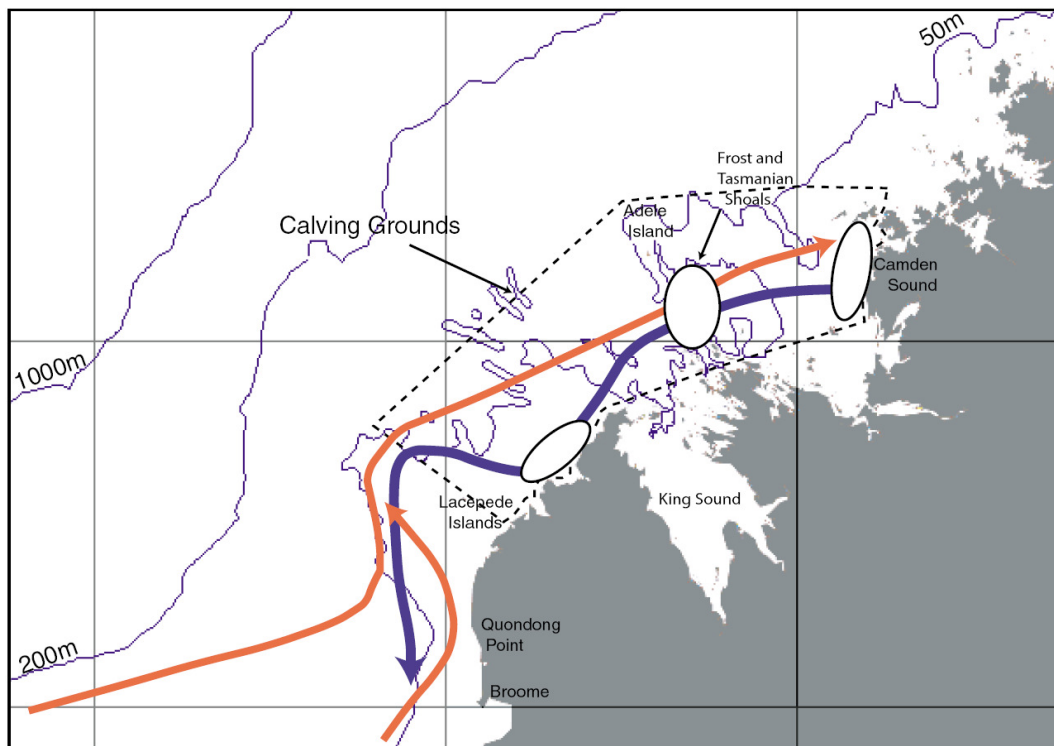
The humpback whale is the most commonly sighted whale in northern Western Australian waters. The species has been observed seasonally to complete their northern migration in the Camden Sound area of the west Kimberley, approximately 95 km south-east of the operational area, after feeding in Antarctic waters during the summer months. It is likely that the whales follow a predictable migratory path and migrate both north and south within the continental shelf boundary (200 m bathymetry). However, on the southbound migration it is likely that most individuals, and particularly cow/calf pairs, will stay closer to the coast than the northern migratory path.

In the Kimberley, humpback whales are seen regularly in coastal waters and out to 50 km offshore from Camden Sound to Joseph Bonaparte Gulf during winter months. As the Group IV humpback whale population continues to recover from whaling, the core calving grounds in the Kimberley (Beagle Bay to Adele Island to Kuri Bay to Montgomery Reef to Cape Leveque - high density areas for calving humpback whales during July-November – **Figure 3**) will continue to expand as animals seek other areas for calving

and breeding. The area from Kuri Bay to Cape Londonderry is a recent extension of this core area. At the closest point, the southern boundary of the Aurora MC3D MSS operational area is located approximately 50 km from Adele Island, along the northern edge of the core calving ground area identified in **Figure 3**.

Upwelling around Browse Island, located adjacent to the northern boundary of the operational area, is believed to be associated with increased concentrations of tropical krill. These tropical krill aggregations may be important as there have been possible, but unconfirmed, sightings of humpback whales feeding in waters around the island. The breaking of internal waves on the shelf edge and around significant breaks in slope (e.g. west of Browse Island and around submerged cliffs – see **Figure 2**) may play an important role in nutrient generation and thus enhanced productivity. Waters around Browse Island are believed to support the highest diversity of cetacean species in Western Australia, including large numbers of oceanic dolphins.

