Bight Petroleum Pty Ltd

Lightning 3D Marine Seismic Survey (Bight Basin) Environment Plan Summary

(EPP-41 & EPP-42)

Date: 14th October 2014

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Revision History

Rev	Date	Description	By	Review	App.
2	14/10/2014	Revised EP Summary to NOPSEMA	LC	SF	MP
1	30/06/2014	Revised EP Summary Issue to NOPSEMA	LC	SF	MP
0	16/06/2014	EP Summary Issue to NOPSEMA	LC	SF	MP

Abbreviations

Abbreviation	Meaning
^{o}C	Degrees Celcius
µm	Micrometres
µPa	Micropascals
AFMA	Australian Fisheries management Authority
AHO	Australian Hydrographic Office
AIS	Automated Identification System
ALARP	As Low as Reasonably Practicable
AMSA	Australian Maritime Safety Authority
ARPA	Automatic Radar Plotting Aid
ASTB	Australian Safety Transport Bureau
ASBTIA	Australian Southern Bluefin Tuna Industry Association
BOD	Biological Oxygen Demand
BRAHSS	Behavioural Responses of Australian Humpback Whales to Seismic Surveys
CCSA	Conservation Council of South Australia
CFA	Commonwealth Fisheries Association
CH_4	Methane
CO_2	Carbon Dioxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFF	Department of Agriculture, Fisheries and Forests (now Department of Agriculture)
dB	Decibels
DENR	Department of Environment Water and Natural Resources
DEWHA	Department of Environment, Water Heritage and Arts (now Department of Environment)
DoE	Department of Environment
DoI	Department of Industry
DMITRE	Department of Manufacturing Innovation Trade Resources and Energy
DPTI	Department of Planning Transport and Infrastructure
DRET	Department of Resources, Energy & Tourism (now Department of Industry)
DSTO	Defence Science and Technology Organisation
eNGO	Environmental Non-Government Organisation
EP	Environment Plan
EPBC	Environment Protection and Biodiversity Conservation
EPO	Environmental Performance Objective
ERA	Environmental Risk Assessment
ESD	Ecologically Sustainable Development
g/m^2	Grams per Metre Square
GAB	Great Australian Bight
GABIA	Great Australian Bight Fishing Industry Association
GABTS	Great Australian Bight Trawl Sector

Abbreviation	Meaning
GHaT	Gillnet Hook and Trap
GHG	Greenhouse Gas
HSE	Health Safety & Environment
Hz	Hertz
IAPP	International Air Pollution Prevention
IFAW	International Fund for Animal Welfare
IMS	Invasive Marine Species
in^3	Cubic Inches
IUCN	International Union for Conservation of Nature
kHz	Kilohertz
KIMAG	Kangaroo Island Marine Action Group
km	Kilometres
lb	Pounds
m	Metres
MARPOL	International Convention for the Prevention of Pollution From Ships
MDO	Marine Diesel Oil
MGO	Marine Gas Oil
mm	Millimetres
MMO	Marine Mammal Observer
m/s	Metres per Second
MSF	Marine Scalefish Fishery
MSS	Marine Seismic Survey
MWN	Migratory Wildlife Network
N_2O	Nitrous Oxide
NATPLAN	National Plan for Maritime Environmental Emergencies
NE	Northeast
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NW	Northwest
ODME	Oil Detection Monitoring Equipment
ODS	Ozone Depleting Substance
OIW	Oil in Water
OPEP	Oil Pollution Emergency Plan
PAM	Passive Acoustic Monitoring
PIRSA	Department of Primary Industries and Resources of South Australia
ppb	Parts per Billion
PTS	Permanent Threshold Shift
RCC	Rescue Coordination Centre
rms	Root Mean Square
SA	South Australia
SARDI	South Australian Research and Development Institute
SARFAC	South Australian Fishing Advisory Council

Abbreviation	Meaning
SARLAC	South Australian Rock Lobster Advisory Council
SASIA	South Australian Sardine Industry Association
SBT	Southern Bluefin Tuna
SBTF	Southern Bluefin Tuna Fishery
SE	Southeast
SEL	Sound Energy level
SETFIA	South East Trawl Fishing Industry Association
SEWPC	Department of Sustainability Environment Water Population and Communities (now Department of Environment)
SOPEP	Shipboard Oil Pollution Emergency Plan
SPL	Sound Pressure Level
STCW95	Standards of Training Certification and Watch-keeping
SW	Southwest
TTS	Temporary Threshold Shift
UK	United Kingdom
WDCS	Wales and Dolphin Conservation Society
WNW	West-Northwest

1 Introduction

Bight Petroleum Pty Ltd ('Bight') is proposing to undertake the Lightning 3D Marine Seismic Survey (MSS) in the Commonwealth waters of the Bight Basin, South Australia (SA). The MSS area is located approximately 104km west of Kangaroo Island (SA) and 68km south of Cape Carnot (Eyre Peninsula) (SA) in Commonwealth Exploration Permit Areas EPP-41 and EPP-42 and adjacent non-permit areas.

The purpose of the Lightning MSS is to better define subsurface geology within EPP-41 & EPP-42 to define potential prospective petroleum targets for exploration drilling. This is consistent with work-plans submitted to the Commonwealth Department of Industry (DoI) as part of the permit award.

Bight, as titleholder of EPP-41 & EPP-42, 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(3) and 11(4) of the *Offshore Petroleum & Greenhouse Gas (Environment) Regulations 2009.*

2 Activity Location

The Lightning 3D MSS activity, shown on a regional basis in **Figure 2-1**, will be undertaken within EPP-41, EPP-42 and adjacent non-permit areas (Bight Basin).

The Lightning 3D MSS covers an area of approximately 3,000km^2 and is located entirely within Commonwealth waters of the Bight Basin. The MSS data acquisition area is defined by coordinates shown in **Table 2-1**. The seismic vessel will also execute turns up to 10km outside this defined MSS area and will work within a 'Vessel Turning Area' defined by coordinates provided in **Table 2-2**. The vessel will operate in a NW-SE direction, as shown in **Figure 2-2**, when acquiring seismic data and will maintain a minimum distance of approximately 68km from the South Australian coastline during the MSS activity. The MSS will be split into two racetracks as shown in **Figure 2-2**. Racetrack 1 will straddle the shelf edge (i.e. on shelf and slope). Racetrack 2 will be in deep water exceeding 1000m.

The Lightning MSS area is located approximately 104km west of Kangaroo Island[1], 68km south of Cape Carnot (Eyre Peninsula) and 68km south-west of the South Neptune Islands (SA). The MSS will be undertaken in water depths ranging from 130m along the northern survey boundary to 2400m along the southern survey boundary.

The MSS vessel will deploy and retrieve equipment off the continental shelf to avoid fisheries interaction. This will be managed by close cooperation between the Bight Offshore Representative, local fishing fleets and the accompanying escort/support vessels to identify any conflicting fisheries activities.

[1] Distance is measured from the nearest MSS boundary.

Figure 2-1: Regional Location of the Lightning 3D MSS

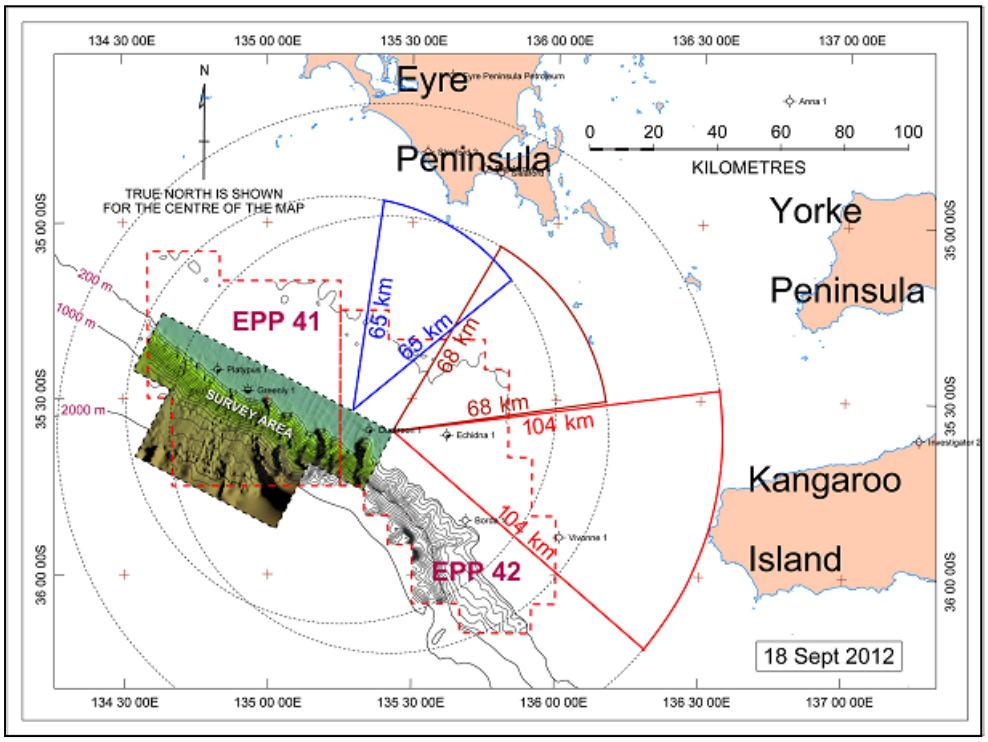


Figure 2-2: Proposed Lightning 3D MSS Seismic Area and Sequence Lines (including Vessel Turning)

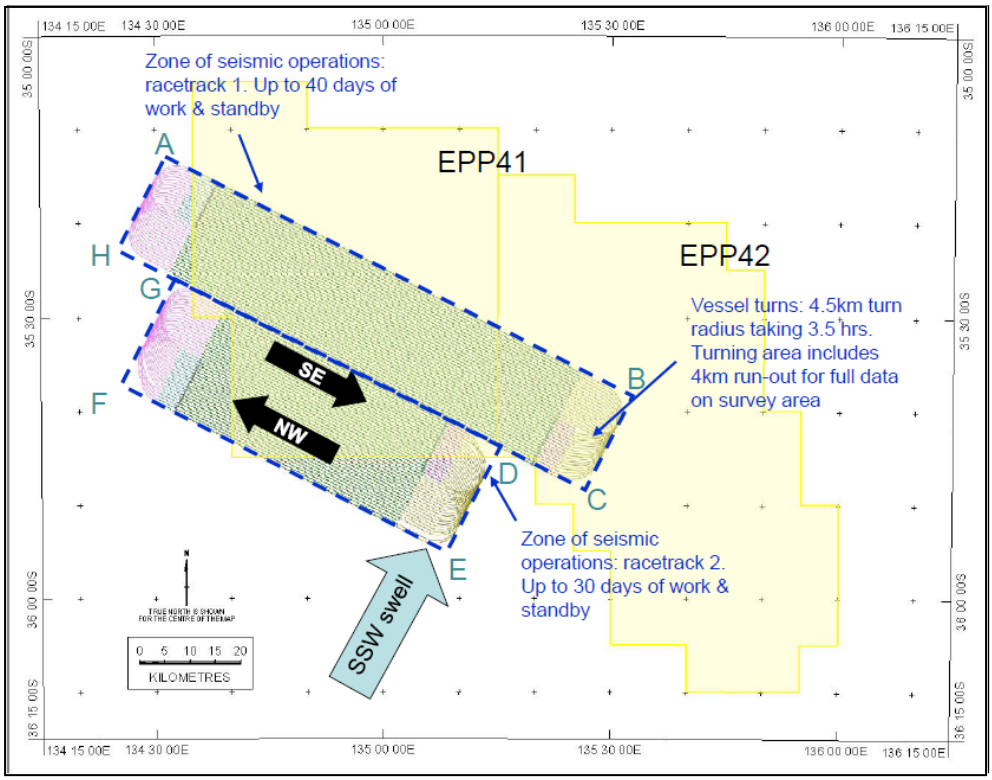


Table 2-1 Lightning 3D MSS 'Full Fold Data Acquisition' Boundary Coordinates

Location Point	Latitude			Longitude		
	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
1	35	15	30.45	134	38	14.47
2	35	35	42.46	135	26	03.11
3	35	45	38.01	135	19	50.12
4	35	40	59.07	135	08	43.93
5	35	52	13.82	135	01	37.77
6	35	39	50.27	134	32	25.09
7	35	28	27.39	134	39	41.55
8	35	25	11.65	134	32	03.50

Table 2-2 Lightning 3D MSS 'Vessel Turning Area' Boundary Coordinates

Location Point	Latitude			Longitude		
	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
A	35	12	50.50	134	31	28.50
B	35	38	15.30	135	32	45.40
C	35	48	28.30	135	27	05.50
D	35	44	01.00	135	15	56.30
E	35	54	50.30	135	08	15.30
F	35	37	30.30	134	25	45.30
G	35	26	02.50	134	32	45.03
H	35	22	50.50	134	25	40.50

3 Seismic Program Activity Description

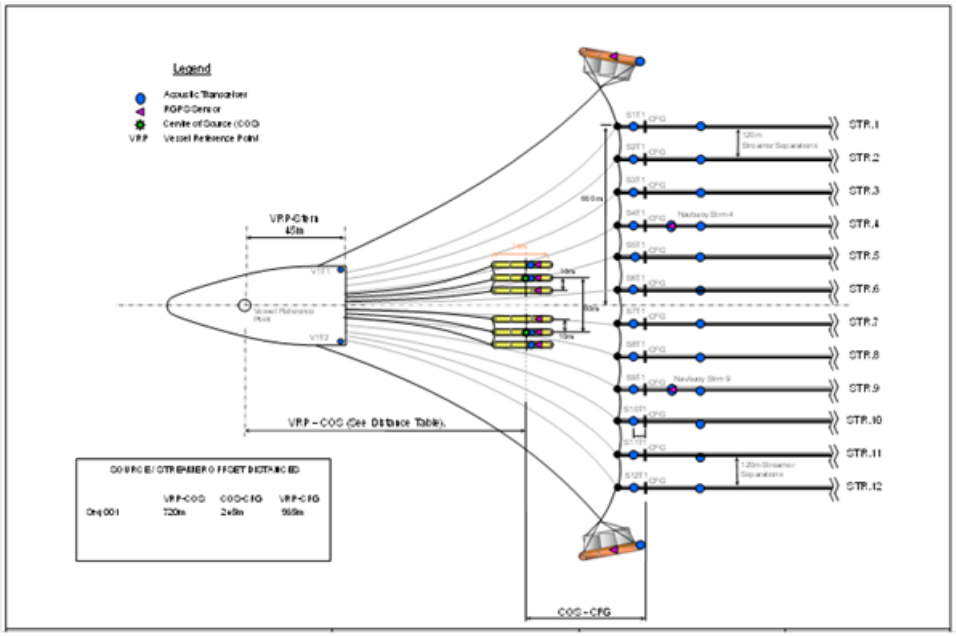
The proposed Lightning 3D MSS program will acquire seismic data between 1st March and 30th May 2015 (or 2016) with the activity expected to take approximately 70days dependent on weather conditions and operational efficiency. Commencement and completion dates are dependent on vessel availability and weather conditions. Seismic acquisition will be undertaken on a 24 hours basis.

The activity will be undertaken by an experienced seismic contractor utilising a purpose-built seismic vessel, towing equipment along a series of pre-determined seismic lines within the survey 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 approximately every 11 seconds, will be directed down through the water column into the seabed via a dual source array. The acoustic signals are attenuated through the subsurface geological structure; reflect at geological boundaries and the reflected signals are detected using hydrophones, arranged in series 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 consist of up to twelve (12) hydrophone collectors ("streamers') towed at a depth of approximately 8m, with a maximum length of 8100m each separated by approximately 100-120m. These hydrophone streamers will be solid streamers (with small amounts of Isopar liquid). The dual source array each with a volume of up to 3250in3 operating at 2000psi will be towed at a depth of approximately 6m. These source arrays will be fired alternately which an approximate shot point interval of 25m. The MSS vessel will traverse the survey area along defined seismic lines approximately 500-720m apart (dependent on number of streamers).

The towing diagram, for a two source array/twelve streamer configuration, is provided in **Figure 3-1.**

Figure 3-1: Typical Two source array/Twelve streamer 3D MSS Towing Diagram



Prior to commencement of MSS operations, Bight (via the Australian Hydrographic Office (AHO)) will issue a Notice to Mariners for the program, to notify vessels of the activity which may be operating in nearby waters. Two vessels will be used for support/escort activities and will be on-standby to direct any shipping traffic away from the MSS area. Additionally, the MSS 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).

Port Lincoln (SA) will be preferentially used as logistics and supply base however the Port of Adelaide (SA) or Geelong (Vic) may also be utilised. During the MSS there will be one support and an escort/chase vessel servicing the seismic vessel for logistical, safety and equipment management support. Functions 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; to act in an emergency-response capacity and, on a secondary basis, support the MSS vessel with logistical supplies.

The vessels will not anchor at sea unless required in an emergency. Refuelling of vessels at sea will preferentially not occur[2].

Crew changes will preferentially occur during port calls however helicopter transfer may also occur. Helicopter services from Port Lincoln or Adelaide may occur during daylight hours however night transfer may be required in the event of an operational emergency or medical evacuation or other non-routine circumstance (i.e. impending bad weather conditions). There will be no helicopter refuelling on-board the seismic vessel.

The seismic vessel 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.

[2] This has been included as a contingent activity in this Environment Plan.

4 Receiving Environment

4.1 Physical Environment

Climate: The climate of the region is temperate with moderate to high rainfall mostly in the winter months. The area has a mean maximum temperature of 22.2°C (February) and a mean minimum temperature of 11.1°C (August). The annual average rainfall is 446mm with the predominant rainfall falling between May and September. Wind roses for March indicate winds predominate from the South-east direction. During the period April-May the winds are more evenly distributed predominantly occurring from the west

Oceanography: The Leeuwin current predominates in the area influencing the local biological productivity and biodiversity of ecosystems. This current is shallow (<300m) and narrow (<100km wide) transporting warm, nutrient-depleted water from the tropics along the southern coast of Western Australia, east to Tasmania. This current also has marked seasonal variation with the strongest flows occurring in winter. During summer the Leeuwin current weakens and coastal winds generate west-bound coastal currents along the inner shelf. Beneath the Leeuwin current is the cooler water, westward flowing Flinders Current which extends to a depth of 1000m with peak currents of 0.2m/s at about 600m depth. The Flinders current is stronger in summer, its strength affected by wind and water body density on the shelf. The current facilitates irregular coastal upwellings when south-easterly winds are present, however the timing of these events is variable. The Lightning MSS area lies adjacent to an upwelling area known as the '*Kangaroo Island Pool*'. This 'pool' of cold, nutrient rich water upwells along the shelf south of Kangaroo Island between December and April, remains in a "subsurface pool" until subsequent upwelling events draws the water into shallower and surface coastal regions south and west of the Eyre Peninsula along the 100m isobath. Upwelling events are unique occurring 2-4 times per year each over 3-10 days during 'upwelling favourable' south-easterly wind regimes. Studies indicate that there is inter-annual variability and stronger events are associated with El Nino conditions.

These upwelling events support aggregations of krill, small pelagic fish and squid that, in turn, attract marine mammals (e.g. pygmy blue whales, sperm whales, dolphins and New Zealand fur seals), sharks, large predatory fish and seabirds.

Downwellings from the inner to outer-shelf and shelf-break occur during winter. Shallow gulf waters are cooler than the continental shelf waters in winter (~12°C) and warmer in summer (~24°C). In autumn when these waters cool, high salinity water at the head of the Spencer Gulf becomes dense enough to form a current known as 'Bonaparte's tongue'. This dense, salty water, around 20km wide and 20m thick, flows out across the Lincoln shelf and over the edge of the shelf. This occurs in regular pulses over a period of approximately three months.

The region has a moderate to high energy coastline with the tidal range in the area of the order of 0.8-1.2m. Swells predominate from the southwest with waves are generally 2-2.5m high, reaching 12-14m high on the outer shelf. Shelf waters are well mixed in winter due to a strong Leeuwin current and swell/storm waves; and stratified (up to 7°C) in summer from cooler Southern Ocean water intruding onto the shelf.

Bathymetry & Seabed: The Lightning MSS area is located in depths of approximately 130-2400m within the Bight Basin over the Australian continental shelf and the continental slope incorporating a portion of the Murray Group of Canyons (specifically the Topgallant, Lincoln and Whidbey Canyons). Swell and storm waves from the Southern Ocean influence seafloor sedimentation to depths of ~120m. Most erosion occurs on the middle shelf with ripples present at ~80m and little sedimentation occurring at shallower depths. In water depths 70-120m exposed limestone substrate is inter-dispersed with patches of mobile sediment which is reworked by swell and storm waves during winter.

4.2 Biological Environment

The Lightning MSS area lies within the south-west marine region and lies within the **Spencer Gulf Shelf Province** and **Southern Province** marine bioregions.

Benthic Fauna: Studies undertaken to characterise and quantify the benthic biodiversity in the eastern GAB identified that large biomass/species characterise the inner shelf waters off the western Eyre Peninsula, however by comparison relatively fewer species and individuals are present on the outer shelf. Benthic fauna in the MSS area consists predominantly of sessile suspension feeding organisms with other feeding guilds (scavengers, predators, deposit feeders and grazers) rare by comparison. Samples taken on shelf waters representative of the Lightning MSS area identified Porifera (63% biomass), Ascidians (28% biomass) and bryozoans (5.5% biomass) dominated.

Fish: The Spencer Gulf Shelf Province is regarded as a productive commercial fishing area in Australia, producing sardines and anchovies and migratory Southern Bluefin Tuna. Other commercial fish species include smaller pelagic species such as the scaly mackerel, jack mackerel (yellowtail), blue mackerel, blue sprat, sandy sprat, round herring, redbait and saury. These species are considered an important trophic link to larger fish eating predators such as bronze-whaler and hammerhead sharks, salmon and barracouta. Commercial fish taken from the shelf break, and upper and mid-slope areas include the orange roughy, blue grenadier, bight redfish, school shark, gummy shark, angel shark, gemfish, deep water flatheads, leatherjackets, latchets, stingrays and stingarees. These fish are prey to deep-diving toothed whales (Sperm and Killer whales), dolphins, seabirds, tunas and other large predatory fish. Productive giant crab and lobster grounds lie along the shelf edge.

The White Shark (*Carcharodon carcharias),* an Environment Protection and Biodiversity Conservation (EPBC) listed threatened and migratory species, is found in the region. The Spencer Gulf and Gulf of St. Vincent are considered important feeding grounds for sub-adult white sharks with the Northern Neptune Island Group considered a significant white shark habitat. White sharks mainly occur between the coast and the 150m depth contour and areas of frequent encounter appear to be around fur seal and sea lion colonies particularly when juveniles are present. Two additional EPBC-listed migratory shark species, the Shortfin Mako (*Isurus oxyrinchus*) and Porbeagle (*Lamna nasus*) are also identified as having habitat likely to occur in the area.

Twenty-seven species of Pipefish, Pipe horse, Seahorse and Sea Dragon species are listed as having possible habitat in the MSS area. These species exist over a broad geographical range but their distribution is limited to suitable habitat which is determined by the species' camouflage, size, food source, behaviour and reproduction. Species can inhabit seagrass and macro-algal habitats, reef habitats, and broken bottom habitats (described as a mixed mosaic of margins of seagrass meadows, shelly or rubbly bottom and sandy bottom with patchy seagrass or detritus, and disturbed areas). Many pipefish, seahorse and the two sea-dragon species lie in shallow bays and coastal waters, especially seagrass beds, and on reefs covered with macro-algae where they are well camouflaged. Pipe-horses usually occur in deeper continental shelf waters however in shallower depths than the Lightning MSS area.

Cetaceans: The eastern Great Australian Bight (GAB) is an important foraging habitat for the Blue Whale (*Balaenoptera musculus)* with the species present in the area between November-May (peaking in November-December), however surveys have identified that abundance is highly variable between and with seasons. Aerial surveys undertaken by Blue Whale Inc. during the 2011-2012 season (November-March), observed Blue Whale presence in November/December and not the January-March period. This is consistent with observations made by other oil and gas operators who verified sighting data early or late in their MSS period (November 2011 to May 2012) and by IFAW who undertook a survey between 26th April and 8th May 2013 and reported no encounters of Blue Whale. During the MSS period (March-May) it is considered Blue Whales, if encountered, will most likely be migrating rather than foraging in the area.

The Southern Right Whale *(Eubalaena australis)* is seasonally present in the region, using coastal water sites for calving between mid-May and mid-November. Key breeding areas in the GAB includes Doubtful Island Bay (approx. 1400km west), Israelite Bay (approx. 1000km west) and Head of Bight (approx. 520km NW). The closest identified Southern Right Whale aggregation area to the MSS area (small numbers) is Sleaford Bay (southern Eyre Peninsula) approx. 85km from the northern edge of the MSS area.

The Sperm Whale (*Physeter macrocephalus)* is known to forage and concentrate at the shelf break south and south-west of Kangaroo Island in canyons and the adjacent shelf break. The species is not seasonal in these areas however encounters to the south/southwest of Kangaroo Island are more frequent during August and September.

A number of other whale species may have a presence in the Lightning MSS area at the time of the survey although encounter rates are not expected to be high. These include the Humpback Whale *(Megaptera novaeangliae),* Fin Whale (*Balaenoptera physalus*), Sei Whale (*Balaenoptera borealis*), Brydes' Whale *(Balaenoptera edeni),* Antarctic Minke Whale (*Balaenoptera bonaerensis*), Pygmy Right Whale *(Caperea marginata),* Killer Whale *(Orcinus Orca),* False Killer Whale (*Pseudorca crassidens*), Pygmy Sperm Whale (*Kogia*

breviceps), Dwarf Sperm Whale (*Kogia simus*), Minke Whale (*Balaenoptera acutorostrata*), Arnoux's Beaked Whale (*Berardius arnuxii),* Andrew's Beaked Whale (*Mesoplodon bowdoini),* Blainville's Beaked Whale *(Mesoplodon densirostris),* Gray's Beaked Whale *(Mesoplodon grayi),* Hector's Beaked Whale *(Mesoplodon hectori),* Strap-toothed Beaked Whale *(Mesoplodon layardii),* True's Beaked Whale *(Mesoplodon mirus),* Cuvier's Beaked Whale *(Ziphius cavirostris),* Shepherd's Beaked Whale *(Tasmacetus shepherdi),* Long-finned Pilot Whale *(Globicephala melas)* and the Short-finned Pilot Whale *(Globicephala macrorhynchus).*

It is possible six dolphin species, the Dusky Dolphin (*Lagenorhynchus obscurus),* Risso's Dolphin (*Grampus griseus)*, the Common Dolphin (*Delphinus delphis)*, The Southern Right Dolphin (*Lissodelphis peronnii*), Indian Bottle-nosed Dolphin (*Tursiops aduncus)* and Bottlenose Dolphin (*Tursiops truncates)* may also be encountered in the MSS area during survey activities.

Sea Lion: Australian Sea Lion (*Neophoca cinerea*) colonies are present in adjacent coastal regions to the Lightning MSS area. Most of the Australian Sea Lion population occurs in South Australia with an estimated 40% of the population found in the three largest colonies located at the eastern end of its range. Relative to the nearest point of the Lightning MSS area, these large colonies are found at The Pages Islands (approx. 250km east); Dangerous Reef (approx. 110km NE); and Seal Bay at Kangaroo Island (approx. 175km ESE). Smaller colonies occur at West Waldegrave Island (approx. 180km north); and Olive Island (approx. 290km NNW) and very small colonies exist at both Liguanea and North/South Neptune Islands.

Australian Sea Lions feed in continental shelf waters, most commonly in depths between 20-100m. Foraging males can extend up to 200km from the coast across the entire continental shelf however lactating females generally forage in depths of less than 150m. The northern boundary of the Lighting MSS area has minor overlap with the identified foraging areas for male Sea Lions, however no overlap with identified female Sea Lion foraging areas in the region.

New Zealand Fur Seal: New Zealand Fur Seal colonies are present in adjacent coastal regions to the Lightning MSS area. Large breeding colonies, which account for more than 80% of the national pup production is found at North Neptune and South Neptune Islands; Kangaroo Island and Liguanea Island. The breeding season is between November-January. During the non-breeding season (February-October) the colonies are occupied by pups and young juveniles, whilst adult females alternate between periods at the colonies and periods foraging at sea. Both male and female Fur Seals forage over the continental shelf and slope.

Reptiles: Three species of Turtle, the Green Turtle (*Chelonia mydas*), Loggerhead Turtle (*Caretta caretta*) and Leatherback Turtle (*Dermochelys coriacea*) may transit through the survey area. The Green Turtle is primarily a tropical species feeding on shallow benthic habitats containing seagrass and/or algae including coral and rocky reefs, and inshore seagrass beds. Nesting beaches are found in the northern tropical areas of Australia. The Loggerhead Turtle inhabits coral and rocky reefs, seagrass beds and muddy bays throughout eastern, northern and western Australia in water depths from near-shore to 55m. Nesting is mainly concentrated on sub-tropical beaches. The Leatherback Turtle is found in tropical and temperate waters and is regularly found in the high latitudes of all oceans including waters offshore from NSW, Victoria, Tasmania and Western Australia. No major nesting areas for the Leatherback Turtle have been recorded in Australia.

Avifauna: EPBC-listed albatross and petrel bird species may have foraging habitat within the Lightning MSS area. These bird species are among the most oceanic of all seabirds, and seldom come to land unless breeding. Albatross have widespread distribution through the southern hemisphere and feed mainly on cephalopods, fish and crustaceans, using surface feeding or plunge diving to seize their prey mainly at the edge of the continental shelf. Albatross are colonial, usually nesting on isolated islands and foraging across oceans in the winter months. No breeding colonies or nesting areas are located in proximity to the Lightning MSS area.

Petrels are oceanic with widespread distribution throughout the southern hemisphere. They are colonial and breed on sub-Antarctic and Antarctic islands in a circumpolar band generally between 40^{O}S and 60^{O}S. Petrels feed on small fish, cephalopods (octopus, squid & cuttlefish) and crustaceans along the edge of the continental shelf and open waters. No breeding colonies or nesting areas for listed petrel species are located within or adjacent to the proposed survey Lightning MSS area.

The flesh-footed Shearwater (*Puffinus carneipes)* is likely to forage within the MSS area. From early September to late May, this species may forage up to 100km offshore along the south-coast along the continental shelf and slope. The species breeds at 41 islands in south-west WA, on Smith Island (~150 pairs) off the south-east coast of the Eyre Peninsula (approx. 85km from nearest survey boundary) and Lord Howe Island.

Fairy Penguins (*Eudyptula monor*) inhabit temperate waters and in South Australia the largest colonies are present at Pearson Island and Troubridge Island (Yorke Peninsula) with other colonies present at Kangaroo

Island (Kingscote, Penneshaw), Granite island (Victor Harbour), the Althorpe Islands (Investigator Strait), Goose Island, Greenly Island, Investigator Group Islands, Lipson Island (near Tumby Bay, Eyre Peninsula) and Sir Joseph Banks Group (Spencer Gulf).. The closest of these colonies to the Lightning MSS area is Greenly Island located approximately 50km north of the MSS area. The species tends to forage within a radius of 8-15km (5-10miles) from their burrow during breeding season; and generally within 20km (12.5miles) of shore in non-breeding season, however longer trips of up to 700km may occur in non-breeding season. Eggs are laid in September and October and until chicks hatch, parents alternate between incubation duties and feeding at sea. Moulting occurs in February-April, during which time individual penguins are unable to go to sea for at least 17 days and lose a considerable amount of weight.

4.3 Social Environment

The landfall areas surrounding the Lightning MSS predominantly support commercial fishing and tourism activities. Defence activities (military flying) are undertaken in Investigator Strait and the adjacent gulfs (north and east of the MSS area). Key regional centres in the area include Port Lincoln, Ceduna and Whyalla.

Commercial Shipping: Key ports within the region include Port Lincoln (grain, seed, fertiliser and petroleum); Port Bonython (petroleum); Port Pirie (zinc, lead, minerals, coal and ore); Wallaroo (seed, grain and fertiliser); Port Giles (grain, seed, petroleum); Whyalla (iron ore, steel); Ardrossan (grain); and Port Adelaide (wine, meat, flour, fruit, fertiliser and timber). Vessels involved in these activities include container ships, bulk carriers, cruise liners and oil tankers. Ship visits to these ports (2002-2003) were in the range 1-250 (per port) however vessels visiting Port Adelaide in the same period were more than 1000 vessels (i.e. 3 vessels per day). The Australian Maritime Safety Authority (AMSA) has identified that the main shipping channel from Investigator Strait to Cape Leeuwin passes through the Lightning MSS area.

With regard to the environmental context on the continental shelf areas immediately within and north of the MSS area, the major shipping channel creates significant background noise. For example, large vessels (tankers) have a low frequency sound emissions of between 180-190dB re 1µPa (at hull); container ships have sound emissions at 181dB re 1µPa (at hull); and medium sized vessels such as fishing trawlers produce sound in the range 165-180dB re 1µPa.

Marine Tourism: Regional tourism ranges from activities such as whale-watching (mainly associated with Southern Right Whale presence at Victor Harbour and Head of Bight Marine Park), diving (underwater heritage trails along coastline and while shark cage diving at Northern Neptune Island Group), recreational fishing, recreational beach use and cruise ship visits (Penneshaw, Kangaroo Island).

The Eyre Peninsula offers as variety of natural landscapes, ranging from inland regional areas to coastal landscapes. A high proportion of the visitors to the peninsula are residents of regional SA (41%) or visitors from WA (6%). Coastal waters around the Eyre Peninsula contain marine life including Sea Lions, Bottlenose Dolphins, Southern Right Whales and terrestrial fauna. The peninsula is acknowledged as one of the finest fishing areas in Australia. Fishing options include rock or surfcasting or fishing charters out of major towns. Species such as Bluefin Tuna (Port Lincoln), kingfish (Port Lincoln, Arno Bay), oysters (Franklin Bay, Coffin Bay) and Murray Cod are also farmed or processed in the area; however these are located in in-shore protected areas. Cruise operators operate from Eyre Peninsula ports to view or swim with Sea Lions, Fur Seals (Hopkins Island approximately 95km NE of nearest MSS Boundary) or swim with tuna (Port Lincoln). On the west coast, tourists can snorkel with Sea Lions and bottle-nosed dolphins from the sheltered waters of Baird Bay (~250km north). The North Neptune Island Group located approximately 70km north-east of the MSS area is a significant habitat for White Sharks and ecotourism activities such as shark cage diving and shark berleying. The CSIRO also undertakes research at this location

Kangaroo Island is listed by the Australian Tourism Commission as one of the nine unique wonders of Australia. Limited development on the island has ensured an abundance of wildlife remains including sea lions, penguins, dolphins, koalas and kangaroos. Tourist activities on the island include going to the beach, wildlife viewing, bushwalking or sightseeing. The environment of Kangaroo Island is characterised by extensive areas of National Parks and Conservation Parks accounting for nearly 30% of the island. Important key natural values important to Kangaroo Island are its spectacular coastal features; clean beaches; unspoilt natural settings; a diversity of native flora and fauna; a rare seal colony; and pollution and contamination free conditions. Tourism is

estimated to generate 15% of direct employment on the Island and this is projected to increase by 17.7% in 2021.

Within and immediately around the Lightning MSS area, due to its distance from adjacent coastlines, little marine tourism occurs. There is the possibility of charter vessel presence, but due to the prevailing oceanic weather conditions these activities are expected to be infrequent.

Commercial Fisheries: Six Commonwealth-managed fishing areas and 4 State –managed fishing areas may operate in the Lightning MSS area. Consultation with Fishing Industry Associations, individual fishermen and review of fishery reports has identified that the:

- Commonwealth Fisheries:
  - *Skipjack Tuna Fishery (Western)* has had no fishing effort in the fishery since the 2008-09 fishing season. Australia is considered at the edge of the species range. *Encounter with fishermen from this fishery is not expected*.
  - Small Pelagic Fishery identifies some fishing effort in the shelf areas to the west of Eyre Peninsula with only three vessels active in the entire fishery with 9 days effort in the 2011/1 2 fishing season. Consultation feedback indicates that fishing targets are relatively difficult and boats do not always participate in this fishery. *Encounter with fishermen from this fishery is not expected*.
  - *Southern & Eastern Scalefish & Shark Fishery*:
    - Great Australian Bight Trawl Sector (GABTS): Consultation feedback indicates that this fishery is concentrated between longitudes 126°E and 132°E along the shelf-break at water depth of 100-250m. *Encounter with fishermen from this fishery is very unlikely.*
    - *Gillnet Hook and Trap Sector* (GHaT) may have a presence in the area however due to fishing closures associated with stock rebuilding, and accidental by-catches of South Australian marine species, most gillnetters now fish in Victorian waters;
  - *Southern Bluefin Tuna Fishery* is active in adjacent shelf areas until February-March each year;
  - *Western Tuna and Billfish Fishery (Southern Sector)* has no active fishing effort within the Lightning MSS area. *Encounter with fishermen from this fishery is not expected.*
  - *Southern Squid Jig Fishery* may have a presence in the area, however consultation feedback indicated squid fishermen tended to fish in south-western Victorian waters;
- South Australian State Fisheries:
  - *Rock Lobster (Northern Zone)* fishermen may be present however only 1% of the catch comes from waters deeper than 90m and in recent years, the focus has been on high value red lobsters caught inshore in depths less than 60m;
  - *Giant Crab Fishery* targets the giant crab which inhabits waters between 20-600m in depth with the highest densities occurring at the shelf-break (approx. 200m). Most crabs are caught in depths less than 120m and usually as by-catch to the Rock Lobster Fishery. Consultation identified only a small amount of giant crab fishing undertaken in the MSS area.
  - *Marine Scale-fish Fishery* (MSF) can operate from the South Australian coastline (including gulf areas) seaward to 200nm. Most catch comes four fish species (King George Whiting, Southern Garfish, Snapper and Southern Calamari) which account for approximately 60% of the total fishery production and 70% of the fishery value. Most of these catches come from Spencer Gulf and Gulf of St Vincent, with the exception of King George Whiting where areas west of Spencer Gulf. MSF fishermen in a 2004 survey identified the following spatial distribution of fishing activities – Spencer Gulf/Coffin Bay (40%), Gulf of St Vincent/Kangaroo Island (32%), West Coast (22%) and other (6%). *Given the target species of the SMF all predominantly occupy inshore/gulf or coastal waters this fishery is not expected to be present in the MSS area.*
  - *Sardine Fishery* can operate operates in all coastal waters out to 200nm. Catch data (2001-2011) indicates that the primary fishing areas are within the Spencer Gulf and to the north of Kangaroo Island and fishermen and not expected to be present within the MSS area.

Cultural Heritage: There are no listed Commonwealth Heritage Places, National Heritage Places or places on the Register of National Estate within, or in the immediate vicinity of the Lightning MSS area. The National Shipwreck Database indicates no shipwrecks lie within the Lightning MSS area. The closest registered shipwreck is the *Lord Roberts* (1902) located approximately 60km NE of the MSS area; the *Gypsy Rose* (1988) and *St. Michele* (1965) located approximately 68km NE at the Neptune Islands; and the *Vale* (1900), *Mermaid* (1914); *Atalanta* (1860) and *Loch Vennachar* (1905) located approximately 104km east on the west coast of Kangaroo Island.

Conservation Values and Sensitivities: A portion of the Lightning 3D MSS area is located within the *Western Eyre Commonwealth Marine Reserve* (Zoned Multiple Use Zone (IUCN VI)). Conservation values identified for this area include seasonal calving habitat for the threatened Southern Right Whale in inshore areas; important foraging habitat for the White Shark, Australian Sea Lion, Blue Whale, Sperm Whale and migratory seabirds; key ecological features including the ancient coastline (high productivity); Kangaroo Island Pool, canyons and adjacent shelf-break and Eyre Peninsula upwelling (high productivity and feeding aggregations); meso-scale eddies (high productivity and feeding aggregations); benthic invertebrate communities of the eastern GAB (high species diversity communities); and areas important for small pelagic fish.

The MSS also lies approximately 70km west of the Western Kangaroo Island Commonwealth Marine Reserve and is 400km east of the Great Australian Bight Marine Park.

The Lightning MSS area also lies in proximity to the following South Australian Marine Parks:

- *Neptune Islands Marine Group Marine Park* located approximately 68km north-east of the MSS area. This park contains breeding populations of Sea Lions, hosts approximately half of the Australian population of New Zealand Fur Seals, is a feeding area for Great White Sharks and hosts roosting and nesting seabirds;
- *Western Kangaroo Island Marine Park* located approximately 75km east of the MSS area contains colonies of Australian Sea Lions, New Zealand Fur Seals, cetaceans and seabirds; and
- *Thorny Passage Marine Park* located approximately 60km NE of the MSS area and contains habitat which supports the Australian Sea Lion, New Zealand Fur Seals, white-bellied sea eagles and cetaceans (Southern Right Whale) at Sleaford Bay.

Lincoln National Park (terrestrial) is located at the tip of the Eyre Peninsula and has large expanses of granite outcrops, sandy beaches and sand dunes (including the Sleaford Bay coastline). The park protects coastal vegetation and is a refuge for migratory bird species such as stints and sandpipers. Within the park boating, fishing, beachcombing, swimming and bird-watching are all popular activities. Sea Lions and Australian Fur Seals are present along the coastline and Southern Right Whales, Bottlenose Dolphin and Common Dolphin are also seen close to shore.

5 Environmental Impact & Risk Assessment

In accordance with the Offshore *Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* R14 (3) & R14 (3A), environmental hazard identification and risk assessment has been undertaken to evaluate the potential sources of environmental and social impact associated with the Lightning MSS activity. This included an assessment of impacts and risks arising from operational activities and unplanned events (non-routine/accident) and the identification of control measures to reduce the impacts and risks to acceptable levels and a level which is as low as reasonably practicable (ALARP).

5.1 Environmental Impact Identification Methodology

Environmental hazards, possible impacts and associated risks from the Lightning MSS have been identified and risk-assessed by undertaking the following steps:

- Defining the activity and associated environmental aspects;
- Identifying the environmental and social values within and adjacent to the survey area (i.e. the environmental context of the activity);
- Determining the inherent risk of each credible environmental hazard associated with the proposed MSS. To achieve this, the worst-case environmental impact of the hazard was identified and, given no control measures, the likelihood of occurrence determined and risk assessed;
- Determining the residual risk of each credible environmental hazard with identified control measures adopted; and
- With controls implemented, defining whether if the impact/residual risk lies at acceptable levels and ALARP. If ALARP has not been achieved, the activity is reviewed and additional control measures adopted until the impact and residual risk can be demonstrated to be ALARP.