Figure 3: Positions of the Group IV humpback whale calving grounds and migratory routes leading to and from the area



Notes: Circled areas have the highest concentrations of whales.

The operational area is located at a minimum distance of 50 km from the nominal boundary of the humpback whale calving grounds off the west Kimberley coast (at Adele Island), and at least 95 km from areas within the calving grounds that have the highest concentrations of whales (Camden Sound, Frost and Tasmanian Shoals—see **Figure 3**).

The Aurora MC3D MSS survey is scheduled to occur in the period between late December 2010 and the end of June 2011, and is expected to be of approximately six months duration. Line orientation within the 7,600 km² core survey area will be north-south. Seismic acquisition will commence in the western part of the survey area and progress in an easterly direction.

Therefore, the survey will not occur during the peak of the humpback whale calving period in the area around Camden Sound and Adele Island (July to November).

The blue whale may be present in the operational area and surrounding waters. The blue whale is rarely present in large numbers outside recognised aggregation areas. Blue whales are believed to calve in tropical

waters in winter and births peak in May to June, however the exact breeding grounds of this species are unknown. The operational area and adjacent waters does not include any known blue whale feeding, breeding or resting areas. In the NWMR pygmy blue whales migrate along the 500 m to 1,000 m depth contour on the edge of the slope, and are likely to be feeding on ephemeral krill aggregations. The northward component of this migration takes place from May to mid-August, with a peak in July-August, and the southward component occurs from late October to November-December, with a few isolated individuals moving south in January. The migration appears to be centred on the 500 m depth contour.

Consequently, there is the possibility that migrating (and possibly feeding) blue whales may be encountered in deeper waters across the western extent of the operational area, during the proposed survey period (late December 2010 to end of June 2011).

Other species whose broad distributions cover the region include whales that are infrequently observed usually restricted to cooler or deeper waters (e.g. killer and Bryde's whales) and are unlikely to be encountered in the area during the survey in significant numbers. There are no known breeding, calving or feeding grounds for any listed threatened or migratory whale species within, or in the immediate vicinity of the survey area.

By applying comprehensive cetacean interaction management procedures (including the use of 'Standard Management Measures': soft starts, a 2 km low-power zone and 500 m shut down zone, plus the additional mitigation measure of a dedicated Marine Mammal Observer [MMO]), direct adverse physiological effects on any whales that may be encountered during the survey are extremely unlikely and any potential disturbance would be minimised.

The MMO will be aboard the survey vessel for the period of seismic acquisition that overlaps the beginning of the humpback whale migration season in the Kimberley region (i.e. from 1st May to 30 June 2011).

Marine Reptiles

Six marine turtle species may occur in the operational area - green turtle, leatherback turtle, hawksbill turtle, loggerhead, flatback turtle, and olive ridley turtle. Scott Reef is an important breeding site for two species of marine turtle listed under the EPBC Act. These include a small, genetically distinct, population of the Vulnerable and Migratory green turtle and a population of the Vulnerable and Migratory hawksbill turtle. Adult and juvenile green turtles and hawksbill turtles are also likely to feed in this region.

Browse Island, located approximately 5.5 km from the north-east boundary of the operational area (**Figure 2**), is a major rookery for green turtles and flatback turtles also nest on the island.

Green turtles feed on macroalgae and are by far the most common turtle seen in nearshore waters. Loggerhead turtles are carnivorous, feeding mainly on molluscs and crustaceans. Hawksbill turtles feed mainly on sponges and are more often found in deeper waters of the NWMR. Green, flatback and loggerhead turtles all breed from September to March, while the hawksbill turtle breeds from July to March. The reefal habitats in the photic zone are key feeding habitats for green and hawksbill turtles. The pinnacle habitats on the mid-shelf may be very important habitats along the migration paths for these species in the sub-region. The leatherback turtle is a pelagic feeder, found in tropical, subtropical and temperate waters throughout the world. Nesting is mainly confined to tropical beaches although some nesting occurs on subtropical beaches. No major nesting has been recorded in Australia, although scattered isolated nesting (1-3 nests per annum) occurs in southern Queensland and the Northern Territory.

It is unlikely that marine turtles will be encountered during the seismic acquisition throughout most of the operational area, given the water depths and lack of shallow submerged features. However, there is a possibility that green turtles particularly may be encountered in the vicinity of Browse Island, given the fact that there is a major rookery for this species on the island. The main nesting season for green turtles in the region is likely to be December to February. No seismic acquisition will be undertaken within 20 km of Browse Island between 1st December 2010 and 31st January 2011 to minimise potential impacts to green turtles.

Other EPBC Act protected marine species that may be present in the operational area include sea snakes. Sea snakes are frequently observed in and around offshore islands and the waters of the shelf generally. There is no information on their frequency of occurrence in deeper offshore waters (except for Scott Reef), though individuals are often observed at the surface. The Kimberley coastline has long been recognised as an important area for saltwater crocodiles. Although crocodiles may occur along the coast, they are expected to be very uncommon further offshore.

Sharks and Ray-finned Fishes

The whale shark is listed as Vulnerable and Migratory under the EPBC Act. Although there are no records of the whale shark's presence in the operational area there have been sightings in the region, and they are known to occur in both tropical and temperate waters and are normally oceanic and cosmopolitan in their distribution. It is possible that they may be encountered during the proposed survey. Other EPBC Act protected marine species that may occur within the operational area include various species of pipefishes and seahorses (Family Syngnathidae).

The green sawfish is listed as Vulnerable under the EPBC Act. Very little information is available concerning the distribution, abundance, feeding and movement patterns of this species in Kimberley coastal waters. It is believed to occur mainly in inshore coastal waters and riverine environments, including mangroves and mudflats.

Seabirds and Shorebirds

Two species of the streaked shearwater are listed under the migratory provision of the EPBC Act, and it is possible that this species may fly over the operational area.

The operational area is located approximately 95 km from the nearest coastline and there is no information concerning the populations of seabirds utilising the waters of these waters. However, the distributions of many common seabirds overlap the southern Browse Basin and are expected to occur in the operational area. These include ten species of tern (family Laridae), three species of booby, and the lesser frigatebird.

Browse Island and Adele Island are important seabird nesting sites. Adele Island (located 50 km south of the southern boundary of the operational area) has significant rookeries of the lesser frigatebird, brown booby, red-footed booby, and masked booby.

Migratory shorebirds are likely to be present in the region between July and October and again between March and April as the operational area is located within the East Asian-Australasian Flyway. Migratory shorebirds are listed as Migratory and Marine species under the EPBC Act and all are also listed under the Convention on Migratory Species (CMS). Additionally, some species are listed on the China-Australia Migratory Bird Agreement (CAMBA), the Japan-Australia Migratory Bird Agreement (JAMBA), or the Republic Of Korea Australia Migratory Bird Agreement (ROKAMBA).

Socio-Economic Environment

Heritage Values

The nearest marine reserve to the operational area is the Mermaid Reef Marine National Nature Reserve, which is located approximately 368 km southwest of the southwest corner the Aurora MC3D operational area. The operational area is encompassed within an Area for Further Assessment under the NWMR Bioregional Planning Process (Kimberley). These areas have been identified for the development of a Commonwealth Marine Reserves Network in the NWMR.

There are no listed World Heritage Properties within, or adjacent to, the proposed operational area.

"Scott Reef and Surrounds" is a Listed Place on the Commonwealth Heritage List. This comprises the emergent reefs, the partially enclosed lagoons and the surrounding oceanic waters extending to the 50 m bathymetric contour. Scott Reef and Surrounds are also listed on the Register of National Estate. South Scott Reef is located approximately 47 km west of the western boundary of the Aurora MC3D operational area. "Adele Island and Reefs" are listed on the Register of the National Estate. Adele Island is located approximately 50 km south of the operational area.

Consequently, no impacts are expected to occur to either of these two listed National Heritage Places from the proposed activities of the Aurora MC3D MSS, due to the fact that their locations are well away from the area where seismic acquisition will occur.