The impact and risk for each credible environmental hazard has been evaluated using a Qualitative Environmental Risk Assessment (ERA) process defined by Bight Petroleum. The Bight Petroleum risk assessment framework is consistent with the approach outlined in ISO14001 (*Environmental Management Systems*), ISO31000:2009 (*Risk Management*) and HB203: 2012 (*Environmental Risk Management – Principles and Process*). In accordance with these processes, environmental risk is assessed as follows:

Risk = Likelihood of Occurrence (as it applies to the end-point environmental impact and not the incident) x Environmental Consequence Severity

This framework identifies and assesses environmental risk for each credible environmental hazard in accordance with the Bight Petroleum Qualitative Risk Matrix (refer **Table 5-3**) using the definitions for Consequence and Likelihood contained in **Tables 5-1** and **5-2.**

Table 5-4 defines management actions and responsibilities for each of the residual risk categories. Residual risks defined as high are unacceptable and further action must be taken to reduce the risk further. Residual risk in the medium classification requires further risk reduction controls to be implemented (if possible) via a risk treatment plan. Residual risk assessed as low requires no risk treatment plan however continuous improvement is attained by implementation of best practice management.

Table 5-1: Definition of Consequence

Consequence	Description
5. Critical	**S:** Extensive Injuries (Multiple Fatalities). **E:** Large scale catastrophic impact; significant recovery work over years/decades; Tier 3 oil spill (>1000tonnes); potential revocation of Licence or Permit. **A:** Extensive Damage (>$25M). **R:** Extreme adverse public, political or media outcry resulting in international media coverage; critical impact on business reputation.

Consequence	Description
4. Major	**S:** Major Injury (Single Fatality). **E:** Major environmental impact with recovery work over a few months; Tier 2 oil spill (10-1000tonnes); material breach of licence, permit or act. **A:** Major Damage ($10M-$25M). **R:** Significant impact on business reputation and/or national media exposure; local community complaint.
3. Significant	**S:** Significant Injury (Lost Time Injury (LTI) or Restricted Work Day Case (RWDC)). **E:** Significant environmental impact with recovery work over a few days/weeks; Tier 1 oil spill (<10tonnes); impact/damage to item of National Environmental Significance (NES); possible administrative fine level. **A:** Significant damage ($5M-$10M). **R:** Serious local adverse public media attention or complaints; local user concern; moderate to small impact on business reputation.
2. Minor	**S:** Minor Injury (Medical Treatment Injury) **E:** Local environmental impact, negligible remedial/recovery work; <1BBl oil spill; no significant impact to others; regulatory notification required. **A:** Minor Damage ($1M-$5M). **R:** Public awareness but no public concern beyond local users; Minor impact on business reputation.
1. Negligible	**S:** Slight Injury (First Aid Treatment). **E:** Negligible Impact, Effect contained locally; no statutory reporting. **A:** Slight Damage (0-$1M). **R:** Negligible Impact on Reputation; no public or regulator interest.

Legend: S: Safety, **E:** Environment, **A:** Asset Damage, **R:** Business Reputation

Table 5-2: Definition of Likelihood

Consequence	Description
5. Very likely	Expected to occur in most circumstances
4. Likely	Probably occur in most circumstances
3. Possible	Might occur at some time
2. Unlikely	Could occur at some time
1. Very Unlikely	Only occurs in exceptional circumstances

Table 5-3: Bight Qualitative Risk Matrix

		Consequence				
		1. Negligible	2. Minor	3. Significant	4. Major	5. Critical
Likelihood	5. Very Likely					
	4. Likely					
	3. Possible					
	2. Unlikely					
	1. Very Unlikely					

Table 5-4: Definition of Risk Acceptability and Management Response

Category	Description & Response
High	**High Risk:** Work cannot proceed as currently planned. Urgent remedy and resources required for immediate risk reduction. If risk is to be accepted temporarily then approval from the CEO must be obtained and the Board consulted.
Medium	**Medium Risk:** Risk reduction measures need to be implemented in keeping with other priorities. Generally acceptable level of risk where further risk reduction is shown not to be practicable.
Low	**Low Risk:** Risks are sufficiently low to be acceptable (i.e. at ALARP). Manage for continuous improvement by application of best practice.

5.1.1 Environmental Hazard Identification

Identification of environmental hazards involves the review of all activities within the environmental context of the activity (routine or potential emergency conditions). This is undertaken via brainstorming and peer reviews utilising industry experts which cover different areas of seismic operation. Reviewers have included seismic vessel representatives, experienced seismic proponents, company representatives and environmental specialists. Information utilised within the hazard identification process includes:

- MSS program details including acoustic array/streamer details/equipment type, proposed location and timing of survey and the support activities which are proposed (e.g. escort vessel, possible wastes generated from seismic acquisition (e.g. lithium batteries, possible fluid discharges from streamers, etc.,);
- An understanding of general vessel activities/operations during periods of MSS acquisition and non-seismic acquisition and the possible threats to marine species and habitats;
- The environmental sensitivity of the receiving environment with respect to species distribution, subsea habitat types and location of environmentally sensitive areas (i.e. breeding, resting, etc.,); and
- Consultation feedback from marine stakeholders to understand possible socio-economic activities.

Within this context, a listing of credible activity-related environmental hazards and possible impacts were identified for the MSS program.

5.1.2 Risk Assessment

Identified credible hazards were then risk assessed. For each hazard, the inherent risk (no controls) was determined by the following technique:

- Impact severity was assessed according to the consequence definition in **Table 5-1**. Impact attributes such as: quantities emitted, concentrations released and time scale of release were considered in determining the severity. The 'worst credible'[3] consequence was assigned in the context of the environmental sensitivities of the area;
- Likelihood was allocated according to the likelihood categories in **Table 5-2.** The likelihood of environmental impact was based on available quantitative incident databases, experienced professionals based on industry experience and professional judgment. Likelihood also considered how frequently the activity was performed.

[3] This allows for the conservative identification of 'reportable incidents'.

Controls (preventative and mitigation) were then identified and documented to either eliminate and/or minimize impacts. The assessment preferentially adopted control measures in the upper section of the controls hierarchy[4]. On the basis of control implementation, impact and likelihood was reassessed and a residual risk ranking assigned. The residual environmental risk ranking therefore represents the likelihood of occurrence of the *worst credible environmental impact end-point* taking into account the implemented controls.

Where residual risks were found to be intolerable (high) or within the ALARP region (medium), they were reassessed for elimination potential and/or additional controls until the residual impact and risk associated with the hazard was ALARP (i.e. *if a measure is practicable and it cannot be shown that the cost of the measure is grossly disproportionate to the benefit gained, the measure is considered reasonably practicable*).

Acceptable Level (Impact & Risk) Demonstration

Bight adopted the following criteria in determining whether impact and risk levels were at an acceptable level:

- The principles of Ecologically Sustainable Development (ESD) are fulfilled;
- Bight Petroleum Health Safety & Environment (HSE) Policy objectives are achieved;
- All relevant Commonwealth/State legislative criteria are met;
- The activity does not contravene management plans or result in unacceptable impacts to protected matters under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*;
- Stakeholders have been provided information sufficient to understand and respond to relevant interests which are then considered; and
- Risk and impact have been demonstrated to be ALARP.

It should be noted that the Bight Petroleum qualitative risk methodology also defines risk criteria whereby risk levels are considered to be acceptable.

ALARP Demonstration

Under-pinning the 'controls' identification are the key principles of environmentally-safe design (i.e. adoption of the hierarchy of controls); options analysis to ensure the most environmentally-sound practice is adopted (i.e. survey timing); and adoption of industry standards and codes. Demonstration of ALARP within the Environment Plan includes one or a combination of the following approaches:

- *Hazard/Risk Criteria Approach*: The Bight Qualitative Risk methodology defines risk criteria which it considers is at a level which is ALARP;
- *Hierarchy of Controls*: Controls identification according to a hierarchy which ensures reliable, effective controls are selected in preference to administrative controls;
- *Comparative Options Assessment of Risks, Costs and Benefits*: Evaluation of a range of control measure options describing the relative merits and drawbacks, with the selection of options which are practicable;
- *Comparison with Standards & Codes:* Comparison of activity design, operational standards adopted, management system frameworks and operational procedures against recognised national, international and industry standards or codes of practice; and
- *Cost Benefit Analysis*: Numerical assessment of costs relating to the control measure, the expected risk reduction expected and the cost of the measure to be implemented.

[4] Controls hierarchy (a key principle underpinning the ALARP principle (NOPSEMA, 2012)) where the principles of prevention influence control selection:
- **Elimination:** Complete removal of the hazard;
- **Prevention:** Preventing hazardous events occurring;
- **Reduction:** Reducing the consequence should the event occur;
- **Mitigation:** Practices to mitigate the consequences once realized.

5.2 Lightning MSS Environmental Hazards

A total of nineteen (19) hazards, with the potential to impact the environment, were identified for the Lightning MSS. These can be grouped into the following broad categories:

- Mobilisation of the seismic and support vessels to the proposed survey area:
  - Introduction of non-indigenous invasive marine species (IMS) from ballast water discharge or biofouling.
- Physical presence of the Seismic Vessel:
  - Disruption to commercial fishing activities;
  - Disruption to commercial shipping;
  - Disruption to Tourism; and
  - Light pollution due to 24 hour MSS activities.
- Seismic acquisition:
  - Discharge of acoustic source pulses in the proposed MSS 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-scraps); and
  - Air emissions.
- Non-Routine events:
  - Accidental hydrocarbon spill due to collision with another vessel;
  - Chemical/oil spill through deck drain system;
  - Oil spill during refuelling at sea;
  - Solid non-biodegradable/hazardous waste overboard incident;
  - Seismic streamer perforation and/or loss in the marine environment; and
  - Collision with a cetacean.

5.2.1 Invasive Marine Species (IMS) Introduction

Background Information and Potential Impacts

Potential sources of IMS introduction into the MSS area include both vessel hull/niche biofouling and ballast water exchange during MSS activities. If an IMS is introduced and survives in the new environment, colonisation may result in a range of ecological impacts including increased competition with native species and changes in ecosystem function. Colonisation however, requires favourable environmental conditions for the particular IMS, including water temperature, water depth and habitat range.

The MSS vessel contracted for the Lightning MSS may either mobilise from Australian or International waters to the Lightning MSS area. If the MSS vessel mobilises from International waters it will not go directly to the Lightning MSS area but will dock initially at an Australian port where it will undergo customs/quarantine inspections as required by regulatory authorities. Where possible, the survey support/escort vessels will mobilise from Australian and local South Australian waters.

Adopted Control Measures

Prior to entry into South Australian waters, the MSS Vessel and support/escort vessel (as applicable) will conform to the following requirements:

- Ballast water exchange to occur in accordance with the Australian Ballast Water Management Guidelines (DAFF, 2011); and
- A risk assessment for the seismic vessel(s) (as required) will be undertaken in accordance with the *National Biofouling Management Guidance for the Petroleum Production and Exploration Industry* (Commonwealth of Australia, 2009); and corrective actions arising from the assessment (dry-docking, cleaning and anti-fouling paint application (as required)) will be implemented prior to entry into Australian waters such that the risk of IMS introduction from biofouling is assessed as low.
- All in-field equipment (e.g. streamers) will be cleaned between survey operations which do not occur in adjacent bioregion waters so the equipment does not present a risk of IMS introduction.

Risk Assessment

The National Database for Marine Pest incursions (DAFF, 2012) indicates no known pests have been introduced to the waters surrounding the proposed MSS area. Should an IMS be introduced to, and colonise the area, it may have a major environmental impact (Consequence 4 - ecosystem disruption). However as the MSS will be undertaken in oceanic waters of depths between 130-2400m, light limitations would be expected to inhibit the success of any IMS colonisation.

With the adoption of the listed ballast water management and biofouling control measures, the likelihood of IMS introduction is considered to be very unlikely. The residual environmental risk is therefore assessed as **medium**.

5.2.2 Disruption to Commercial Fishing Activity (Spatial Conflicts)

Background Information and Potential Impacts

The Lightning MSS area is located within seven (7) Commonwealth and four (4) South Australian state fishing management areas. Review of fisheries literature and information obtained during consultation activities with fishery stakeholders has identified the following:

- Commonwealth Fisheries:
    - Skipjack Tuna Fishery (*not expected to be present in MSS area*);
    - Small Pelagic Fishery (*not expected to be present in MSS area*);
    - Great Australian Bight Trawl Sector (GABTS) (*possible but very unlikely presence in MSS area*);
    - Gillnet Hook & Trap Fishery (GHaT) (*possible but very unlikely presence in MSS area*);
    - Southern Bluefin Tuna Fishery (SBTF) (*present on adjacent shelf areas, fishing activities essentially complete in February but contingencies in place for March timeframe*);
    - Western Tuna and Billfish Fishery (*not expected to be present*); and
    - Southern Squid Jig Fishery (*not expected to be present*).
- South Australian State Fisheries:
    - Sardine Fishery (*not expected to be present in MSS area*);
    - Scale-fish Fishery (*not expected to be present in the MSS area*);
    - Giant Crab Fishery (*possible presence in MSS area*); and
    - Northern Rock Lobster Fishery (*possible presence in MSS area*).

Adopted Control Measures

To avoid spatial conflict with the Southern Bluefin Tuna (SBT) Fishermen the following control measures will be adopted (as determined during consultation activities):

- Prior to April 1, seismic acquisition will commence on the deep water racetrack to avoid conflict with pontoons being towed over the shelf portion of the MSS area unless the Australian Southern Bluefin Tuna Industry Association (ASBTIA) has advised that fishing operations are complete;
- Close on-water communication will occur between seismic and fishing operations;
- Towed pontoons will have right-of-way over seismic vessels; and
- The source will not be activated or will be shut-down if a towed pontoon comes within 3km of the source.

More general controls to ensure that fisheries are aware of the MSS activities and to avoid spatial conflicts include the following:

- Consultation during the planning phase of the Lightning MSS has provided information to marine stakeholders and identified 'relevant' affected fishery stakeholders and the seasonality of their activities;
- The MSS vessel will deploy and retrieve equipment off the continental shelf to avoid fisheries interaction (in water depths greater than 500m) on shelf areas;
- The Australian Hydrographic Office (AHO) will be notified of the Lightning MSS activity six weeks prior to the MSS commencement and a Notice to Mariners will be issued for the duration of MSS activity;
- Mobilisation/demobilisation notifications will be issued to all relevant fishing industry stakeholders with consultation continuing during the survey period;
- The Australian Maritime Safety Authority (AMSA) Rescue Coordination Centre (RCC) will be notified two weeks prior to commencement of the MSS activity to allow for AusCoast warnings to be issued to minimise the potential for marine activity conflicts;
- Bulletins will be provided to fishermen who fish in the area providing details of which sections (e.g. racetracks) of the survey area are being utilised for data acquisition and the likely acquisition period. Changes to schedule will be relayed to relevant fishermen;
- Support/escort vessels will scout within the MSS area to ensure that spatial conflicts between seismic/fishing vessels are avoided; and
- Cooperation based on the recognition that the seismic trailing equipment (source array and streamers) and fishing gear (such as lobster pots) cannot be in the same area at the same time due to entanglement and safety hazards. Thus, a willingness by Bight to consider compensation to fishermen for potential impacts to equipment and resultant loss of catch.

Inherent in the design of the MSS, Bight is surveying the most prospective parts of the survey area (survey area minimised) and utilising a multi-streamer vessel which minimises the acquisition period and presence in the area.

Environmental Risk Assessment

The presence of the MSS activity has the potential to disrupt fishing activity present in the area for a period of approximately 70days. Review of the regional fishing data and stakeholder feedback indicates that the MSS vessel has a low likelihood of encounter with both Commonwealth (GABTS and GHTS) and state fishery groups (Giant Crab and Rock Lobster) given the seasonal fishing distribution and the distance of the survey area from fishing ports.

The SBTF season is expected to be completed in February based on the most recent seasonal fishing data however, on a contingency basis if fishing continues into March control measures have been agreed with ASBTIA to prevent spatial conflict. It is possible, although unlikely, that SBT fishermen might be present on shelf areas to the north of the Lightning MSS area during March towing SBT pontoons to Port Lincoln. If this situation eventuates, data acquisition will commence over the deep water section of the survey area which separates spatially the survey activity and fishermen.

Given the known low effort of commercial fishing within the area, with the possible exception presence of SBT fishermen on the shelf during March, spatial conflicts are expected to be minor[5] (Consequence: 2). With industry standard and specific SBTF controls implemented (during March) spatial conflict with fisheries is considered very unlikely and on this basis the residual risk is assessed as **low.**

5.2.3 Disruption to Commercial Shipping Activity (Spatial Conflicts)

Background Information and Potential Impacts

AMSA has identified that a major shipping channel running east-west from Investigator Strait to Cape Leeuwin passes through the Lightning MSS area. This traffic includes international and national cargo trade, passenger services and petroleum tankers.

The presence of the MSS activity and maintenance of a requested 'safe distance' around the MSS vessel and array may interfere with commercial shipping vessels in portions of the Lightning MSS area over a period of approximately 70days. A safe distance shall be defined by the MSS Vessel Master according to the weather, sea conditions and currents in the area. The 'safe distance' is implemented to prevent interference/collision with towed equipment/vessels and to prevent interruptions to survey activities. This may require commercial vessels to deviate from planned routes to avoid the survey activities increasing transit times and resulting in small increases in fuel consumption.

Adopted Control Measures

As per fishing activities, the following actions will be undertaken to ensure that commercial shipping is aware of the MSS activities to avoid spatial conflicts:

- A Notice to Mariners will be issued via the AHO for the duration of the activity;
- Vessel activity reports will be reported to AMSA RCC who will issue shipping warnings to minimise the potential for marine activity conflicts; and
- Support/escort vessels will scout within the MSS area to ensure that possible spatial conflicts are avoided, and if encountered alerts (i.e. flares) will be implemented to identify potential hazards.

Additionally the following measures will be adopted:

- Mobilisation routes to/from the proposed MSS area will avoid recognised shipping routes wherever possible and for those routes which cannot be avoided, the vessels will cross on a perpendicular basis; and
- Vessels maintain a 24/7 watch with trained crew (STCW95 competent) and appropriate navigation safety equipment (radar, radio, AIS, etc.) is available on-board to ensure early detection of third party vessels with implementation of vessel diversion (as necessary).

Inherent in the design of the MSS, Bight is surveying the most prospective parts of the survey area (survey area minimised) and utilising a multi-streamer vessel which minimises the acquisition period and presence in the area.

Environmental Risk Assessment

It is possible the presence of the seismic/escort vessels in the Lightning MSS area may cause minor disruption to commercial shipping vessels given the observed vessel density in the area (Consequence: 2). As the survey will take place for a limited period (70days) and with the controls implemented, it is expected that commercial vessel disruption is very unlikely to occur during the MSS acquisition period. On this basis, the residual risk is assessed as **low**.

[5] Consequence assessed based upon SBTF presence. Other fisheries which may be present in the area are expected to have lower consequence rankings given available fishing distribution data.

5.2.4 Artificial Lighting Impacts

Background Information and Potential Impacts

Lighting is required for safety and navigational purposes on the seismic/support vessels during MSS activities. Lighting provides for marine safety to ensure clear identification of the vessels to other marine users; and allows for safe movement of personnel during hours of darkness. For intermittent periods during night hours, spot lighting may be required for in-sea equipment inspection, deployment, and retrieval (this will mainly involve the use of spot-lights focusing aft of the vessel towards the source and deflectors). The use of such lighting is minimized as far as possible. It should be noted that prevailing sea state conditions in the region may preclude in-water night-hour inspections on a personal safety basis.

Light on vessels operating offshore may create light pollution which has the potential to affect marine fauna, notably marine turtles (particularly during breeding season on nesting beaches), fish and seabirds.

Given there are no turtle nesting beaches in southern Australia, no impacts are expected to these species. Potential impacts to other marine fauna, such as invertebrates, fish and seabirds are expected to be restricted to localised and temporary impacts as the vessel transits though the area (i.e. constant movement). Light emissions are considered to be similar to passing commercial shipping and fishing vessels.

Adopted Control Measures

Vessel lighting will be controlled via the following:

- Use of standard navigational identification features (e.g. lighting, beacons, signals) to align with the navigation safety requirements of the *Navigation Act 2012*;
- Deck lighting which is required for workplace safety will be directed in-board to minimise the amount of direct light spill onto marine waters; and
- Night hour in-sea equipment inspections activities are be minimised as far as possible.

A pre-mobilisation inspection will identify any opportunities to reduce stray light spill to the marine environment. These opportunities will be corrected prior to mobilisation.

Inherent in the design of the MSS, Bight is surveying the most prospective parts of the survey area (survey area minimised) and utilising a multi-streamer vessel which minimises the acquisition period and presence in the area.

Environmental Risk Assessment

High levels of marine vessel lighting can attract and disorient species resulting in species behavioural changes in the vicinity of the light source. Potential impacts to marine fauna present, such as fish and seabirds, are expected to be restricted to localised and temporary attraction. It is understood that bird strikes have been recorded on fishing vessels in the Southern Ocean where powerful ice lights are used in back-deck activities[6], however bird mortality arising from these events are generally low. As the seismic vessels do not utilise such lighting, impacts arising from light emissions are considered to be similar to passing commercial shipping and fishing vessels and is expected to have negligible impact to these species transiting through the MSS area (Consequence: 1).

In-sea inspection activities, if they occur, will be for short periods of time. The use of spot-lights is minimised as far as possible and will have minor impacts (Consequence 2) to species while operational.

Given the limited duration of MSS acquisition and constant movement of the vessel, permanent alteration to marine species foraging patterns or behavioural impacts are considered to be very unlikely. On this basis the residual environmental risk to marine species from light spill is assessed as **low**.

[6] Black, A (2004) – Short Note on Light Induced Seabird Mortality on vessels operating in the Southern Ocean: Incidents and Mitigation Measures, Antarctic Science 17(1): 67-68

5.2.5 Disruption to Tourism Activities (Spatial Conflict)

Background Information and Potential Impacts

As the Lightning MSS area lies at distance from land or coastal islands there is little marine-based tourism which occurs within the area. Specifically the marine tourism activities (values) of the region are as follows:

- Recreational beach use (sightseeing, swimming, surfing and snorkelling) and diving (located in coastal areas). *Coastal locations are not considered to be at spatial threat from survey activities*;
- Charter boating for activities such as sightseeing, fishing, diving, marine mammal watching. *Charter boat operators involved in recreational game fishing activities may have a presence in the MSS area (refer recreational game fishing). Other charter activities will not occur in the MSS area*.
- Marine Mammal Watching Operations. These activities are focussed around Southern Right Whale presence which calf in coastal habitats. Most operators run tours between June and October (outside the survey period) or operate on half day tours (insufficient time allowance to transit to the Lightning MSS area). *Marine Mammal watching operations will not be spatially affected by the survey activities*;
- Recreational boating utilises small inshore craft which are not expected in the oceanic conditions of the Lightning MSS area;
- Yacht Racing occurs inshore of the survey area in December and February. *Survey activities will not affect these events*.
- Cruise ship visits to Kangaroo Island dock at Penneshaw (NE corner of the island). Access to this area is covered in Commercial shipping. *No other effects are expected to cruise liners*;
- Recreational (game) fishing is primarily carried out around coastal islands along the SA coastline however, in literature the area is recorded as having a low recreational fishing effort. Game fishing also occurs between January and June which is within the survey period.

The presence of the MSS vessel, towed array and maintenance of a requested ‘safe distance’ around the MSS vessel/array may exclude recreational game fishermen from portions of the Lightning MSS area over a period of approximately 70days. This control prevents interference/collision with towed equipment/vessels and interruptions to survey activities.

Adopted Control Measures

As per commercial fishing activities, the following actions will be undertaken to ensure that recreational game fishermen (if present) are aware of the MSS activities to avoid spatial conflicts:

- A Notice to Mariners will be issued via the AHO for the duration of the activity;
- Vessel activity reports will be directed to AMSA RCC who will issue AusCoast warnings to minimise the potential for marine activity conflicts;
- Mobilisation and demobilisation notifications will be issued to the SA Recreational Fishing Advisory Council to advise of survey activity in the area; and
- Support/escort vessels will scout within the MSS area to identify third party vessels which may have spatial conflicts between seismic vessels and warn them of the activity.

Additionally the following measure will be adopted:

- Vessels maintain a 24/7 watch with trained crew and appropriate navigation safety equipment (radar, radio, Automatic Identification System (AIS), etc.) is available on-board to ensure early detection of third party vessels with implementation of vessel diversion (as necessary).

Inherent in the design of the MSS, Bight is surveying the most prospective parts of the survey area (survey area minimised) and utilising a multi-streamer vessel which minimises the acquisition period and presence in the area.

Environmental Risk Assessment

The presence of the seismic/escort vessels in the Lightning MSS area may cause minor spatial disruption to recreational game fishing activities given the observed low level fishing effort in the area (Consequence: 2). As the survey will take place for a limited period (70days) and with the controls implemented, it is expected that recreational fishing activities will utilise other fishing areas and the risk of impact to their activities is very unlikely. On this basis, the residual risk is assessed as **low**.

5.2.6 Seismic Operation – Acoustic Disturbance

Background Information and Potential Impacts

Acoustic Modelling: Acoustic modelling[7] has been undertaken for the Lightning MSS utilising a 3090in^3 array for the purpose of identifying Sound Exposure Levels (SELs) at three locations representative of the different propagation conditions within the Lightning MSS area. These points were located on the continental shelf (@200m water depth) within the MSS area at a point closest to Kangaroo Island; on the continental shelf in the centre of the MSS area (@200m water depth) and on the continental slope in the centre of the deep water section of the MSS (@2000m water depth).

Modelling results indicate the following:

- The maximum SEL for adjacent sensitive coastlines are as follows:
    - At the 50m water depth contour off the western end of Kangaroo Island (approx. 104km from MSS area) the SEL is predicted to be less than 115dB re 1 µPa^{2}s[8] with similar SELs predicted just off the coast of the Eyre Peninsula (approx. 67km);
    - The maximum SEL at the North Neptune Group Islands is approximately 110dB re 1µPa^2.s (~140dB re 1µPa) and for the Southern Neptune Groups Islands of 120dB re 1µPa^2.s (~150dB re 1µPa). These islands produce a 'sound shadow' inshore to the Spencer Gulf; and
    - Sound levels do not impact acoustically within Spencer Gulf as sound is 'blocked' by barrier islands at the mouth of the gulf.
- SELs are predicted to attenuate rapidly up the continental slope when operating off the continental shelf area. For example, the sound energy levels at the edge of the shelf will have reduced to 120dB re 1 µPa^{2}s when operating in deeper waters;
- SELs are also predicted to attenuate rapidly when acquisition is undertaken on the continental shelf towards the coastline. Modelling undertaken in the middle of the survey area on the continental shelf (@200m water depth) predict a SEL reduction to 120dB re 1 µPa^{2}s by the 100m water depth contour and attenuation to 130dB re 1 µPa^{2}s at each end of the survey area along the shelf edge;
- When the vessel is operating on the shelf, the SEL's received at one end of the survey from source points at the other end of the survey will be less than 120dB re 1 µPa^{2}s; and
- Confirmation that SELs attenuate rapidly in most areas. For example, the following SELs are expected with distance from the acoustic array:
    - At 50m: 195dB re 1µPa^2.s;
    - At 300m: 180dB re 1µPa^2.s; and
    - At 900m: 170dB re 1µPa^2.s.

[7] Centre for Marine Science and Technology (CMST) (2012) – Sound exposure modelling for the Bight 3D seismic survey in the eastern Great Australian Bight, South Australia, Project CMST 1085, Report C2012-36 (June 2012)
[8] This SEL level represents the highest obtained from all modelling positions within the MSS area (i.e. the closest survey line at a point closest to Kangaroo Island on the continental shelf) and therefore represents the worst case acoustic footprint in proximity to the coastline.

A study[9] undertaken for a similar MSS located in the Otway Basin in proximity to Logan's Beach, utilising a combination of measured survey sound levels from past MSS data of similarly sized acoustic arrays (3147in^3) and modelled data, established sound exposures for adjacent shorelines. Both modelled and measured data agreed that in shallow near-shore water at distances 15-20km from the proposed MSS would not be detectable. As the Lighting MSS is located over 60km from shore, received shoreline sound levels from the survey are not expected to be above ambient conditions. It is likely that sound levels from commercial shipping, which are in closer proximity to coastline areas, may have a greater impact upon ambient sound levels.

Response to Acoustic Sound:

Cetaceans: Cetaceans are sensitive to sound in the marine environment. Their extensive use of sound for communication, prey capture, predator avoidance, navigation, and their physical makeup (i.e. large gas-filled organs) make them vulnerable to both disturbance and physiological damage from underwater sound of sufficient magnitude.

Baleen whales (e.g. Blue, Southern Right & Humpback whales) are considered the most sensitive of the marine mammals to seismic arrays due to their use of low-frequency signals (Range: 12Hz-8kHz but predominantly less than 1kHz) for communication[10]. Their low frequency hearing capability is believed to overlap the sound output frequency of the marine seismic and the potential for disturbance in this species is considered higher than for toothed whales ('odontocetes').

Little is known about the sound levels at which hearing damage or physical injury occurs in cetaceans. There have only been two studies which have measured hearing Temporary Threshold Shift (TTS) onset levels in cetaceans in response to airgun-like pulses. One study[11] identified a TTS in hearing for a beluga whale at 186dB re 1µPa^2.s and another observed no TTS in one bottlenose dolphin at approximately 188dB re 1µPa^2.s. Sound modelling results showed that these sound levels lie only within 300m of the source for all locations modelled.

The threshold of 160dB re 1µPa^2.s has been adopted as the acoustic level whereby damage to whales may occur based upon *EPBC Policy Guidelines 2.1 - Interaction between offshore seismic exploration and whales.*

Behavioural responses to acoustic sound in Baleen whales range from tolerance at low/moderate acoustic levels; to graduated behavioural responses at higher levels including shifts in respiratory and diving patterns. Researchers have found that Gray & Bowhead whales practiced avoidance at received sound pressure levels between 150-180dB re 1µPa; migrating Humpback whales were observed to 'stand-off' behaviour at received sound pressure levels of 157-164dB re 1µPa; with resting pods (including cows) exhibiting stand-off at received sound levels of 143dB re 1µPa and avoidance at 140dB re 1µPa[12]. It is expected that with acoustic sources operational, most baleen whales will practice avoidance and not position themselves at a range whereby physical damage from sound will occur. Soft-start procedures which 'ramp-up' acoustic sources also facilitate this expected response behaviour and protect whales from sudden acoustic sound which may be damaging.

It has also been observed that cetacean avoidance behaviour to differing acoustic levels depends on their activity at the time and is variable between/within species[13]. Studies indicate that cetaceans are less responsive when migrating or feeding than when suckling, resting or socialising. It is considered that avoidance behaviour represents only a minor effect to the individual or species unless the avoidance results in displacement of species from nursery, resting or feeding areas.

[9] CMST, 2007 – Prediction of underwater noise transmission from the proposed Casino seismic survey in western Victorian waters (CMST Project 588, Report R2007-09), A Report for Santos Limited
[10] McCauley, R.D., 1994, *Seismic Surveys* in *Environmental Implications of Offshore oil and Gas Development in Australia- The Findings of an Independent Review*, Swan, J.M., Neff, J.M., and Young, P.C.,(Eds.), Australian Exploration Association, Sydney, pp.19-121
[11] Gedamke, J., Gales, N., & Frydman, S., 2011 – Assessing the risk of baleen whale hearing loss in seismic surveys: The effect of uncertainty and individual variation, Australian Marine Mammal Centre, Australian Antarctic Division, J. Acoust. Soc. Am 129(1), January 2011 (DOI: 10.1121/1.3493445)
[12] McCauley, R.D, Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M-N., Penrose, J.D., Prince, R.I.T., Adhitya, A., Murdoch, J., and McCabe, K., 2000, *Marine Seismic Surveys- A Study of Environmental Implications*, APPEA Journal, pp 692-708
[13] Richardson, W. J., Greene, C. R., Maime, C. I. and Thomson, D. H., 1995 - Marine Mammals and Noise, Academic Press, San Diego, California

Behavioural responses of Eastern Gray Whales in a study in the Bering Sea identified that 10% the whales stopped feeding at a received sound level >163dB re 1µPa while other whales continued to feed at 177dB re 1µPa[14]. In that study, whales that stopped feeding and moved away resumed feeding within 1hr after the seismic noise ended. A mitigation strategy adopted during the 2001 Odoptu 3D MSS, based on known exposure levels which would cause cessation of feeding, involved reducing the sound exposure of Gray whales to acoustic sound less than 163dB$_{rms}$ re 1µPa corresponding to a SEL of 156dB re 1µPa^2.s[15]. Results of this study identified the species continued to occupy the main feeding area during the MSS and there was no significant displacement outside these grounds.

Observations of behavioural responses of Blue whales to seismic surveys along the southern margins of Australia have also been documented. Marine Mammal Observer (MMO) data obtained collected from a collection of surveys undertaken in the region identified the following:

- March 2008 Seismic Survey (Western Tasmanian waters): A total of 5 Blue whale sightings were recorded during this 8-day survey during March. Two of the sightings lead to shutdowns with the low power zone set at 2km for the survey. Both of these sightings indicate that Blue Whales were about 1200m from the active source without exhibiting any behavioural effects.
- Santos EPP-32 Seismic Survey (South Australian waters)[16]: Aerial surveys conducted during this 2003 MSS where the behaviour of Blue whales was continuously monitored west of Kangaroo Island (same area as Bight) observed no discernable behavioural reaction of Blue Whales (i.e. avoidance of the operating vessel) within 2.5km of the active source before it was shut-down. Key observations from this survey included:
    - Blue whales did not move away from the oncoming vessel – they continued to feed on the very small scattered krill swarms present just off the edge of the shelf, even though there were much larger krill swarms where other whales were feeding, on the shelf to the north;
    - The shortest distance between the blue whale and the active source was 2.5km. Given the precautionary power-down distance used for this survey (3km), it is not known at what distance whales would have responded to the approaching source, however the whales showed no behavioural response right up to the time the observers in the aircraft instructed the vessel to stop recording when the whale was within the nominated 3km power-down zone; and
    - When the soft start recommenced as a result of whales being more than 6km away from the source (i.e. beyond the tail of the 6km streamer), it's interesting to note that it foraged in the general direction of the source.

  Seismic records acquired during this survey were subsequently analysed by Curtin University Centre for Marine Science and Technology for whale calls detected in different sections of the 6km streamer. The resultant detections were triangulated to provide an estimate of the distance of the whales from the active source. Most whale detections were identified between 2km and 3km during this analysis.

On this basis, the sound "threshold of concern" whereby behavioural impacts are observed is similar to the conservative 160dB re 1µPa^2.s SEL identified in EPBC Act Policy Statement 2.1 for "physiological impacts". This threshold has been adopted within this EP for behavioural impacts to whales. It is important to note that in the study is being conducted over a period of four seasons (2010, 2011, 2013 and 2014) in Australian Waters - the "Behavioural Responses of Australian Humpback Whales to Seismic Surveys (BRAHSS)", the SEL thresholds (which are based on the potential for inducing TTS) include the requirements that "no individual whale is to receive a cumulative dose of 183 dB re 1 µPa^2.s or greater" and "for a single airgun shot, (the sound exposure level) is no greater than 170 dB re 1 µPa^2.s"[17]. These thresholds are being closely monitoring against potential

[14] Richardson, W. J., Greene, C. R., Maime, C. I. and Thomson, D. H., 1995 - Marine Mammals and Noise, Academic Press, San Diego, California
[15] Nowacek, D.P., Broker, K., Doovan, G., Gailey, G., Racca, R., Reeves, R.R., Vedenev, A.I., Weller, D.W., & Southall, B.L. (2013) – Responsible practices for minimising and monitoring Environmental Impacts for Marine Seismic Surveys with an emphasis on Marine Mammals, Aquatic Mammals 2013, 39(4), 356-377, DOI: 10.1578/AM.39.4.2013.356
[16] Morrice, M.G., Gill, P.C., Hughes, J., and Levings, A.H. (2004) – Summary of Aerial Surveys Conducted for the Santos Ltd EPP-32 Seismic Survey 2-13 December 2003
[17] EPBC Referral 2013/6927 available at www.environment.gov.au

humpback whale reactions however it demonstrates that adopted criteria within EPBC Policy 2.1 are conservative.

Odontocetes (i.e. toothed cetaceans such as sperm whales, killer whales and dolphins) produce echo clicks that have the highest source levels of any recorded marine mammal sound ranging from 220-230dBA at 1µPa@1m at frequencies up to 30kHz. Sperm Whale clicks bear some resemblance to sonar (i.e. 235 dB re 1µPa [or 196 dB re 1µPa^2.s]) in the frequency range 5-20 kHz although Sperm whales emit a very narrow beam of energy compared with the wide radiation pattern of sonars[18]. The majority of toothed whales have their highest hearing sensitivity to sound in the ultrasonic range (>20,000Hz) although most have a moderate sensitivity from 1000-20,000Hz.

A review[19] of the effects of seismic on marine mammals in United Kingdom (UK) waters during the period 1998-2000, identified for surveys with large airgun arrays, that:

- Small odontocetes (dolphins and porpoises) had the strongest avoidance response to low frequency sound. Several species were seen less often during periods of seismic acquisition, remaining further from the air-guns and showing altered behaviour (e.g. less bow-riding, orienting away from vessel, faster swimming);
- Killer Whales also showed some localised avoidance to seismic surveys; and
- While sperm whales were a frequently observed species during the surveys, the species did not show any observable effects from seismic operations.

Observations on Sperm Whale behaviour in the Gulf of Mexico[20] associated with seismic surveys found no horizontal avoidance of Sperm Whales to MSS activity, however found a decrease in foraging activity during full array acquisition for a small number of Sperm Whales studied.

Beaked whales are also known to be sensitive to high-energy, mid-frequency (*not used in this survey*) military sonars (i.e. ping energy 221-235 dB re 1µPa^2.s between 2.6 to 8.2 kHz of long duration ~1 second). Mass strandings of beaked whales are thought to be related to the use of this equipment in areas where there was the presence of a shelf-break very close to the coast and there was a documented presence of a beaked whale foraging in this deep water habitat[21].

Turtles: Marine Turtles have a hearing range between 100–700Hz[22] with best hearing between 250-700Hz. Studies indicate that turtles may begin to show behavioural responses (i.e. increase in swimming behaviour) to an approaching seismic array at received sound levels of approximately 166dB re 1µPa (rms), and avoidance at around 175dB re 1µPa (rms) From measurements of a vessel operating a typical airgun array (2678in^3, 12 elements) in 100-120m of water, sound levels would create behavioural changes at approximately 2km and avoidance at 1km[23].

Pinnipeds: Phocid Seals (e.g. gray seals) have a hearing range between 1kHz-50kHz with sensitivity dropping above 50kHz. Otariid Seals (fur seals and sea lions) have a lower hearing sensitivity than Phocid Seals below 1kHz and similar hearing between 1kHz and 36-40kHz (their high frequency cut-off)[24]. Californian Sea Lions have relatively poor underwater hearing at frequencies below 1000Hz (i.e. sound thresholds required were greater than 100dB re 1µPa)[25].

[18] ICES, (2005) – Report of the Ad-hoc Group on the Impacts of Sonar on Cetaceans and Fish (AGISC) (2nd Edition0, ICES CM 2005/ACE:06
[19] Stone, C.J. 2003 –The Effect of Seismic Activity on Marine Mammals in UK Waters 1998-2000, JNCC Report No 323
[20] Jochins, A.E., 2008 – Sperm Whale Seismic Study in the Gulf of Mexico Synthesis Report downloaded on 22nd May 2012 at http://www.data.boem.gov/PI/PDFImages/ESPIS/4/4445.pdf
[21] ICES, (2005) – Report of the Ad-hoc Group on the Impacts of Sonar on Cetaceans and Fish (AGISC) (2nd Edition 0, ICES CM 2005/ACE:06
[22] McCauley, R.D., 1994, *Seismic Surveys* in *Environmental Implications of Offshore oil and Gas Development in Australia- The Findings of an Independent Review*, Swan, J.M., Neff, J.M., and Young, P.C.,(Eds), Australian Exploration Association, Sydney, pp.19-121
[23] LGL Ltd., (2003) - *Environmental Assessment of Marine Seismic Testing Conducted by the R/V Maurice Ewing in the Northern Gulf of Mexico, May – June 2003* downloaded on 28th October 2008 at http://www.nmfs.noaa.gov/pr/pdfs/permits/ldeo_gom.ea.pdf
[24] International Council for Science Scientific Committee on Antarctic Research (SCAR) 2002 – Impacts of Marine Acoustic Technology on the Antarctic Environment accessed at http://www.geoscience.scar.org/geophysics/acoustics_1_2.pdf on 3rd February 2008
[25] Kastak, D. and Schusterman, R.J., 1998 – Low Frequency Amphibious Hearing in Pinnipeds: Methods, Measurements, Noise and Ecology. J. Acoust. Soc. Am. 103(4) April 1998

Sound exposures that elicit TTS in pinnipeds under water have been measured in Harbour Seals at 183dB re 1µPa^2.s, in Sea Lions at 206dB re 1µPa^2.s and the Northern Elephant Seal at 204dB re 1µPa^2.s. All animals showed full recovery in 24hours[26]. Additional studies identified that there was no measurable TTS following exposure of two Californian Sea Lions to sound levels of 183dB re 1µPa or 163dB re 1µPa^2.s, however the two test animals did show avoidance responses at these levels. Southall et al (2007) has estimated that SEL thresholds of 186dB re 1µPa^2.s (or 218dB re 1µPa (peak)) may induce Permanent Threshold Shift (PTS) in harbour seals. The threshold for onset of mild TTS for a Harbour Seal has been estimated at a SEL of 171dB re 1µPa^2.s and it is expected that TTS onset would occur at appreciably higher received levels in Californian Sea Lions than in Harbour Seals. Sound modelling results showed that sound levels of 186dB re 1µPa^2.s lie within 300m of the source and 171dB re 1µPa^2.s within 1km of the source.

Behavioural observations of pinnipeds during seismic monitoring studies have noted that some pinnipeds show avoidance reactions to airguns, but their avoidance reactions are generally not as strong or consistent as those of cetaceans. The behaviour of seals during a near-shore seismic program in Alaska[27] observed that approximately 79% of seal sightings occurred within 250m of the seismic vessel, and that there was partial avoidance of the zone at less than 150m from the vessel during full array seismic, but seals did not move much beyond 250m.

Studies[28] undertaken on Sea Lion behavioural response to mid-frequency (3.2-3.5kHz) sonar provides some guidance on the dose-response relationship for behavioural change in the species[29]. Study results identified a received Sound Pressure Level of 170dB re 1µPa to be a threshold in the mid-frequency range whereby adult Sea Lions start to experience behavioural responses (i.e. avoidance responses).