There are no listed Ramsar wetlands within, or adjacent to, the proposed Aurora MC3D operational area. The nearest listed Ramsar site is Roebuck Bay, which is located approximately 320 km south from the southern boundary of the operational area.

There are no known shipwrecks within the operational area. A search of the National Shipwrecks Database indicates that there are a large number of listed historic shipwrecks in the region, located mainly around Browse Island and South Scott Reef. There are nine listed historic shipwrecks around Browse Island, including one which is listed on the Register of the National Estate (Browse Island (East) Wreck).

Cultural Values

It is considered highly unlikely that any items of Aboriginal cultural significance are located in the proposed Aurora MC3D MSS operational area. There are no known indigenous cultural heritage values or issues for the waters and seafloor within and immediately adjacent to the operational area. Similarly, there are no Native Title claims or issues covering the waters and seafloor within and immediately adjacent to the Aurora MC3D MSS operational area.

Commercial Fisheries

The principal commercial fisheries in the NWMR focus on tropical fin fish, particularly the high-value emperors, snappers and cods which are taken by the Northern Demersal trap fisheries. The typical catch is in the order of 3,000 tonnes annually, making these fisheries, at an estimated annual value of around \$12 million, the most valuable fin fish sector in the state. The NWMR has a number of small, limited-entry trawl fisheries for prawns, producing about 700 tonnes annually, valued at around \$10 million. There are also significant fisheries for Spanish mackerel, barramundi/threadfin salmon and shark, and a developing fishery for blue swimmer crabs. However, the bioregion is increasingly coming under threat from international poaching, particularly for sharks. A number of fin fish activities, including offshore demersal line fishing and near-shore beach seining and gillnetting, also occur in the region.

Commercial fisheries that can operate in the region include:

- the Northern Demersal Scalefish Managed Fishery (NDSF);
- the Northern Shark Fishery;
- the North West Slope Trawl Fishery;
- the Western Skipjack Fishery;
- the Southern Bluefin Tuna Fishery; and
- the Western Tuna and Billfish Fishery.

These are generally small, non-intensive fisheries that have very limited activity in the southern Browse Basin and are unlikely to be impacted by the proposed survey, with the exception of the NDSF.

The NDSF divided into two fishing areas, an inshore sector (Area 1) and an offshore sector (Area 2). Under a voluntary industry agreement, the offshore sector (Area 2) has been further divided into three zones – A, B and C. Zone B comprises the area of historical fishing activity and exploitation, while Zone A is an inshore developmental area and Zone C is an offshore deep-slope developmental area representing waters deeper than 200 m. Access to the offshore sector (Area 2) of the NDSF is currently limited to 11 licences under an individually transferable effort system. During 2008, seven vessels (trap fishing only) collectively held and operated the effort individually assigned to the 11 licences.

The NDSF principally targets red emperor and goldband snapper, with a number of species of snappers (Lutjanidae), cods (Serranidae) and emperors (Lethrinidae) comprising the remainder of the catch. It is possible that some vessels active in this fishery within Zones A and B will target areas in and around the Aurora MC3D MSS operational area. The eastern edge of the operational area is located within Zone A of the offshore sector (Area 2). At present, the majority of the activity (and consequently catch levels of key target species) in the NDSF occurs in Zone B of the offshore sector, which is located further offshore. Acquisition within the eastern portion of the operational area during the Aurora MC3D survey is not expected to increase the likelihood of detrimental impacts on the NDSF to any great extent, primarily because most catch effort in the fishery is expended in Zone B rather than Zone A.

Traditional Fisheries

Indonesian fishermen have visited the north-western Australian coast and around the islands and reefs of this coastline for almost three centuries, focusing their fishing effort on a range of species, including:

- beche-de-mer (trepang or sea cucumber);
- various molluscs, particularly trochus shell and clams;
- seabirds (particularly frigate birds) and eggs;
- sharks; and
- marine turtles.

In November 1974, traditional Indonesian fishing practices - referring exclusively to non-motorised sailing craft, were permitted in the region and formalised under a Memorandum of Understanding (MOU) between the Governments of Australia and Indonesia. This MOU covers Scott Reef, Seringapatam Reef, Browse Island, Ashmore Reef and Cartier Island (the MOU 74 Box).