The nearest point of the Lightning MSS to SA coastlines is 64km (Neptune Islands). The survey area lies within male Sea Lion foraging areas and in proximity to female Sea Lion foraging grounds to the south of Eyre Peninsula and west of Kangaroo Island. For the closest seismic line to shore, maximum residual SELs at the shoreline are 115dB re 1µPa^2.s and at the southern edge of the female foraging area estimated at 145dB re 1µPa^2.s (~175dB re 1µPa). On this basis, residual acoustic sound produced during shelf acquisition of data (38% of survey period)[30] may result in avoidance of foraging male Sea Lions to a distance of approximately 10km around the acoustic source. Small localised levels of avoidance may be observed in female Sea Lion foraging behaviour at *the southern boundary of the identified female foraging grounds*[31]. The sound levels closer to shore which diminish to 115dB re 1µPa^2.s (~145dB re 1µPa) should not elicit behaviour changes (including breeding) in adult Sea Lions. Again it is emphasised that these stated thresholds for behavioural change are based upon mid-frequency sound impacts which lie within the normal hearing range for pinnipeds. Thresholds for low frequencies would be expected to be larger in magnitude.

Additionally, it should be noted that the environmental context of the continental shelf includes a major shipping lane passing through the Lightning MSS area. The shipping land is located closer to pinniped colonies at Liguanea and Neptune Islands when compared with the Lightning survey activity. The shipping lane carries traffic such as container ships, oil tankers and cruise liners which emit a low frequency sound level of at least 180-190dB re 1µPa (at hull). Sound from commercial shipping is expected to predominate through the area and be more of a behavioural deterrent to foraging activity, particularly in the female foraging grounds in the region, than the residual sound impacts from the proposed MSS activity.

[26] Southall, B. L., A. E. Bowles, William T. Ellison, J. J., J. J. Finneran, R. L. Gentry, C. R. G. Jr., D. Kastak, D. R. Ketten, J. H. Miller, P. E. Nachtigall, W. J. Richardson, J. A. Thomas, and P. L. Tyack., 2007 - Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals 33:1-521

[27] Harris, R.E, Miller, G.W, Richardson, W.J, 2001 – Seal Responses to Airgun Sounds during Summer Seismic Surveys in the Alaskan Beaufort Sea, Marine Mammal Science, 17(4): 795-812 (October 2011)

[28] Houser, D.S., Martin, S.W., Finneran, J.J. – Behavioural Responses of California Sea Lions to mid-frequency (3250-3450Hz) Sonar Signals, Marine Environmental Research: 92(2013) 268-278

[29] Sea Lion hearing is best within the range 1kHz to 50kHz and hence this study provides guidance on behavioural responses within the species within its dominant hearing frequency range. It is to be emphasised that seismic sources are low frequency (<1kHz with the predominant frequency less than 200Hz) and larger sound thresholds (dB) would be expected in the 'poorer hearing range frequencies' to illicit the same response if the response occurs at all.

[30] This does not consider the sound contribution above this level which would be emanating from shipping activities.

[31] Foraging ground for lactating females adjacent to the survey area on the shelf is rated medium and not high.

Sharks: Limited research has been conducted on shark responses to seismic surveys. Sharks are known to be highly sensitive to low frequency sounds between 40-800Hz sensed solely through the particle-motion component[32] of an acoustic field. Free ranging sharks are attracted to sounds possessing specific characteristics – irregular pulse, broadband frequency and transmitted with a sudden increase in intensity (i.e. resembling struggling prey). Studies have also observed that sharks can withdraw immediately if sound intensity suddenly increases by 20dB re 1µPa (10 times) or more above the previous transmission[33].

Trauma from acoustic sources to marine species appears dependent of the presence of a swim bladder, a gas filled chamber which assists with buoyancy or as an aid in hearing. Because of the disparity of acoustic impedance between water and gas filled chambers, vibrations in water may induce trauma in species with swim bladders. Many adult fish do not possess a swim-bladder and so are not susceptible to this trauma. This includes Elasmobranchs (sharks and rays), many pelagic fish, flatfishes and lizardfish. It must also be mentioned that fish attacks on seismic streamers from large pelagic species is not uncommon as evidenced by damaged hydrophone streamers (shark-bites)[34].

Given the wide-ranging habitat of most shark species present in the MSS area; the lack of an air-bladder; their known avoidance response to sudden sound increases; and the sound characteristics of seismic activity (regular, not sudden); it is possible the impact to shark species is, at most, very localised avoidance of the MSS activity (i.e. negligible consequence) . Given the open ocean environment of the MSS, free-ranging sharks are not expected to be significantly impacted as they transit through the region to feeding grounds.

For shark species which are not wide-ranging but inhabit certain depth ranges (i.e. Gulper Shark) and have sensitive habitat adjacent to the acquisition area, impacts based upon reported shark behaviour is expected to be negligible with expected received SELs less than 140dB re 1µPa^2.s. The Lightning MSS area overlaps the eastern buffer area of the Gulper Shark closure area by approximately 7nm. In the very unlikely event that some displacement of the species occurs to the west along the continental slope as a result of survey activities significant closure area remains to the west (~50nm) to protect the species.

Fish: Anatomical features important in determining the level of acoustic sound impact on fish include the presence of a swim bladder (more susceptible if present); large fish with a swim bladder of resonate frequency in the order of several hundred hertz may be more sensitive to seismic sounds; and fish with a mechanical coupling of swim-bladder to ear will be most susceptible to ear trauma from the transmission of sound[35]. Hence larger benthic fish such as emperors, sea bream, snappers and perch should be more at risk than pelagic fish such as mackerels and some tuna species which do not have a swim-bladder; or smaller reef fish that lack swim-bladder to ear linking. Most fish can hear in the frequency range 100-1000Hz but there is significance variance according to species outside that range. Within this range, minimum hearing thresholds vary widely, with the hearing specialists having best sensitivity as low as 50dB re 1µPa, and non-hearing specialists having best sensitivities as high as 110dB re 1µPa.

Lethal effects from acoustic sources have been shown to occur for some plankton at close range to an operational acoustic source (<10m distance) and fish eggs (~5m) however, mortality to adult fish and invertebrates directly exposed to acoustic sources has not been observed. Woodside studies[36] [37] [38] undertaken at Scott Reef on tropical reef fish during MSS activities also identified:

- No lethal or sub-lethal effects on fish. Behavioural responses were observed at close range with general movement from the water column to the seabed, however normal feeding behaviour returned within 20 minutes of the MSS vessel passing and when the vessel was beyond a distance of 1.5km;

[32] This is most dominant in the near-field of the survey in close proximity to the acoustic source.
[33] Myrberg, A.A., 2001. - The acoustical biology of elasmobranchs. *Environmental Biology of Fishes*, 60(3), p.31-45, Available at: http://www.springerlink.com/index/J14611J202771866.pdf
[34] McCauley, R.D., 1994, *Seismic Surveys* in *Environmental Implications of Offshore oil and Gas Development in Australia- The Findings of an Independent Review*, Swan, J.M., Neff, J.M., and Young, P.C.,(Eds), Australian Exploration Association, Sydney, pp.19-121
[35] McCauley, R.D., 1994, *Seismic Surveys* in *Environmental Implications of Offshore oil and Gas Development in Australia- The Findings of an Independent Review*, Swan, J.M., Neff, J.M., and Young, P.C.,(Eds), Australian Exploration Association, Sydney, pp.19-121
[36] Woodside Petroleum Limited, 2012a – Browse LNG Development, Maxima 3D MSS Monitoring Program Information Sheet 1 – Impacts of Seismic Airgun Noise on Fish Behaviour: A Coral Reef Case Study
[37] Woodside Petroleum Limited, 2012b – Browse LNG Development, Maxima 3D MSS Monitoring Program Information Sheet 2 – Impacts of Seismic Airgun Noise on Fish Pathology, Physiology and Hearing Sensitivity: A Coral Reef Case Study
[38] Woodside Petroleum Limited, 2012c – Browse LNG Development, Maxima 3D MSS Monitoring Program Information Sheet 2 – Impacts of Seismic Airgun Noise on Fish Diversity and Abundance: A Coral Reef Case Study

- Fish exposed to acoustic pulses shown no structural abnormalities, tissue trauma or lesions, or auditory threshold changes (highest exposure level 190dB re 1µPa^2.s). However, a small number of damaged hair cells (less than 1% of fish hearing capacity) were observed in fish exposed to acoustic sound; and
- No significant decreases in the diversity and abundance of fish after the MSS were detected compared with the long term temporal trend before the MSS.

Reef fish are considered 'site –attached' and there is reluctance for the species to move away from their specific habitat. Therefore physiological impacts are expected to be greater for these fish than for pelagic fish which are non-site attached.

It has been observed that acoustic sound can lead to behavioural responses in fish however the nature and extent of the response varies. McCauley (1994) applying the behavioural observations of benthic fish to sound observed by Pearson et al (1992)[39], in a simple spherical spreading model, indicated for an array (source sound pressure level 250dB re 1µPa-m) approximate distances at which behavioural changes in fish would be observed include:

- A startled response (at ~200-205dB re 1µPa) at approximately 178-316m directly beneath the array whereby fish flee the sound of the array;
- An alarm response (at ~180dB re 1µPa) at distances of 630-2000m where there is an increase in general activity and changes in schooling of the species; and
- A subtle behavioural response (at ~160dB re 1µPa) at a distance of 2.1-12km.

The impacts of these behavioural changes in fish have been reported to lead to smaller commercial fishery catches. Catch studies undertaken on redfish species[40] identified reduced catches after MSS activity resulting from fish increasing their depth range and being drawn into seabed structures. On this basis, it was observed that fish with an affinity for the seabed appear less likely to disperse compared with pelagic fish species located in less unique bank areas. Other studies[41] also identified decreased catches within, and adjacent to, the immediate seismic area that lasted for at least five days after seismic acquisition ceased, however others[42] have produced results which indicate some catches increase and remain high after MSS, others decrease while others were not affected.

The Lightning MSS area is located close to the edge of the continental shelf and over the continental slope. Review of commercial fishing species which are present in the area identifies that species spawning over the March-May period on the mid-outer continental shelf include the Australian Sardine, a weekly serial spawner between January and March on the mid-continental shelf area with larvae predominantly present in inshore; and the Pink Snapper, serial spawners between late October and early March in water depths less than 50m. As previously identified, lethal effects from acoustic sources have been shown to occur for some plankton at close range to an operational acoustic source (<10m distance) and fish eggs (~5m)[43]. Given the location of the Lightning MSS area relative to the recognised spawning areas for fish species, acoustic sources impacts to fish eggs is expected to be negligible.

[39] Pearson, W.H., Skalski, J.R., and Malme, C.I, 1992 – Effects of sounds from a geophysical survey device on the behaviour of captive rockfish (Sebastes spp.) Can. J. Fish. Aquatic Sci. 49(7): 14343-56-

[40] DNV Energy, 2007 – Effects of seismic surveys on fish, fish catches and sea mammals, Report 2007-0512, Cooperation Group – Fishing Industry and Petroleum Industry

[41] DNV Energy, 2007 – Effects of seismic surveys on fish, fish catches and sea mammals, Report 2007-0512, Cooperation Group – Fishing Industry and Petroleum Industry

[42] Boertmann, D., Tougaard, J., Johansen, K. & Mosbech, A., 2010 - Guidelines to environmental impact assessment of seismic activities in Greenland waters, 2nd edition, National Environmental Research Institute, Aarhus University, Denmark. 42 pp., NERI Technical Report no. 785. http://www.dmu.dk/Pub/FR785.pdf

[43] McCauley, R.D., 1994, *Seismic Surveys* in *Environmental Implications of Offshore oil and Gas Development in Australia- The Findings of an Independent Review*, Swan, J.M., Neff, J.M., and Young, P.C.,(Eds), Australian Exploration Association, Sydney, pp.19-121

Crustaceans: Crustaceans, such as crabs and lobster, do not possess gas-filled cavities and hence are at lesser risk of physiological damage compared with marine mammals and fish with air bladders[44]. Field studies relating to MSS impacts on invertebrates are scarce. During the 1960s, when explosive charges were used as a source for MSS, studies indicated that 25lb charges killed a variety of fish species, but when discharged 14m above rock lobster pots no discernible damage occurred to the rock lobsters. This is consistent with other studies identifying the remarkable resistance of crustaceans to high force explosive events. Studies undertaken into the effects of thirty-three (33) MSSs on catch rates of Rock Lobsters in western Victoria between 1978 and 2004 identified that there was no evidence indicating a decline in Rock Lobster catch rates for the period both on a long-term and short-term basis[45].

Limited research has been undertaken on the effects of marine seismic on marine invertebrate larvae. Available research for crustacean species includes:

- Pearson et al (1994)[46] conducted experiments with air-guns on early life stages of Dungeness crabs (*Cancer magister*). From a seven air-gun array (acoustic sound levels of 231dB re 1µPa and capacity 13.8litres) Pearson exposed early stage II zoeal crab larvae to acoustic sound at 1m, 3m and 10m. The study was specifically designed so that exposures were at the high end realistically expected during a typical survey operation. No statistically significant differences were found in immediate survival rates, long-term survival rates or time to moult between the exposed and control larvae, even within 1m of the source.

- Christian et al (2004)[47] undertook research of seismic impacts to snow crabs including observation of developmental differences in fertilized eggs between control and test groups. Crabs were exposed at a distance of 2m from a single 40in^3 air-gun of 200 shots at 10 second intervals (received peak sound pressure levels of approximately 216dB re 1µPa). Twelve weeks after this exposure, the fertilized eggs showed a 1.6% higher mortality compared with the control group, and 25.7% fewer eggs had developed to the next developmental stage in the exposed group. It should be noted that these crabs were exposed at very close distances to the air-guns. Snow crabs (as per Rock Lobsters) in natural situations are not this close to a seismic array or these received levels because the eggs are held by the adult females beneath their tails on the seabed. *No impacts to lobster eggs are expected from the Lightning MSS due to the water depths (130-1000m) in the survey area*.

The MSS is therefore not expected to impact upon crustacean resources in the MSS area.

Cephalopods: Norris and Møhl (1983)[48] identified a short term tolerance of sound levels to 260dB re 1µPa by one cephalopod species but lethal effects at levels of 246-252dB re 1µPa for another. Further work was recommended to confirm these exposure levels however results would suggest that squid might be killed within a few meters of individual, large airguns. Andre et al (2010), in experiments conducted over a period of two (2) years on caged adult cephalopod species exposed to low frequency sound[49] (157-175dB re 1µPa), identified lesions on statocysts within the species which became more pronounced with increased exposure (12 to 96hrs). Andre (2012)[50] identified limitations with this study with respect to MSS activity in that the animals were caged in a small tank and unable to move away; and the nature of the sound exposure was different to seismic impulses.

[44] Parry, G.D, & Gason, A, (2006) – The Effect of Seismic Surveys on Catch Rates of Rock Lobsters in Western Victoria, Australia, Fisheries Research 79(2006) 272-284
[45] Parry, G.D, & Gason, A, (2006) – The Effect of Seismic Surveys on Catch Rates of Rock Lobsters in Western Victoria, Australia, Fisheries Research 79(2006) 272-284
[46] Pearson, W.H., Skalski, J.R., Sulkin, S.D., Malme, C.I. (1994) – Effects of Seismic Energy Releases on the Survival and Development of Zoeal Larvae of Dungeness Crab, Marine Environmental Research 38 (1994) 93-112
[47] Christian, J.R., Mathieu, A., &, Buchanan, R.A. (2004) – Chronic effect of seismic energy on Snow Crab (*Chionoecetes opilio*) Environmental Research Funds Project No. 158, Calgary
[48] (Cited in)SCAR 2012 Anthropogenic Sound in the Southern Ocean: an update. Antarctic treaty consultative meeting XXXV Hobart 2012
[49] This is attributable to shipping, offshore industry, naval manoeuvres.
[50] André, M., Solé, M., Lenoir, M., Durfort, M., Quero, C., Mas, A., Lombarte, A., van der Schaar, M., López-Bejar, M., Morell, M., Zaugg, S. and Houégnigan, L., 2011 - Low-frequency sounds induce acoustic trauma in cephalopods. Frontiers in Ecology and Environment, 9, 489-493.

Studies into behavioural impacts of squid to airgun sound are limited. McCauley *et al*., (2000)[51] assessed the effects of air gun noise on caged squid (*Sepioteuthis australis*). In the first trial, several squid showed alarm responses at 156-161dB re 1 μPa_{rms} and a strong startled response to the start-up of a nearby air-gun by firing their ink sacs and/or jetting away from the source (at received level 174dB re 1μPa_{rms}). During this trial the squid showed avoidance to the air-gun by keeping close to the water surface at the end of the cage furthest from the airgun (within the sound shadow at surface). During trials with a ramped start-up approach (rather than near-by sudden start-up), the strong startle response was not seen but there were increased alarm responses once the gun level exceeded 156-161dB re 1μPa_{rms}. No avoidance was observed but there was a trend for the squid to increase their swimming speed on air-gun approach but then to slow at the closest approach and remain close to the water surface during the operation. The responses seen in the cages suggest that behavioural changes and avoidance to an operating air-gun would occur at some range. Hence it is probable that seismic operations at distances of 2-5km would displace squid at an expected exposure threshold of approximately 161dB re 1μPa_{rms} based upon available literature.

Hirst & Rodhouse (2000)[52] found no change in squid catch (trawling) in an area exposed to <149dB re 1µPa (a distance of approximately 1.35km to the source). This observation suggests that squid would likely move outside the lethal range of a sound source.

Benthic Fauna (*Porifera, Ascidians, Bryozoans*): Very little is known about sound detection and use of sound by aquatic invertebrates. Organisms may detect sound by sensing either the 'particle motion' or pressure component (or both) however no physical structures have been discovered in aquatic invertebrates which would be expected to be stimulated by the pressure component of sound. Marine invertebrates present (i.e. porifora, bryozoans and ascidians) are at the same density as water and do not contain air cavities which might function like a fish bladder in responding to pressure (i.e. trauma due to rapid pressure changes). On this basis, no impacts to benthic fauna in the MSS area are expected from the sound "pressure" component of the sound wave.

Some aquatic invertebrates (e.g. cephalopods) have specialised organs called statocysts for determining equilibrium and in some cases linear or angular acceleration which may be affected by marine sound[53]. Benthic species such as porifora, bryozoans and ascidians present in the Lightning MSS area do not contain statocysts.

Little research has been undertaken as to sound impacts on ascidians, bryozoans or porifora. Most studies into aquatic invertebrates have focussed on commercial species (crab, lobster, squid, shrimp, etc.). One study, looking at possible acoustic impacts from seismic sources to (glass) sponge (i.e. porifora) feeding characteristics, identified no increased feeding rates within the species when exposed to an air-gun of source level 151dB re 1μPa^2.s at 160m[54]. This is however, a much lower SEL than a seismic acoustic array.

On the basis of the known anatomy of benthic fauna in the region and the distance between acoustic array and the seafloor, no impacts to benthic fauna are expected with acoustic impacts from MSS activities.

Tourism: As assessment of possible impacts and risks to regional tourism-related activities/values associated with the acoustic impacts from seismic operation are as follows:

- Recreational Beach Use (sightseeing, swimming, surfing and snorkelling) and diving (coastal areas): Sound levels at coastal beaches are expected to be less than 115dB re 1μPa^2.s (~145dB re 1µPa)[55] and hence no physiological or aversion impacts to people located within the water are expected. The Northern and Southern Neptune Islands both have rocky shorelines (no beaches) and plenty of white sharks (no snorkelling). *Hence no recreational beach use tourism-related impacts are predicted;*

[51] McCauley, R.D, Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M-N., Penrose, J.D., Prince, R.I.T., Adhitya, A., Murdoch, J., and McCabe, K., 2000, *Marine Seismic Surveys- A Study of Environmental Implications*, APPEA Journal, pp 692-708

[52] Cited in SCAR 2012 Anthropogenic Sound in the Southern Ocean: an update. Antarctic treaty consultative meeting XXXV Hobart 2012

[53] Normandeau Associates, Inc. 2012. Effects of Noise on Fish, Fisheries, and Invertebrates in the U.S. Atlantic and Arctic from Energy Industry Sound-Generating Activities, A Workshop Report for the U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Contract # M11PC00031. 72 pp. plus Appendices

[54] Tunnicliffe V., Chapman, N.R., Wilmut, M.J., Yalhal, G. & (2008) – Final report – Environmental Impacts of Airguns on Glass Sponges , Ministry of Energy & Mines and University of Victoria, British Columbia

[55] Studies (1993, 1995) undertaken on low frequency underwater sounds to humans (divers) by the US Department of Navy identified that sound levels below SPL 160dB re 1µPa would not be expected to cause physiological damage to a diver. Further studies (1997, 1998) concluded that SPLs of 157dB re 1µPa did not produce physiological damage in humans, further only 2% of divers experienced "very severe" adverse reactions at a level of 148dB re 1µPa. On this basis, the threshold was scaled back by 3dB (a 50% reduction in signal strength) to provide a suitable margin of safety for divers. Interim guidance for the operation of low frequency sound sources in the presence of recreational divers is recommended not to exceed a SPL of 145 dB re 1µPa.

- Diving (Heritage Trails): Identified heritage diving areas are located outside the MSS acoustic footprint areas and will be less than 115dB re 1µPa^2.s (i.e. Sound Pressure Level (SPL) ~145dB re 1µPa). *Hence no heritage diving-related tourism impacts expected from acoustic activities;*
- Whale Watching Operations: Lightning MSS activities occur outside the time window for whale watching (June-October) which is predominantly association with coastal Southern Right Whale aggregations. *Hence no impacts expected to whale watching operations expected;*
- Charter boating (sightseeing, fishing, diving, marine mammal watching): Coastal charter boats are concentrated around Port Adelaide, Kangaroo Island and the Eyre Peninsula. Charter vessels also utilise the waters surrounding the Northern and Southern Neptune Islands for sight-seeing and/or coastal recreational fishing. SPL levels at the Northern & Southern Neptune Islands Group (considered the 'worst case' for all coastal areas) are predicted to be at levels below those where behavioural responses in fish result (i.e. 160dB re 1µPa). Accordingly, no coastal recreational fishing displacement effects are predicted around these islands or coastal areas.

  Deep Sea Charters may experience minor fish displacement (i.e. at sound levels between 180-200dB re 1µPa or ~3km from the MSS boundary).

  Marine mammal watching (pinnipeds) (ecotourism) also occurs in coastal areas and islands where colonies are present (i.e. Neptune Islands and Hopkins Island). Avoidance behaviour (i.e. no entry into water) is expected by Sea Lions (& Fur Seals) at received sound levels of 170dB re 1µPa *in the species preferred mid-frequency hearing range*. It is noted that higher sound levels are required in the low-frequency range to illicit the same response. Low frequency sound levels of 140-150dB re 1µPa are expected at the Northern and Southern Neptune Islands (considered worst case for coastal tourism areas). *No avoidance behaviour by pinnipeds is expected as a result of acoustic sound and no subsequent impact to tourism;*
- Recreational boating (small inshore craft): Recreational vessels (non-charter) will not be affected by Lightning MSS acoustic sound. *No impacts to tourism are expected;*
- Yacht Racing: As yacht races are undertaken during periods outside the Lightning MSS time period, *no impacts to yacht racing events are expected from acoustic impacts from the Lightning MSS;*
- Cruise Ships visiting Kangaroo Island: Cruise vessels transiting to Kangaroo Island will not be affected by Lightning MSS acoustic sound. *No impacts to tourism are expected;*
- Cage Diving with Great White Sharks (Northern Neptune Islands) (ecotourism): Anchorages for shark diving occur on the eastern coastlines of North Neptune Group Islands in water depths of approximately 12-18m away from the prevailing westerly winds and swell. The western coastline of the islands is only suitable in summer during easterly wind regimes[56] [57] and calm seas (i.e. not in the MSS time window). Sound levels predicted on the prevailing *western face* of the North Neptune Group Islands is ~140dB re 1µPa which is lower than the recommended received SPL of 145 dB re 1µPa. As the anchorage locations are on the lee side of the island it is expected that sound levels will be lower at approximately 130dB re 1µPa. Additionally, as previously identified, acoustic sound from MSS activities are not expected to impact on shark species at this location. *No impacts to diving tourism are expected from acoustic sound.*

Adopted Control Measures

The following controls have been adopted to avoid or minimise impacts to environmental and social values in the region:

- Lightning MSS period (March-May) selects the 'time window' which has a reduced likelihood of upwelling conditions and minimises encounter with cetaceans and other marine fauna;
- The minimum array size will be selected to acquire seismic data;

[56] Rodney Fox Shark Expeditions, 2014 available at https://www.rodneyfox.com.au/index.php/selectedContent/21965891
[57] Shark Cage Diving – Calypso Star Charters, 2014 available at http://www.sharkcagediving.com.au/shark-tours/dive-locations/

- An aerial survey will determine the presence of whale species and SBT Pontoon towing in the MSS area three (3) days prior to survey commencement to establish species presence of species and determine survey start location. Two trained and experienced observers will be utilised to record sighting and effort data.
- Four qualified MMOs will be engaged for the survey, two located on the MSS vessel and one on each of the scout/supply vessels to observe for whales during daylight hours.
- A towed Passive Acoustic Monitoring (PAM) system, capable of detecting call frequencies of Sperm Whales, Killer Whales, Beaked Whales and Pilot Whales will be utilised on a 24hr basis for detection purposes.
- Two competent and experienced PAM operators will monitor for Sperm Whales, Killer Whales, Beaked Whales and Pilot Whales on a 24hour basis while acquiring seismic data.
- Standard management controls within EPBC *Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales (2008)* will be adopted for the survey including 30minute prestart watch, 35min soft-start period, 3km precautionary zone, 2km low power zone & power-down procedures, 500m shutdown zone & shut-down procedures and protocols for array start-up during periods of low visibility;
- During all daylight hours when whales are known to be in the area of the operations (i.e. as a result of aerial surveys, vessel surveys or previous sightings), a vessel will scout the area 5-10km ahead (30-60minutes) of the MSS vessel to assist with managing behavioural impacts to the species.
- For Low Visibility Conditions:
    - When whales are known to be in area, during the 4 hours prior to darkness, a vessel will scout the area scheduled to be traversed by the operating MSS vessel during the night and, if whales are present in the area, the vessel will record on the least sensitive part of the survey area;
    - Except for species detectable during the hours of darkness by PAM such as Sperm, Beaked, Killer and Pilot Whales; if 3 or more power-downs due to whales entering the 2km power-down zone occurs in a 24hr period then no night-time recording will continue until a full day's operation has elapsed without power-downs due to whale sightings.
- All personnel on-board the vessel will be made aware of these arrangements via an environmental induction prior to mobilisation.
- Acoustic source will be powered down to lowest practicable setting on line turns.

Inherent in the design of the MSS, Bight is surveying the most prospective parts of the survey area (survey area minimised) and utilising a multi-streamer vessel which minimises the acquisition period and presence in the area.

Environmental Risk Assessment

Cetaceans: Literature indicates that high acoustic sound levels (i.e. Sound levels above 230dB re 1µPa) might be expected to cause injury to cetaceans. Although these types of sound levels (and hence impacts) would only occur in close proximity to the seismic source they are considered a 'significant' consequence (Consequence 3) in accordance with the Bight Qualitative Risk Matrix.

The selected timing for the proposed Lightning MSS (1 March – 30 May):

- Avoids peak periods where migratory and endangered species may be present in the area;
- Has minor temporal overlap with Southern Right Whale species as the first species observed in be arriving the area occurs from mid-to-late May;
- Avoids observed 'high presence' periods (August-September) for the Sperm Whale; and
- Avoids the peak presence period for Blue Whales (December) although the species is recorded in the SW Marine Bioregional Plan as occurring in the area between November and May. Surveys undertaken to support survey timeframe selection has identified the species presence in the period March to May is low. It should be noted that 'upwelling conditions' which attract aggregations of Blue Whales is irregular (not as consistent as the Bonney upwelling) and intermittent at Kangaroo Island (i.e. 2-4 instances lasting 3-10days

per year if upwelling conditions are present). Wind roses for the area indicate that favourable SE wind regimes may occur in March however the likelihood of these conditions occurring in April and May are low.

With control measures identified in the DEWHA Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales (2008) – Part A (Standard Management) and Part B (Adaptive Management) exposure of cetaceans to unacceptable sound levels (i.e. physiological or behavioural changes) is considered very unlikely and the residual environmental risk to the species is assessed as **low**.

Turtles: For risk assessment purposed, it has been assumed that turtles may be at risk of physical damage if exposed to sudden levels of acoustic activity (i.e. in close proximity to an operating array starting up at full power). These types of impacts are considered a 'significant' consequence (Consequence 3) in accordance with the Bight Qualitative Risk Matrix.

The Lightning MSS area does not contain important biological habitat (i.e. feeding, resting & breeding) critical to the identified turtle species however, the species may transit through the area.

Control measures adopted in the DEWHA Policy Statement 2.1 – *Interaction between Offshore Seismic Exploration and Whales* (2008) with respect to soft starts procedures will allow turtles to relocate from the area before the potential for physical damage occurs. For continuous acoustic sound, turtles will practice avoidance. On this basis the likelihood of significant impacts to turtles is considered very unlikely and the residual risk to the species is assessed as **low**.

Pinnipeds: The following assessment is made with respect to physical damage, behavioural and breeding impacts/risks to pinniped species which may be present on a transitory basis in the Lightning MSS area during survey activities:

- Physical: Based upon available scientific literature, the threshold for mild TTS-onset for a harbour seal (i.e. TTS in hearing [Consequence 3]) is estimated at a received SEL of 171dB re 1µPa^2.s which is localised around the vessel within 1km of the acoustic array. The estimated TTS for Sea Lions is expected to be significantly higher based on observed PTS data. Given the controls adopted during survey activities for cetaceans (i.e. soft-starts) pinniped relocation is expected to occur prior to any physical damage occurring and hence TTS impact is expected to be very unlikely. The risk to pinnipeds associated with TTS impacts is therefore **low**.
- Behavioural/Foraging: Based upon available scientific literature for *mid-frequency* sources behavioural impacts would be expected at sound thresholds of approximately 175dB re 1µPa (or 145dB re 1µPa^2.s). Based upon acoustic modelling undertaken for the survey, this sound threshold is achieved within 10km of the acoustic array. Male Sea Lion foraging activities may be displaced by approximately 10km around the acoustic source (localised impacts - Consequence 2)) however given the extensive foraging grounds available to the species, foraging impacts are unlikely and the residual risk associated is assessed as **low**. Female Sea Lions foraging inshore of the Lightning MSS area may have some localised (negligible) displacement (Consequence 1) however major encroachment/impact into this foraging area, based upon available modelling, is unlikely. The residual risk to foraging female Sea Lions is assessed as **low.**

  The area also provides foraging grounds for the New Zealand Fur Seal. These foraging grounds are extensive across the region with no known key foraging areas identified[58]. On the basis of behavioural change sound thresholds observed in the Sea Lion, it is expected that seals would also practice localised avoidance of the area around the acoustic source (Consequence 2). Given the areas for foraging within the region are extensive, it is unlikely that foraging impacts to the species will be realised and the risk is considered to be **low**.
- Breeding: Sound levels at Sea Lion and seal colonies are unlikely to exceed 115dB re 1µPa^2.s (or ~145dB re 1µPa). These sound levels are below thresholds for behavioural change and therefore are not expected to have any impact on breeding success. Additionally for seals, breeding periods occur outside the MSS period (for New Zealand Fur Seals between November and January) and no impacts would be expected. On the basis of available scientific information breeding impacts (Consequence 3) to these species are considered very unlikely and the risk is assessed as **low**.

[58] SEWPC, 2012b - Marine Bioregional Plan for the SW Marine Region access on 9th February 2014 at http://www.environment.gov.au/system/files/resources/1da7aaed-019f-471f-9cd5-f7bd86122a0e/files/sw-profile-full.pdf

Fish/Sharks: McCauley (1994) reported that no lethal effects from seismic sources have been observed for adult fish, crustaceans or shellfish exposed to seismic arrays. Studies indicate that some fish may relocate from areas where unacceptable sound impacts are present creating temporary displacement of fish stock. Juvenile fish species (eggs & larvae) may also be impacted in close proximity to the acoustic source, however at a population level these impacts are not considered to be significant. On this basis, impacts to fish are considered short-term (for duration of seismic) and localised with temporary displacement of fish (i.e. 'minor' consequence) possible. The environmental risk to fish on a short-term basis is therefore considered to be medium and on a long-term basis is considered **low**.

No impacts are expected to benthic invertebrates (porifera, bryozoans or ascidians) or crustaceans.

Cephalopods: Cephalopods respond to acoustic sound within the marine environment. Given the control measures adopted for cetaceans (e.g. soft-starts) temporary and localised cephalopod displacement from areas where seismic acquisition is occurring is probable. As the species is wide-spread across the continental shelf this small, temporary displacement is considered negligible (i.e. low residual risk). Higher trophic levels dependent on cephalopods as a food source (Sperm Whales, Dolphins, Fur Seals and Killer Whales), if present in the MSS area, would also be temporarily displaced on a localised basis, however it should be noted that most of these predator species are opportunistic with alternate prey species.

Accordingly temporary localized displacement of the species and its predators (i.e. Sperm Whale) during the MSS is possible, however Bight considers that this should not result in permanent habitat modification and, given predator species are opportunistic is expected to have a negligible impact. The residual risk is assessed as **low**.

Tourism: Assessment of regional tourism activities has identified that only deep sea charter fishing, if present in proximity to the survey activities may experience some displacement of fish. Given the observed low fishing effort in the area and the availability of alternate fishing locations, impacts to charter fishermen will be negligible (Consequence 1) and the residual risk assessed as **low**.

5.2.7 Vessel Operation – Acoustic Disturbance

Background Information and Potential Impacts

Typically, marine vessels produce low frequency sound (i.e. below 1 kHz) from the operation of machinery on-board; from hydrodynamic flow noise around the hull; and from propeller cavitation, which is typically the dominant source of sound. Most sounds associated with vessels are broadband (i.e. contain a broad range of frequencies), though, tones are also associated with the harmonics of the propeller blades[59]. Studies[60] have identified that for a rig tender vessel underway with a broadband source level of 177dB re 1µPa, the measured vessel noise was broadband in nature, with the highest level measured at 137 dB re 1µPa at 405 m astern; levels of 120 dB re 1µPa recorded at 3-4km; and the noise audible at up to 20 km against a 'natural background level' of 90 dB re 1µPa.

Usually, the larger the vessel or the faster a vessel moves results in more sound emissions. Depending on the vessel, source levels can range from less than 160dB (trawlers) to over 200dB re 1µPa @1m (super-tankers)[61]. On this basis, potential sound impacts from the MSS survey vessels are unlikely to be greater than that from existing vessels operating in the vicinity of the Lightning MSS area. The MSS vessel will be generally operating at a low speed 4-4.5knots during the survey, although the support vessels may operate at faster speeds in order to effectively patrol the requested clearance area around the MSS vessel.

[59] Skjoldal H.R., Cobb, D., Corbett, J., Gold,M.,Harder, S., Low, L.L.,Noblin, R., Robertson, G. Scholic-Schlomer, A.M., Sheard, W., Silber, G., Southhall, B., Wiley, C. Wilson, B and Winebrake, J., 2009 - Arctic Marine Shipping Assessment. Background Research Report on Potential Environmental Impacts from Shipping in the Arctic http://www.pame.is/images/stories/AMSA/AMSA_Background_Research_Documents/Environmental_Impacts/6-1-Environmental-Impacts-from-Current-and-Future.pdf

[60] McCauley R.D., 1998 - Radiated underwater noise measured from the drilling rig Ocean General, rig tenders Pacific Ariki and Pacific Frontier, fishing vessel Reef Venture and natural sources in the Timor Sea, Northern Australia. Report to Shell Australia

[61] Whale and Dolphin Conservation Society (WDCS), 2003 - *Oceans of Noise,* [Online],. Available from: http://ww.wdcs.org/stop/pollution/index.php

Sound levels from vessel operations are not expected to be high enough to cause physical damage to marine fauna, however temporary behavioural changes (avoidance) in species (cetaceans, turtles, fish) may be observed. Sound levels which might be expected to cause significant disturbance in marine fauna would be confined to the immediate vicinity of the vessels; within a radius of a few metres of the sound source.

Given the vessels will be continually operating within the lightning MSS operational area (i.e. continuous sound) it is likely that sound-sensitive marine fauna present will avoid approaching vessels if sound disturbance was too high.

Adopted Control Measures

The following controls have been adopted to avoid or minimise impacts to marine species from sound disturbances associated with vessel operations:

- Vessel propulsion systems undergo regular preventative maintenance and routine inspection against manufacturers specifications;
- Proximity distances and low speeds will be adopted in accordance with the EPBC Regulations 2000 (Part 8) for cetaceans (including dolphins and porpoises) to avoid behavioural impacts;
- Support/escort vessels will also apply EPBC Regulation 2000 (Part 8) requirements for dolphins, to pinniped species;
- The on-board MMOs will monitor and report on interactions in accordance with EPBC Regulation 2000 Part 8 requirements for the nominated marine fauna; and
- This requirement will be included in the environmental induction for the Lightning MSS.

Inherent in the design of the MSS, Bight is surveying the most prospective parts of the survey area (survey area minimised) and utilising a multi-streamer vessel which minimises the acquisition period and presence in the area.

Environmental Risk Assessment

Sound from the operation of vessels during the MSS, based upon available literature, may create extremely localised behavioural impacts (i.e. avoidance) to sound-sensitive marine fauna (i.e. 'negligible' consequence – Consequence: 1). It is considered with the adoption of the nominated controls, it is possible that with these temporary impacts may occur during the activity. On this basis the residual environmental risk posed by the sound emission from vessels is assessed as **low**.

5.2.8 Helicopter Operation – Acoustic Disturbance

Background Information and Potential Impacts

Helicopters may be used for crew change or medical emergencies during survey activity. However, crew change will preferentially occur in port due to the weather conditions expected within the survey area.

Helicopter operations produce strong underwater sounds for brief periods when the helicopter is directly overhead with the received sound levels dependent on source altitude and lateral distance, receiver depth and water depth. Sound emitted from helicopter operations is typically below 500Hz and sound pressure in the water directly below a helicopter is greatest at the surface but diminishes quickly with depth.

Sound levels reported for a Bell 212 helicopter during fly-over is 162dB re 1µPa and for a Sikorsky-61 is 108dB re 1µPa at 305m. Reports for a Bell 214 indicated that sound is audible in the air for 4 minutes before the helicopter passed over underwater hydrophones; and the Helicopter was audible underwater for only 38s at 3m depth and 11s at 8m depth[62].

[62] BHPB, 2006 - Stybarrow Petroleum Development WA-255-P(2) Draft Environmental Impact Statement (Draft EIS), BHP Billiton, Perth, WA

Observations of cetacean behaviour associated with Helicopter presence indicates that, for bowhead whales, most individuals are unlikely to react significantly to occasional single-pass low-flying helicopters transporting personnel and equipment at altitudes above 150m[63]. Minke whales have been observed to respond to helicopters at an altitude of 230m by changing course or slowly diving[64].

Adopted Control Measures

The following controls have been adopted to avoid helicopter sound impacts to cetaceans in the area include:

- Crew change will preferentially occur during port calls, minimising the need for helicopter support;
- Proximity distances will be adopted for Helicopters in accordance with the EPBC Regulations 2000 (Part 8) to avoid behavioural impacts to marine fauna. In particular helicopters will not fly within 500m of a whale or dolphin; and
- The MMOs on-board the MSS vessel will keep watch for cetaceans and will report on interactions managed in accordance with this requirement.

Inherent in the design of the MSS, Bight is surveying the most prospective parts of the survey area (survey area minimised) and utilising a multi-streamer vessel which minimises the acquisition period and presence in the area.

Environmental Risk Assessment

Sound from the operation of helicopter during the survey, based upon literature, indicates extremely localised and temporary behavioural impacts (i.e. avoidance) on cetaceans (i.e. 'negligible' impact, Consequence: 1). It is considered with the implementation of the nominated controls and the infrequent use of helicopters, impacts to cetaceans are very unlikely. On this basis, the residual environmental risk posed by the activity is assessed as **low**.

5.2.9 Vessel Operation – Treated Bilge Water Discharges

Background Information and Potential Impacts

Routine drainage system discharge from survey vessels has the potential to contain hydrocarbons from vessel drainage areas. Untreated discharges may lead to localised marine pollution.

All vessels engaged on the Lightning MSS will have bilge water treatment systems compliant to MARPOL 73/78 Annex I requirements in accordance with the *Protection of the Seas (Prevention of Pollution from Ships) Act 1981* (S9), or retain all bilge/machinery space water on-board the vessel for onshore disposal.

Treated volumes of bilge water discharged are small and intermittent.

Adopted Control Measures

Controls adopted for all vessels to reduce impacts from treated bilge water discharges include:

- All shipboard operations associated with oil transfer/movement are recorded in the Oil Record Book;
- Oil-water discharges will be compliant to MARPOL 73/78 Annex I requirements as follows:
  - Where an oil-water separation system is installed :
    - Oily water passes through an oil/water treatment system which can achieve an oil-in-water (OIW) content less than 15ppm;
    - On detection of an OIW concentration greater than 15ppm the discharge stream shuts-in or directed discharge in-board;
    - The Oil Detection Monitoring Equipment (ODME) on the discharge stream will be routinely calibrated to ensure the validity of discharge concentrations overboard;

[63] Richardson W.J. and Malme CI., 1993 - Man-made noise and behavioural responses, In: Bruns,J. J., Montague, J. J. and Cowles, C. J. (eds), The Bowhead Whale. Spec.Publ. 2, Soc Mar. Mamm., Lawrence, KS, pp. 631
[64] Leatherwood, S., Awbrey, F.T. and A. Thomas, 1982 - Minke whale response to a transiting survey vessel. Report of the International Whaling Commission 32: 795–802

- Discharge occurs when the vessel is proceeding *en-route;*
- The treatment system will be maintained in accordance with manufacturer's specifications via the vessel's Planned Maintenance System;
- Separated whole oil stored in dedicated tank for onshore disposal or the MSS vessel may also incinerate oily residues on-board.

- Where an oil-water separation system is not installed there will be no discharge of bilge water. Bilge water will be transported to shore to be treated in an approved onshore facility.

Inherent in the design of the MSS, Bight is surveying the most prospective parts of the survey area (survey area minimised) and utilising a multi-streamer vessel which minimises the acquisition period and presence in the area.

Environmental Risk Assessment

The intermittent discharge of treated bilge water at 15ppm OIW to the marine environment may result in temporary, localised increases in oil content of marine waters immediately surrounding the vessel discharge point. This small waste stream as it enters the marine environment will be compliant with MARPOL 73/78 Annex 1 requirements; discharged only while vessels are *en route*; and at distances of more than 60km from the nearest coastline in highly dispersive oceanic waters. Environmental impacts from the discharge will be extremely localised and temporary (i.e. 'negligible' – Consequence 1). Given these discharges will occur at intermittent periods during the survey it is considered very unlikely that this discharge will impact water quality to the extent that impacts to marine fauna will occur. The residual environmental risk for this discharge is assessed as **low**.