The northern part of the operational area for the proposed Aurora MC3D MSS (see **Figure 1**), extends into the south-eastern corner of the MOU 74 Box, to the west of Browse Island.

The MOU 74 Box is an area of approximately 50,000 km² within the Australian Fishing Zone where Indonesian traditional fishermen are allowed to fish under the provision of the MOU that recognised the long history of traditional Indonesian fishers, enabling them to continue their customary practices and target species such as trepang, trochus, abalone and sponges. As a result, Indonesian fishing vessels may move through waters adjacent to the operational area, although traditional fishing is predominantly around the shoals. Fishing effort is difficult to estimate.

Commercial Shipping

No defined commercial shipping lanes exist in the operational area for the Aurora MC3D MSS, or in adjacent waters. The major commercial shipping route through the region passes well to the west of Scott Reef.

Oil and Gas Industry

The southern Browse Basin has been the target of significant petroleum exploration activity stretching back over the past 40 years. There have been a large number of both 2D and 3D seismic surveys conducted in the region, plus the drilling of both exploration and appraisal wells. At least 12 exploration wells have previously been drilled within the Aurora MC3D operational area (**Figure 2**).

At present, there are no petroleum production facilities located within or adjacent to the operational area, but the area overlaps a number of previously-discovered gas and oil fields (see **Figure 2**).

Defence Activities

Exploration Permits WA-425-P, WA-429-P, WA-431-P and WA-432-P lie within a military exercise area, the RAAF Curtin Air-to-Air Weapons Range R811. When activated by a Notice to Airmen (NOTAM), the restricted airspace can operate down to sea level.

MAJOR ENVIRONMENTAL HAZARDS AND CONTROLS

All aspects of the Aurora MC3D MSS have been subjected to risk analysis, which has been used to evaluate the potential environmental risks and effects, and characterize risk likelihood and severity. **Table 2** summarises the risk analysis for the key aspects of the survey.

Given the management requirements that will be implemented for all environmental aspects of the survey, the risk of significant adverse environmental effects from the proposed Aurora MC3D MSS has been assessed as low for all aspects, apart from acoustic disturbance to cetaceans, interference with commercial fishing activities, and fuel and oil spills, which have been assessed as medium. The implementation of specific whale monitoring and encounter procedures will be used to minimise the potential for any adverse effects to whales. These procedures comply fully with the Australian Commonwealth Government Guidelines: *EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales* (September 2008).

A dedicated, expert Marine Mammal Observer (MMO) will be aboard the survey vessel for the period of seismic acquisition that overlaps the beginning of the humpback whale migration season in the Kimberley region (i.e. from 1st May to 30 June 2011). The key role of the MMO will be to visually monitor the waters around the survey vessel for the presence of cetaceans during daylight hours. The MMO will be responsible for recording any cetacean sightings during the survey on the appropriate sightings forms, using the 'Cetacean Sightings Application' software provided by the Australian Marine Mammal Centre (AMMC) at the Australian Antarctic Division. Sighting records will be sent to the PGS Environmental Adviser by the Client Site Representative, and also reported to the AMMC. The MMO will also be responsible for ensuring that the interaction procedures are implemented and followed correctly during survey activities.

The survey will be conducted in water depths of 50-410 m away from any shallow water habitat areas that may be important for dugong or turtle feeding. The operational area is located at least 5.5 km away from any beaches and adjacent shallow waters on Browse Island that are important for green turtle nesting, hatching and breeding. No seismic acquisition will be undertaken within 20 km of Browse Island between 1st December 2010 and 31st January 2011 to minimise potential impacts to green turtles.

Additionally, the operational area is located at least 50 km from any locations important for seabird breeding (Adele Island), or shorebird feeding.

The survey is unlikely to have any significant effects on benthic communities due to the water depths across the operational area (50-410 m). Anchoring of the survey or support vessel will only occur in emergency circumstances and both vessels are fitted with highly sophisticated position fixing equipment.

At sea refuelling of the *Ramform Explorer* will only take place during daylight hours. Additionally, at sea refuelling will not be undertaken within a distance of 25 km from Scott Reef, Browse Island, Adele Island or Beagle Reef.

MANAGEMENT APPROACH

The environmental management approaches relevant to key aspects of the Aurora MC3D MSS are summarised in **Table 2**. The survey will be conducted in accordance with all legislative and regulatory requirements, to the satisfaction of the Designated Authority (DMP). The design and execution of the proposed Aurora MC3D MSS will be conducted under the framework of the PGS Health, Safety, Environment & Quality Management System and the survey vessel operator HSE Management System.

PGS and its contractor will apply a tiered approach to optimising the environmental performance of the project and ensuring that PGS's environmental objectives and management standards are achieved. The approach involves identification of local and regional environmental sensitivities, prioritisation of risks, determination of appropriate practices and procedures to reduce those risks, and clear designation of roles and responsibilities for implementation.

Table 3: Summary of Environmental Risks and Management Approach for Key Aspects of the Aurora MC3D MSS

Hazard/ Incident	Potential Hazard Consequence	Risk and Management Approach
Disturbance to marine fauna	Cetaceans - behavioural reactions (avoidance, diving, increased dive times). Disturbance to marine turtles. Disturbance to fish communities. Disturbance to benthic invertebrates.	<p>Low (benthic invertebrates, fish, turtles), medium (cetaceans) risk.</p> <ul style="list-style-type: none"> ➤ Interaction procedures in place and adhered to ➤ Observation zone of 3 km radius, low power zone of 2 km radius, shut-down zone of 500 m radius ➤ 'Soft start' procedures ➤ Use of a dedicated marine Mammal Observer (MMO) for the period of seismic acquisition that overlaps the beginning of the humpback whale migration season in the Kimberley region (i.e. from 1st May to 30 June 2011) ➤ Sighting reports completed and returned to PGS and to the Australian Marine Mammal Centre at the Australian Antarctic Division, using the 'Cetacean Sightings Application' software ➤ Application of vessel-whale interaction procedures for non-acoustic energy source operations ➤ No seismic acquisition will be undertaken within 20 km of Browse Island between 1st December 2010 and 31st January 2011 to minimise potential impacts to green turtles
Disturbance to benthic habitats	Small localised disturbance to epibiota in event of loss of equipment	<p>Low risk.</p> <ul style="list-style-type: none"> ➤ The survey will be conducted in water depths of 50-410 m away from any shallow water areas ➤ No anchoring of the either the survey vessel or support vessel will take place during the survey unless in an emergency ➤ All reasonable efforts taken to retrieve lost equipment ➤ Recording and reporting of all items lost overboard
Interference with commercial fisheries	Interference to commercial fishing vessels operating within or near the survey area and surrounding waters. Potential direct and indirect noise impacts on target species. Restriction of access to fishing grounds, loss or damage to fishing gear.	<p>Medium risk.</p> <ul style="list-style-type: none"> ➤ Consultation with fisheries management agencies, fishing industry bodies and individual companies prior to survey commencing, to inform them about the location of the survey area and timing of operations, and to ascertain if proposed operations overlaps any key fishing grounds ➤ Additional consultation with DoF, WAFIC and NDSF fishermen ➤ Use of a support vessel to manage vessel interactions ➤ Compliance with AMSA administered marine safety regulations and marine notification requirements ➤ Fishermen and other mariners alerted of vessels presence and extent of towed array ➤ Display of appropriate navigational beacons and lights, radar watch ➤ Recording of sightings of fishing vessels ➤ Consultation with fishermen at sea, if necessary