5.2.10 Vessel Operation – Sewage Discharges

Background Information and Potential Impacts

The discharge of untreated sewage to the marine environment may reduce water quality and stimulate algal and bacterial growth. This may have both visual amenity impacts and possible health risks to marine fauna.

All vessels engaged on the Lightning MSS will have sewerage treatment systems compliant to MARPOL 73/78 Annex IV requirements or comply with sewage discharge requirements of the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*. This includes:

- Sewage treated in a certified Sewage Treatment Plant meeting the requirements of MARPOL 73/78 Annex IV (R9) may be discharged if the effluent does not produce visible floating solids and discolouration of the sea;
- Comminuted and disinfected sewage may be discharged at distances greater than 3nm from the nearest land; and
- Sewage stored in holding tanks, not comminuted will be discharged at distances greater than 12nm from the nearest land at a moderate rate with the vessel proceeding at a speed of at least 4knots.

Treated volumes of sewage discharged are small and intermittent.

Adopted Control Measures

Controls adopted for all vessels to reduce impacts from sewage discharges include:

- Sewage is treated in accordance with MARPOL 73/78 Annex IV requirements prior to discharge in accordance with legislated distances from the shoreline for different equipment types;
- Equipment is routinely maintained and inspected (Vessel's Preventative/Planned Maintenance System;
- For vessels with treatment facilities on-board, the Vessel Masters will ensure that persons on board (POB) will not exceed the design capacity of the treatment system.

Inherent in the design of the MSS, Bight is surveying the most prospective parts of the survey area (survey area minimised) and utilising a multi-streamer vessel which minimises the acquisition period and presence in the area.

Environmental Risk Assessment

The discharge of treated sewage to the marine environment may result in temporary, localised increases in nutrient/Biological Oxygen Demand (BOD) loading immediately surrounding the discharge point. This small biodegradable waste stream as it enters the marine environment will be compliant with MARPOL 73/78 Annex IV requirements and discharged at distances of more than 60km from the nearest coastline in highly dispersive oceanic waters. On this basis environmental impacts will be localised and temporary (i.e. 'negligible' – Consequence 1). Given these treated discharges will occur at intermittent periods during the survey period, it is considered very unlikely that impacts to marine fauna will occur. The residual environmental risk assessed for this discharge is assessed as **low**.

5.2.11 Vessel Operation – Putrescible Waste (Food-scrap) Discharges

Background Information and Potential Impacts

The discharge of food-scraps to the marine environment may reduce water quality. Marine fauna, such as fish and seabirds, attracted to the food source may also alter their natural behaviour and increase vessel interactions.

Food-scrap discharges from vessels engaged on the survey will either:

- Macerate wastes on-board to a size which is less than 25mm prior to discharge overboard at a distance greater than 3nm the coast in accordance with MARPOL 73/78 Annex V requirements; or
- Discharge the waste stream at sea at a distance greater than 12nm from the coast in accordance with MARPOL 73/78 Annex V requirements; or
- Freeze for storage on-board with subsequent disposal at an onshore facility.

Volumes of putrescible waste discharged are small and intermittent.

Adopted Control Measures

Controls adopted for all vessels to reduce impacts from putrescible waste discharges include:

- Macerators can achieve the 25mm particle size and are regularly maintained and inspected as per manufacturer's specifications;
- The vessels will operate under a Shipboard Waste Management Plan which details the requirements for collecting, storing, processing and disposing of garbage and all personnel will be trained/inducted into these requirements;
- Placards displayed on the vessel provide guidance on vessel garbage management requirements;
- Food waste disposed overboard will be recorded in the Garbage Record Book;

No other solid or hazardous waste materials (excluding oily water and sewage previously discussed) are disposed overboard.

Inherent in the design of the MSS, Bight is surveying the most prospective parts of the survey area (survey area minimised) and utilising a multi-streamer vessel which minimises the acquisition period.

Environmental Risk Assessment

The intermittent discharge of food-scraps to the marine environment may result in temporary, localised increases in nutrient/Biological Oxygen Demand loading in marine waters immediately surrounding the discharge point. This small waste stream as it enters the marine environment will be compliant with MARPOL 73/78 Annex V requirements and will be discharged at distances of more than 60km from the nearest coastline in the highly dispersive oceanic waters. On this basis environmental impacts will be localised and temporary (i.e. 'negligible' impact, Consequence: 1). It is considered very unlikely that this discharge will impact water quality to the extent that impacts to marine fauna will occur. Also given the constant movement of the vessels, species behavioural changes are not expected. The residual environmental risk for this discharge is assessed as **low**.

5.2.12 Vessel Operation – Air Emissions

Background Information and Potential Impacts

Gaseous greenhouse gas (GHG) emissions such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) together with non-GHG emissions such as NO_x, SO_x, smoke and particulates may be emitted from vessel engines, generators, incinerators (MSS vessel only) and helicopters. The fuel sources used for combustion purposes will be Marine Gas Oil (MGO) or Marine Diesel Oil (MDO) with anticipated consumption of the seismic vessel in the order of 45m^3 per day during MSS activities. These types of emissions can lead to a localised reduction in air quality and contribute to global warming by contributing to the national GHG loading.

Vessels may also use Ozone Depletion Substances (ODSs) in closed system rechargeable refrigeration systems. ODS loss from these systems can contribute to ozone layer depletion.

Adopted Control Measures

Controls to reduce impacts from combustion emissions include:

- MDO/MGO use is compliant with MARPOL Annex VI requirements for total sulphur and will be used to fuel MSS vessels;
- Vessels carry a current International Air Pollution Prevention Certificate (IAPP) (or equivalent equipment specification) to show compliance with MARPOL 73/78 Annex VI. This prescribes the sulphur content of fuel used on-board; operational exhaust treatment systems to prevent excessive NO_x and SO_x emissions for certain categories of engine; and the use of the approved incineration equipment (for oily residue and waste disposal);
- All combustion equipment (engines, plant, incinerator) will be maintained in accordance with Manufacturer's instructions via the vessel's Planned Maintenance System;
- Proactive management of fuel usage on-board the vessels ensures consumption is monitored and benchmarked and corrective action initiated in the event of abnormally high fuel usage;
- The MSS vessel incinerator will be MARPOL compliant. If the incinerators are used, the volumes of waste incinerated will be recorded in the Garbage Record Book.

Controls adopted to prevent the accidental release of ODS include:

- Maintenance of closed system refrigeration systems on-board vessels is undertaken by suitably qualified personnel in accordance with approved procedures; and
- Any repair or maintenance of equipment containing ODS or incidents which involve the accidental release of ODS to the atmosphere is recorded in an ODS Record Book in accordance with MARPOL 73/78 Annex VI

Inherent in the design of the MSS, Bight is surveying the most prospective parts of the survey area (survey area minimised) and utilising a multi-streamer vessel which minimises the acquisition period and presence in the area.

Environmental Risk Assessment

The discharge of combustion products to the marine environment may result in temporary, localised reduction of air quality in the marine environment immediately surrounding the discharge point for the MSS period (i.e. 'negligible' impact, Consequence: 1). This small waste stream as it enters the marine air environment will be compliant with MARPOL 73/78 Annex VI requirements and discharged at distances of more than 60km from the nearest coastline in the highly dispersive oceanic conditions. With the control measures adopted and the constant vessel motion, impacts associated with air quality reduction are considered unlikely. The residual environmental risk for this discharge is assessed as **low**.

The accidental discharge of ODS substances, given the expected volumes in refrigeration systems, will contribute on a minor basis (Consequence: 2) to ozone layer depletion. With maintenance controls implemented, the likelihood of an accidental release is considered very unlikely. The residual environmental risk for this discharge is assessed as **low**.

5.2.13 Non-Routine Incident – Vessel Oil Spill (Collision, Hull Damage)

Background Information and Potential Impacts

The environmental context of the region includes a major commercial shipping channel to the north of the Lightning MSS area which carries larger vessels (container ships, bulk carriers, cruise liners and oil tankers) in closer proximity to coastal areas. Additionally it is expected these vessels operate on "less environmentally friendly" fuels (i.e. Heavy Fuel Oil), and are permitted to discharge treated bilge water at 15ppm which carries higher potential impacts and risks to tourism values in the area compared with the Lightning MSS activity.

An assessment of oil spill risks was performed for the Lightning MSS activity. Given the nature of the activity and the number of adopted controls to prevent interference with seismic streamer equipment and acoustic interference with seismic recordings (i.e. requires clearance from third party vessels by approximately 20km to avoid recording interference), it was determined that a third party vessel collision of sufficient energy to cause hull perforation, whilst an extremely unlikely event, was still credible.

Predictive oil spill trajectory modelling[65] was undertaken for a 300m^3 Marine Gas Oil (MGO) spill incident from a survey vessel at the survey point closest to both Kangaroo Island and Eyre Peninsula (considered to be worst location point in the survey area which would potentially impact on environmental resources). MGO is a commonly used marine fuel which is a mixture of both low and semi-volatile components (95%) and a portion of persistent hydrocarbons (5%); and contains low levels of aromatic (toxic) hydrocarbons. In the marine environment, MGO undergoes rapid spreading and evaporative loss and surface residues quickly disperse and breakup.

For the purposes of assessing oil spill 'impact' thresholds, a surface oiling thickness of 10µm is nominated as the threshold whereby intersecting wildlife (i.e. cetaceans, turtles, birds, pinnipeds) may be impacted, and a surface oiling thickness of 0.5µm (barely visible sheen) is nominated as the threshold for potential amenity impacts to coastal tourism. Shoreline impact thresholds adopted was a hydrocarbon residue accumulation in excess of 100g/m^2. This oiling is considered sufficient to impact upon benthic epifaunal invertebrates on hard substrates (e.g. shoreline rocks) and sediments (mud, silt, sand or gravel).

It should be noted that MGO in the presence of moderate winds (i.e. >12knots) or breaking waves visible surface oil will entrain in the upper water column (~5m). In the period March-May most wind regimes are in excess of 12knots and it is therefore extremely unlikely that visual sheens (i.e. 0.5µm) will be observed.

Predictive modelling identified:

- Surface oiling in thicknesses of 10µm were short-lived present in the environment in proximity to the operational area for approximately 24hrs after the spill incident. Approximately 80% of all spill trajectories with 10µm surface thicknesses remained within 10km of the spill site;
- Visual sheens at a surface thickness of 0.5µm did not persist in the environment for more than 5.5days and are largely confined to Commonwealth waters. However there is a very low probability (1%) of visual sheens entering state waters around the Southern Neptune Islands Marine Park approximately 3-5 days after the spill event but with no direct 'sheen' impact to coastlines predicted. Additionally no visual sheens are expected within the state waters of the Northern Neptune Islands Group, Eyre Peninsula or Kangaroo Island. The nearest predicted sheen from such a spill lies within 15-20km of the western section of Kangaroo Island;
- Aromatic and dispersed phase compounds, localised within the upper levels of the water column (~upper 5m), do not remain in the environment for sufficient time to cause impacts to marine biota;
- No impacts to shoreline environments from accumulated hydrocarbon residues are predicted.

Potential Impacts associated with a large MGO spill in the marine environment include:

[65] Asia Pacific Applied Science Associates (APASA) (2013) - Oil Spill Modelling for Bight Petroleum Seismic Survey, SA

Cetaceans: Cetaceans have smooth skins, limited pelage with limited opportunity for oil adhesion to skin, however surface oil exposure during surfacing events may lead to aspiration hazards present in fresh spills[66]. Exposure could damage mucous membranes or damage airways[67] (Consequence 3). Additionally, Baleen whales which skim the sea surface for food are more likely to ingest oil compared with the 'gulp feeders' or toothed cetaceans[68]. Adhesion of tar-like residues to the whale's baleen plates can adversely affect the feeding of the animal. Refined products, such as MGO, do not carry 'tar-like' hydrocarbon fractions and adhesion is not expected.

Cetaceans may be present in the marine waters of the Lightning survey area however at the time of the survey (March to May), and it is expected that threatened cetacean presence in the area, will be migratory to breeding grounds located in Indonesia (Blue Whale) or southern coastline (Southern Right Whale from mid-May).

Turtles: As for cetaceans, marine turtles through surfacing activities may contact a surface slick which may coat the species and allow for inhalation exposure. On contact with the slick, turtles might experience skin irritation and injury to airways or lungs, eyes and mucous membranes of the mouth and nasal cavities[69]. Evidence from the Montara crude oil spill identified that turtles may exhibit severe dermal pathologies as a result of surfacing behaviour[70] (Consequence 3). Adult sea turtles spend 1-10% of their time at the surface with each dive lasting between 30-70minutes[71] hence the opportunity for impact, if transiting through the survey area, is extremely limited.

Marine turtles may be present in the marine environment of the Bight Basin however their precence will be transitory. No nesting beaches are found in South Australian waters hence hatchlings and juveniles not present in the area.

Pinnipeds: The Australian Sea Lion and New Zealand Fur Seal are present within the region. The closest breeding area for Sea Lions is located at Dangerous Reef (approx. 110km NE of the survey area) and for New Zealand Fur Seals at Liguania Island located 65km to the north. The ZPI defined by the 10µm surface oiling contour does not impact on these sensitive areas however adult male Sea Lions and fur seals (both sexes) may be present on a transitory basis in the Lightning survey area foraging.

Adult fur seals have blubber and do not suffer from hypothermia if oiled. Particular types of oil residue (e.g. sticky oils such as heavy fuel oil not MGO) can 'stick' flippers to sea lion/fur seal bodies preventing escape from predators. Oil residues may also disguise scent that pups and mothers rely upon to identify each other leading to pup abandonment and starvation; and ingestion of oil may damage digestive tracts, suppress immune systems or damage mucous membranes[72] (Consequence 3). Sea Lions spend approximately 35% of the time, when foraging, close to the seafloor.

Migratory Seabirds: Migratory albatross, petrel and shearwater species and skuas and gulls may forage or over-fly the area, however low density presence is expected. Marine seabirds are vulnerable to hydrocarbon spills owing to the high potential for contact at the sea surface where they feed or rest. As most fish survive beneath floating slicks, they will continue to attract foraging seabirds. Oil-coated birds can suffer hypothermia, dehydration, drowning and starvation, and become easy prey. Ingestion of oil can be sub-lethal or acute depending on the type of oil, its weathering stage and inherent toxicity. Effects can include tissue and organ damage, altered metabolism, pneumonia and reduced reproduction capability[73] (Consequence 3). Exposure to impacts from an oil spill is dependent on the method of obtaining prey, with aerial divers such as albatross and petrel species having a lower likelihood of exposure when compared with birds which feed from the sea surface.

[66] GESAMP (2002) The 2002 Revised GESAMP Hazard Evaluation Procedure for Chemical Substances carried by Ships Rep. Stud. GESAMP No 64. 126pp ISSN 1020-4873 ISBN 92-801-5131-2 http://gesamp.imo.org
[67] AMSA, 2011b – The Effects of Maritime Oil Spills on Wildlife including Non-Avian Marine Life available at www.amsa.gov.au
[68] AMSA, 2011b – The Effects of Maritime Oil Spills on Wildlife including Non-Avian Marine Life available at www.amsa.gov.au
[69] AMSA, 2011 – The Effects of Maritime Oil Spills on Wildlife including Non-Avian Marine Life available at www.amsa.gov.au
[70] Gagnon, M.M., Rawson, C. A., 2010. Montara Well Release: Report on necropsies from a Timor Sea green sea turtle. Curtin University, Perth, Western Australia. 15 pages
[71] French-McCay, 2009 – State of the Art and Research Needs for Oil Spill Impact Modelling in proceedings of the 32nd AMOP Technical Seminar on Environmental Contamination and Response, Emergencies Science Division, Environment Canada, Ottawa, ON, Canada pp. 601-653, 2009
[72] AMSA, 2011 – The Effects of Maritime Oil Spills on Wildlife including Non-Avian Marine Life available at www.amsa.gov.au
[73] AMSA, 2011 – The Effects of Maritime Oil Spills on Wildlife including Non-Avian Marine Life available at www.amsa.gov.au

Fish/Sharks: Shark and fish species inhabit all levels of the water column, are mobile and have a transient presence in the survey area. Impacts to shark/fish species would be primarily through exposure to water soluble (aromatic) fractions associated with the oil spill which lie immediately below the surface slick[74]. Adult free-swimming fish seldom suffer any long-term damage from oil spill exposure as any dissolved oil concentrations in marine waters rarely reach sufficient levels to cause harm[75]. Additionally, the dissolved phase components associated with MGO are present in the environment for short periods which re not considered sufficient exposure periods for impacts to arise (Consequence 1).

Eggs, larvae and young fish are comparatively sensitive to oil (particularly dispersed oil) however there are no case histories to suggest that oil pollution has significant effects on fish populations in the open sea. This is partly because any oil-induced deaths of young fish are often of little significance compared with huge natural losses each year through natural predation and because fish spawn over large areas[76] (Consequence 1).

The region supports a significant finfish fishery (sardine and anchovy) with peak spawning periods for the species during January to March. Sardine and anchovy eggs and larvae are widely distributed in shelf waters[77].

Commercial Fishing: Surface oil can foul vessels/equipment used to catch commercial fish and transfer contaminants to the catch. For fisheries operating in the Bight Basin, this would occur when demersal trawl/line and trap or pots are retrieved through surface slicks to the vessel OR if Southern Bluefin Tuna pontoons are caught within the slick (Consequence 2). Studies identify that fish tainting may occur at low hydrocarbon concentration exposures (~250ppb)[78]. Tainting is reversible but, whereas the uptake of oil taint is frequently rapid, the depuration process where contaminants are metabolised and eliminated is slower (weeks to months) making commercial species unpalatable. As the MGO spill is surface based dispersion of hydrocarbons is expected only within the upper 5m of the water column.

Tourism: An assessment of known tourism values within the region within the 0.5µm oil spill footprint has been undertaken and is reflected below:

- Recreational Beach Use (sightseeing, swimming, surfing and snorkelling) and diving (coastal areas): Visual oil sheens are not predicted to impact on regional recreational beaches or diving area. The Northern and Southern Neptune Islands both have rocky shorelines (no beaches). *Hence no recreational beach use tourism-related impacts predicted from a Lightning MSS oil spill;*
- Diving (Heritage Trail): Identified heritage diving areas are located outside areas which have a probability of visual oil sheens from a Lightning MSS oil spill. *No diving-related tourism impacts predicted from a Lightning MSS oil spill;*
- Whale Watching Operations: Lightning MSS activities occur outside the time window for whale watching (June-October) which is predominantly association with coastal Southern Right Whale aggregation. *No impacts expected to whale watching operations from oil spill expected;*
- Charter boating (sightseeing, recreational fishing, diving, marine mammal watching): Charter boats are concentrated around Port Adelaide, Kangaroo Island and the Eyre Peninsula, however charter vessels also utilise the waters surrounding the Northern Neptune Islands for ecotourism (white shark cage diving/pinniped observation) or over both Neptune Island groups for recreational fishing[79];

  As the visible oil sheen does not enter the Northern Neptune Group state waters, *no impacts to ecotourism activities are expected*. Visible oil sheens which enter the waters of the Southern Neptune Islands Group will be small, localised and temporary. It is expected that Charter fishermen present in the area would seek other fishing locations around the islands (suggest possibly on the leeward side not affected by sheen). *Negligible impacts (Consequence 1) to recreational fishing are anticipated*;

[74] International Petroleum Industry Environmental Conservation Association (IPIECA) (2000) - Report Series No 8: Biological Impacts of Oil Pollution: Fisheries downloaded on 2nd July 2012 at http://cleancaribbean.org/ccc_doc/pdf/Vol8_Fisheries.pdf
[75] Source: ITOPF Technical Information Paper No 3: Oil Spill Effects on Fisheries (2010)
[76] AMSA, 2011 – The Effects of Maritime Oil Spills on Wildlife including Non-Avian Marine Life available at www.amsa.gov.au
[77] Pattiaratchi, C., 2007 – Understanding areas of high productivity within the South-west Marine Region, Report prepared for the Department of the Environment, Water, Heritage and the Arts, September 2007 downloaded on June 5th 2012 at http://www.environment.gov.au/coasts/mbp/publications/south-west/pubs/sw-high-productivity.pdf
[78] Davis, H.K., Moffat, C.F., & Shepard, N.J. – Experimental Tainting of Marine Fish by Three Chemically Dispersed Petroleum Products with Comparisons to the Braer Oil Spill, Spill Science and Technology Bulletin, Vol 7, Nos.5-6, pp.257-278, 2002
[79] Explore Australian, 2014–Neptune Islands available at http://www.exploreaustralia.net.au/South-Australia/Eyre-Peninsula-and-Nullarbor/Lincoln-National-Park/Neptune-Islands/Fishing-spot

It is possible Deep Sea Charters may encounter oil sheens in open waters closer to the MSS area. It is considered with the availability of alternate charter locations, together with the small, localised and temporary extent of the visual sheen, impacts to Deep Sea Charters if present will be negligible (Consequence 1).