Hazard/ Incident	Potential Hazard Consequence	Risk and Management Approach
Interference with shipping activities	Interference to commercial shipping operating within or near the survey area and surrounding waters.	<p>Low risk.</p> <ul style="list-style-type: none"> ➤ Use of a support vessel to manage vessel interactions ➤ Compliance with AMSA administered marine safety regulations and marine notification requirements ➤ Mariners alerted of presence of survey vessel and extent of towed array ➤ Issuance of Notice to Mariners ➤ Display of appropriate navigational beacons and lights, radar watch ➤ Radio warnings to shipping, as required
Waste disposal	Localised temporary decrease in ambient water quality from discharge of sewage, grey water, putrescible waste, chemicals and solid and hazardous wastes.	<p>Low risk.</p> <ul style="list-style-type: none"> ➤ Survey and support vessels will have certified approved sewage treatment plants, under <i>Marine Orders, Part 96 (Marine Pollution Prevention – Sewage)</i> ➤ Treat in accordance with MARPOL 73/78 Annex IV prior to discharge ➤ No discharge of treated sewage within 4 nm of land ➤ Sewage treatment systems operational and includes maceration and disinfection; and relevant discharge requirements are adhered to ➤ Quantities of treated sewage and putrescible wastes discharged overboard are recorded on the vessel's <i>Waste Log Forms</i> ➤ Procedures comply with requirements of <i>Marine Orders, Part 95 (Marine Pollution Prevention – Garbage)</i> and <i>Marine Orders, Part 94 (Marine Pollution Prevention - Harmful Substances in Packaged Forms)</i> ➤ Correct segregation of solid and hazardous wastes ➤ Vessel <i>Waste Log Form</i> details quantities of wastes transported ashore
Fuel and oil spills	Acute toxicity effects on marine fauna such as marine turtles, fishes and seabirds.	<ul style="list-style-type: none"> ➤ Medium risk. ➤ Seismic and support vessel will maintain a Shipboard Oil Pollution Emergency Plan (SOPEP) in accordance with requirements of MARPOL 73/78 Annex I ➤ All vessel operations will be conducted in compliance with the Australian <i>Offshore Support Vessel Code of Safe Working Practice</i> (e.g. radar monitoring, vessel communications etc.) ➤ MARPOL <i>Oil Record Book</i> kept up to date ➤ Fuel spill contingency procedures are in place and operational ➤ At sea refuelling will not be undertaken within a distance of 25 km from Scott Reef, Browse Island, Adele Island or Beagle Reef

Hazard/ Incident	Potential Hazard Consequence	Risk and Management Approach
		<ul style="list-style-type: none"> ➤ At sea refuelling during daylight hours only ➤ Designated containment areas onboard the vessel for storage of oils and greases ➤ Sufficient spill response equipment on board to respond to foreseeable spill events ➤ Any significant spills (>80 L) are reported to the relevant sections within WA DMP
Introduction of marine pests	Introduction and establishment of non-indigenous (i.e. foreign) marine species with consequent impacts on benthic communities, fisheries etc.	<p>Low risk.</p> <ul style="list-style-type: none"> ➤ Procedures comply with AQIS <i>Australian Ballast Water Management Requirements</i> ➤ AQIS ballast water log is kept up to date ➤ Procedures comply with the <i>National Biofouling Management Guidance for the Petroleum Production and Exploration Industry</i> ➤ Both survey and support vessel have all AQIS clearances to operate unrestricted in Australian waters

CONSULTATIONS

Consultation regarding the proposed Aurora MC3D MSS has been undertaken with stakeholder groups, including a number within the commercial fishing industry, in Western Australia. The following organisations have been contacted and informed of the proposed operations:

- A Raptis and Sons
- Austral Fisheries Pty Ltd
- Australian Fisheries Management Authority (AFMA)
- Australian Hydrographic Office (AHO)
- Australian Maritime Safety Authority (AMSA)
- Border Protection Command (BPC)
- Centre for Whale Research (CWR)
- Coastwatch
- Commonwealth Fisheries Association (CFA)
- Department of Defence
- Kimberley Professional Fishermen's Association (KPFA)
- Northern Fishing Companies Association (NFCA)
- TunaWest
- Western Australian Department of Fisheries
- Western Australian Fishing Industry Council (WAFIC)
- Western Australian Northern Trawl Owners Association (WANTOA)

Additional consultation has been undertaken with the WA Department of Fisheries, WAFIC and licence holders in the Northern Demersal Scalefish Managed Fishery (NDSF) to minimise the potential for negative interactions between the survey and support vessels and vessels fishing in Zones A and B of the NDSF during the period when the Aurora survey will be taking place.

Consultation with all of the stakeholders listed above, plus any others identified during the consultation process, will continue during and after the survey, if necessary.

FURTHER DETAILS

For further information about the proposed PGS Aurora MC3D MSS within southern Browse Basin offshore from Western Australia, please contact:

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