- Recreational boating (small inshore craft): Recreational vessels (non-charter) are typically small, non-ocean going vessels and are not expected to be present in areas of visible oil sheen. *No impacts to recreational vessels are expected;*
- Yacht Racing: As yacht races are undertaken during periods outside the Lightning MSS time period, *no impacts to yacht racing events are expected from a Lightning MSS spill;*
- Cruise Ships visiting Kangaroo Island: Cruise vessels transiting to Kangaroo Island may transit through areas of visible sheen however the areal extent of the visible sheen will be small. Given the small temporary nature of the sheen, and as the cruise liner is located in shipping lanes where vessels are permitted to discharge oily bilge at 15ppm, it is expected that an observed sheen would have negligible impact to tourists on the vessel;
- Cage Diving with Great White Sharks (Northern Neptune Islands): Anchorages for shark diving occur on the eastern coastlines of Northern Neptune Island (eastern area) in water depths of approximately 12-18m away from the prevailing westerly winds and swell. The western coastline is only suitable in summer during easterly wind regimes[80] [81] (and calm seas) for these activities (i.e. outside the timeframe of the MSS survey). Given no oil sheens are predicted at the Northern Neptune Islands, *no impacts to diving activities are predicted from a Lightning MSS spill.* Transit to this location from Port Lincoln may result in sheen encounter by charter vessels. As before, however, given the sheen is small, temporary and located in shipping lanes to Port Lincoln where vessels are permitted to discharge oily bilge at 15ppm, it is expected that an observed sheen would have negligible impact to tourists present on the charter vessel.

Adopted Control Measures

Control measures to prevent or reduce impacts from a third party vessel collision with a MSS vessel which results in a 300m^3 oil spill include:

- MSS vessels are class certified and carry appropriate safety audit documentation;
- Navigation safety equipment (AIS, navigation lighting, day shapes, Automated Radar Plotting Aid (ARPA) & radio) are present on all vessels and routinely maintained;
- Noise detection from third party vessels is detected in hydrophone equipment (monitored by the seismic crew);
- Notification to AMSA RCC of Lightning MSS activity who will issue AusCoast warnings;
- Notification to AHO to issue a Notice to Mariners for Lightning MSS activity;
- Vessel operated by experienced and competent crew (STWC95) with 24/7 bridge watch;
- Availability of support/chase vessels to detect third party vessels and prevent spatial conflict with third party vessels;
- Third Party Vessel interaction/Response Procedures to prevent interference with MSS Vessel/streamers;
- Availability of approved and tested Vessel Shipboard Oil Pollution Emergency Plan (SOPEP) and Lightning MSS Oil Pollution Emergency Plan (OPEP);
- Notification of the spill via radio to other marine users;
- AMSA is Combat Agency to respond to vessel-based spill in Commonwealth waters;

[80] Rodney Fox Shark Expeditions, 2014 available at https://www.rodneyfox.com.au/index.php/selectedContent/21965891
[81] Shark Cage Diving – Calypso Star Charters, 2014 available at http://www.sharkcagediving.com.au/shark-tours/dive-locations/

- Operational monitoring will take place in accordance with OPEP to support oil spill response and characterise environmental impacts;
- Marine diesel (MGO) rapidly evaporates, spreads to thin layers and has low persistence in the environment.

No landfall impacts identified with largest spill volume.

Inherent in the design of the MSS, Bight is surveying the most prospective parts of the survey area (survey area minimised) and utilising a multi-streamer vessel which minimises the acquisition period and the potential for third party vessel collisions.

Environmental Risk Assessment

Spill Event: In accordance with the Bight Qualitative risk matrix, environmental consequences associated with a Tier 2 hydrocarbon spill (>10tonnes) is considered to have a major impact (Consequence 4) on the marine environment. Analysis of oil spill frequency data from vessel collision data in the eastern Great Australian Bight identifies a frequency for spills under 100tonnes to be 1 event every 1000-10,000years[82]. In absolute terms oil spill frequencies in all Australian sub-regions are considered low to very low[83]. Additionally, based upon a review of the Australian Transport Safety Bureau's (ATSB) marine safety database, there have been no instances of collision, grounding or sinking of a petroleum activity related survey vessel in Australian waters for the past 30 years. On this basis, the likelihood of a collision event, resulting in a 300m^3 spill during the Lightning MSS is considered very unlikely with the preventative controls implemented. The residual environmental risk is therefore assessed as **medium.**

Cetaceans: Cetacean presence is expected to be transitory in the survey area during March to May. It is expected that threatened cetaceans present in the area, will be migrating to breeding grounds located in Indonesia (Blue Whale) or southern coastline (Southern Right Whale from mid-May). Given the rapid spreading and weathering of a MGO spill; and the limited time and spatial area of the surface slick at 10µm (~80% of all spill trajectories occur within 10km of the spill site); it is very unlikely that impacts to whale populations s will result and the residual risk is assessed as **low**.

Turtles: Marine turtle presence in the marine environment of the Bight Basin is transitory. As per cetaceans, given the rapid spreading and weathering of a MGO spill; and the limited time and spatial area of the surface slick at 10µm and the low likelihood of encounter in the survey area; it is very unlikely that significant numbers if turtles will be exposed to harmful thresholds and the residual risk is assessed as **low.**

Pinnipeds: Adult male Sea Lions and fur seals (both sexes) may be present on a transitory basis in the Lightning survey area foraging during the survey period. As per cetaceans, given the rapid spreading and weathering of a MGO spill; and the limited time and spatial area of the surface slick at 10µm; it is considered very unlikely that significant numbers of pinnipeds will be exposed to harmful surface oil thresholds prior to the natural weathering of the slick. The residual risk is assessed as **low.** No shoreline impacts to colonies are predicted.

Seabirds: Migratory albatross, petrel and shearwater species and skuas and gulls may forage or over-fly the area, however low density presence is expected. As per cetaceans, given the rapid spreading and weathering of a MGO spill; and the limited time and spatial area of the surface slick at 10µm; it is considered very unlikely that significant numbers of marine seabirds will be exposed to harmful thresholds prior to the natural weathering of the slick. The residual risk is assessed as **low**

Sharks/Fish: Shark and fish species inhabit all levels of the water column, are mobile and have a transient presence in the survey area. As previously identified dissolved phase impacts associated with an MGO spill are very unlikely to have lethal impacts on adult fish (Consequence 1) due to the limited concentrations and exposure periods associated with the spill and the species mobility within the environment. The residual risk to adult fish is assessed as **low**.

[82] Det Norske Veritas (DNV) (2011) – Final Report: Assessment of the Risk of Pollution from Marine Oil Spills in Australian Ports and Waters (Report No: PP002916 Rev 5, December 2011) – A report prepared for the Australian Maritime Safety Authority
[83] Det Norske Veritas (DNV) (2011) – Final Report: Assessment of the Risk of Pollution from Marine Oil Spills in Australian Ports and Waters (Report No: PP002916 Rev 5, December 2011) – A report prepared for the Australian Maritime Safety Authority

While an oil spill may lead to localised impacts on eggs and larvae which are entrained in the upper water column, fish population impacts are not considered significant given the short period of time dispersed oil components are present in the environment; the predominant movement of the plume parallel to the coastline (i.e. limited shelf ingress into areas where eggs are present) and the limited areal extent of the MGO spill. The residual risk to fish populations is assessed as **low**.

Commercial Fishing: Vessel/equipment fouling from oil residues is possible in the event of a spill (Consequence 2). Most fisheries which may be present in the area during the lightning MSS are demersal, however with notifications to marine users in the event of a spill, it is considered that vessel/equipment fouling impacts are very unlikely and the residual risk is **low**.

With regard to fish tainting, as the MGO spill is surface based, dispersion of hydrocarbons within the upper 5m of the water column is expected. Commercial fishing known to be undertaken in the area involving pelagic species include Southern Bluefin Tuna. The Small Pelagic Fishery and Southern Squid Jig Fishery are not expected to be present in the MSS area and other pelagic fisheries such as the Sardine Fishery and Marine Scale-fish Fishery operate well inshore from the Lightning MSS area. Based upon MGO weathering characteristics areas of entrained (dispersed) hydrocarbon concentrations which may cause fish tainting are considered small and if a spill occurs will move in a plume parallel to the coastline. In the March timeframe, if SBT pontoons are present and should an MGO spill occur, dispersed oil will remain in deeper waters parallel to the coastline and tainting is considered very unlikely. The residual risk is assessed as low.

Tourism: As previously identified, regional tourism activities which may be impacted from a Tier 2 MGO spill from the Lightning MSS area include:

- Charter Boating (sight-seeing, recreational fishing, marine mammal watching) within the Southern Neptune Island Group state waters may experience small, localised and temporary oil sheens leading to recreational fishermen seeking other fishing locations around the island (possibly on lee side). Impacts are considered negligible (Consequence 1) to fishing activity occurring, and given the probability of an oil spill occurring is very low, the residual risk is assessed as **low.**
- Deep Sea Charters (game fishing) may encounter small, localised and temporary oil sheens in open waters closer to the MSS area and alternate fishing locations may be sought. Impacts to this activity is considered to be negligible (Consequence 1) and very unlikely. The residual risk is assessed as **low**.
- Cruise Ships visiting Kangaroo Island may transit through small areas of visible sheen (Consequence 1) however given the environmental context (i.e. heavy commercial shipping lane) it is very unlikely that a sheen in this area, located at least 15-20km from the western end of Kangaroo Island, would impact on tourist values (real or perceived) in the area. The residual risk is assessed as **low**.

Spill Response Strategy:

In the event of a spill, it is expected a natural weathering/surveillance monitoring strategy will be adopted.

5.2.14 Non-Routine Incident – Chemical/Oil Spill through Deck Drainage System

Background Information and Potential Impacts

Chemical inventories on-board the survey vessels are minimised to the extent practicable. Packaged chemicals/oils used on-board during seismic operations are limited to small quantities of cleaning products, solvents, cable fluid, hydraulic oils, paints and primers, and lithium batteries. These chemicals/oils could potentially leak during handling and enter the marine environment through the deck drainage system. The volume of liquid which could be released will be small and limited to the volumes of individual containers stored on deck. Spills to the marine environment may lead to impacts to marine fauna through contact with contaminated water residues.

Adopted Control Measures

Control measures implemented on the seismic vessel to minimise chemical handling risk include:

- Chemical/oil hazards are isolated from the deck drainage system (i.e. stored in suitable containers in appropriately bunded areas); and
- Information is available to all personnel on chemical/oil handing (i.e. Material Safety Data Sheets are available for all chemicals and hydrocarbons).

On-board deck drainage consists of two distinct areas; drainage from bunded areas (containing chemicals/oils and areas at high risk of spills); and open deck areas which handle 'uncontaminated' water runoff (wash down water, rainwater and sea-spray). To minimise the marine contamination risk from deck drainage the following controls are implemented:

- Deck bunding (e.g. tubs, scupper placement, etc.) provided for temporary activities where there is an increased risk of oil/chemical spill;
- Spill kits are strategically placed near high risk spill locations on all vessels;
- Routine inspection of bunded areas and spill kits undertaken on all vessels to ensure they are adequately stocked and clearly labelled;
- All personnel are aware of appropriate hydrocarbon/chemical spill response requirements through vessel induction;
- Spills are cleaned up immediately, reported through the vessels incident reporting system and contaminated material contained on-board for on-shore disposal;
- Marine impacts from deck wash-down waters minimised by utilising biodegradable detergents; and
- High standards of house-keeping are maintained on decks.

Vessels will utilise their SOPEP (or equivalent) to respond to vessel-sourced oil spills. Vessel spill exercises are conducted on a routine basis.

Environmental Risk Assessment

Spill Event:

Given the packaged chemical/oil volumes used and stored during seismic operations are small in volume, the consequence of any chemical spills on deck which entered the marine environment are assessed as minor (i.e. Consequence 2). With the safeguards adopted, the likelihood of chemical spills entering the environment is considered unlikely and the residual environmental risk is assessed as **low**.

Spill Response Strategy:

In the event of a spill, it is expected a natural weathering/surveillance monitoring strategy will be adopted.

Given the small spill volumes involved, the very limited area where marine impacts might be experienced; and the rapid evaporation/dispersion of MGO, impacts to protection priorities if present (whales, turtles, seabirds, sharks) are expected to be negligible (Consequence 1) and exposure considered very unlikely. The residual risk associated with the adoption of a natural weathering/monitoring response stragegy to these protection priorities is assessed as **low**.

5.2.15 Non-Routine Incident – Refuelling Spill

Background Information and Potential Impacts

A common source of oil spill in offshore marine operations is associated with refuelling (bunkering) activities. Causal pathways include hose breaks, coupling failures and tank over-fill. Spill volumes associated with offshore refuelling activities, which utilise equipment such as dry-break couplings are estimated at the volume of the transfer hose (i.e. typically a volume less than $1m^3$). Note for the Lightning MSS refuelling will preferentially occur in port facilities rather than at sea (i.e. at sea refuelling is a contingent activity and will be the exception). Spills to the marine environment may lead to impacts to marine fauna through contact with contaminated water residues.

Adopted Control Measures

If refuelling activities are undertaken offshore the following controls will be applied:

- Activity will be fully supervised, in accordance with documented bunkering procedures, Job Hazard Analysis or Permit-to-Work Permit using trained personnel;
- A Toolbox meeting in undertaken before bunkering operations commence;
- Refuelling will only occur during suitable weather conditions, good visibility, during daylight hours and will be fully supervised;
- Refuelling equipment is routinely inspected, tested and maintained;
- Tank levels are monitored so they are not over-filled;
- The transfer area will be bunded with spill kits in the event of a spill or leak; and
- SOPEP/SOPEP equipment (or equivalent) is available, and tested, to respond to spill by appropriately trained personnel.

Based upon oil spill trajectory modelling undertaken for large spill scenarios and screening calculations a refuelling spill will cover a small spatial area will rapidly disperse/evaporate.

Environmental Risk Assessment

Spill:

The consequence associated with a refuelling spill/leak has been conservatively assessed as having minor consequences (i.e. localised marine water impacts with rapid evaporation/dispersion - Consequence 2). Given the implementation of the nominated control measures and also that refuelling at sea will be on an exception basis, spills to the marine environment are considered unlikely and the residual environmental risk is considered **low**.

Spill Response Strategy:

In the event of a spill, it is expected a natural weathering/surveillance monitoring strategy will be adopted due to the type and volume of the hydrocarbon released.

Given the small spill volumes involved, the very limited area where marine impacts might be experienced; and the rapid evaporation/dispersion of MGO, impacts to protection priorities if present (whales, turtles, seabirds, sharks, pinnipeds) are expected to be negligible (Consequence 1) and exposure considered very unlikely. The residual risk associated with the adoption of a natural weathering/monitoring response strategy to these protection priorities is assessed as **low**.

5.2.16 Non-Routine Incident – Solid Non-biodegradable/Hazardous Waste Overboard

Background Information and Potential Impacts

During the Lightning MSS, small quantities of solid non-biodegradable wastes such as plastic packaging; and hazardous wastes, such as used chemical containers, batteries, waste oils, may be produced.

Solid, non-biodegradable wastes disposed overboard have the potential to damage benthic habitats or marine fauna may ingest (particularly turtles or marine seabirds with respect to plastics) or become entangled in the waste. Disposal of oils and chemical residues overboard reduce water quality and may expose marine fauna to toxic impacts.

Survey vessels engaged for the Lightning MSS will operate under Vessel Garbage Management Plans compliant with MARPOL 73/78 Annex V requirements. Guidelines for the development of Garbage Management Plans revolve around three complementary principles to manage garbage: source reduction, recycling, and disposal (i.e. waste minimisation hierarchy).

Adopted Control Measures

Waste protocols adopted on the vessels will include:

- A 'No solid or hazardous waste overboard' policy;
- All wastes are appropriately containerised (i.e. with lids to prevent wind-blown material (plastics) or rain ingress), labelled and stored in dedicated areas which are routinely inspected and maintained with high levels of house-keeping;
- For the seismic vessel allowable wastes and oily residues may be combusted in the on-board incinerator approved under MARPOL 73/78 Annex VI requirements;
- Hazardous wastes (used oils, lithium batteries, chemical and metallic wastes) are segregated and stored on-board and either disposed onshore in accordance with SA waste disposal regulations;
- Training and reinforcement to all crew (& other) personnel of waste management requirements and
- Solid/hazardous waste disposal records are documented in the Garbage Record Book.

Environmental Risk Assessment

Solid non-biodegradable/hazardous wastes will be handled in accordance with the vessel's Garbage Management Plans and will work to a 'no solid non-biodegradable/hazardous waste overboard' policy. Hence under normal operation no impacts to the marine environment will be incurred, however, it is possible that accidental releases (e.g. small amounts of wind-blown packaging) to the marine environment may occur. In this instance the material will be small in volume however for materials such as plastic, fauna impacts (i.e. mortality) may occur. On this basis the impact is considered moderate (Consequence: 3). With the on-board controls implemented with respect to inspection and waste containment standards, the likelihood of such an incident occurring during the survey is considered very unlikely and the residual risk assessed as **low**.

5.2.17 Non-Routine Incident – Seismic Streamer Release

Background Information and Potential Impacts

Seismic streamer loss can create marine debris hazards leading to impacts to fisheries (equipment) or might lead to benthic habitat impacts through physical contact.

Adopted Control Measures

Controls which are adopted to prevent the loss of streamers in the marine environment include the following:

- Seismic streamers undergo regular inspection and maintenance system checks on bridles and harnesses for wear and damaged components. These components are replaced on an 'as required' basis;
- During operation a secondary retaining/attachment device is utilised to prevent streamer loss (i.e. system redundancy); and
- The solid-state seismic streamer contains buoyancy devices which allows for support vessel surface retrieval if lost; and are fitted with marker buoys and radar reflectors which allows for rapid location and identification of the lost equipment.

The seismic vessel will operate using approved procedures for streamer retrieval. All relevant personnel will be trained in these procedural requirements.

Should a seismic streamer release occur during the survey, other marine stakeholders (primarily fisheries) will be notified of the incident and its' location.

Environmental Risk Assessment

As the streamer is fitted with buoyancy, the potential for disturbance to benthic communities is considered extremely unlikely.

Temporary loss of a seismic streamer to the marine environment may create minor impacts (interference with fishing equipment, etc.) (Consequence 2) to other marine users, if present, however with the controls adopted to prevent loss from occurring, the recovery procedures available and notification to relevant stakeholders, the likelihood of disturbance occurring is considered very unlikely. The residual environmental risk associated with this temporary impact is assessed as **low**.

5.2.18 Non-Routine Incident – Seismic Streamer Liquid Release

Background Information and Potential Impacts

Solid seismic streamer will be utilised for the Lightning MSS. While the streamer primarily contains solid material which cannot leak, there are certain small sections within the streamer which contain hydrocarbons.

Perforation of these streamer sections due shark-bite or third party vessel impact may lead to small amounts of hydrocarbon release. The maximum release volume to the environment is estimated to be 720litres resulting from a third party vessel impact across all streamer tail sections.

Liquid release from shark bites to streamers is much lower in volume (~60litres (max)).

Adopted Control Measures

Controls which are adopted to prevent the loss of hydrocarbon contained in the streamers and any associated environmental impacts to the marine environment include the following:

- Adoption of 'vessel collision controls' as detailed in **Section 5.2.13**;
- As part of deployment, streamers are checked for integrity to prevent liquid leaks to the environment
- Solid streamers are utilised which contain small volumes of liquid;
- The hydrocarbons utilised are low-odour, low aromatic hydrocarbons with low acute and chronic toxicity; moderate biodegradability; little environmental persistence; a low water solubility and is volatile which rapidly evaporates in air

Environmental Risk Assessment

Spill:

The consequence associated with a streamer perforation is considered to have temporary, localised impacts[84] (i.e. Consequence: 2) given the type of liquid, limited quantity released and the rapid dispersion experienced while the vessel is moving. Also as only small sections of the streamer which contain liquid, and with preventative (refer vessel collision controls) controls implemented, the incident is considered very unlikely during the MSS campaign. The residual environmental risk, associated with streamer perforation is assessed as **low**.

Spill Response Strategies:

In the event of a spill, it is expected a natural weathering/surveillance monitoring strategy will be adopted due to the type and volume of the hydrocarbon released.

Given the small spill volumes involved, the very limited area where marine impacts might be experienced; and the rapid evaporation/dispersion of the hydrocarbon, impacts to protection priorities if present (whales, turtles, seabirds, sharks, pinnipeds) are expected to be negligible (Consequence 1) and likelihood of exposure considered very unlikely. The residual risk associated with the adoption of a natural weathering/monitoring response strategy to these protection priorities is assessed as **low.**

[84] This has been assessed on largest spill volume (i.e. third party vessel collision with streamers).

5.2.19 Non-Routine Incident – Marine Mammal Collision

Background Information and Potential Impacts

Vessels associated with the Lightning MSS will be operating on a 24/7 basis for the duration of the survey. All vessels pose a collision risk to cetacean (including dolphins and porpoises) and pinniped species. The Lightning MSS area is recognised as having habitats which may support the presence of these marine mammals and it is possible that these species may transit the survey area during the survey period.

Studies[85] have identified that larger vessels moving in excess of 10knots may cause fatal or severe injuries to cetaceans, with the most severe injuries caused by vessels travelling faster than 14knots. Vessel strikes are also identified as a threat to Sea Lions.

The EPBC Regulations 2000 (Part 8), recognise the potential for interference and damage to cetacean species associated with vessel interactions. These regulations prescribe proximity distances between vessels and cetaceans, and also vessel management practices when a cetacean is observed, including vessel speed and vessel course change.

The MSS vessel will transit at low speeds (typically less than 5knots) during seismic acquisition. Operational acoustic sources together with vessel sound create conditions such that cetaceans avoid the immediate vessel area. Bight considers the MSS survey vessel, as a slow moving and restricted manoeuvrability vessel with an operating array, does not present a significant collision risk to pinnipeds.

Support/escort vessels generally travel at higher speeds to effectively patrol the requested clearance zone around the MSS vessel/towed array and possibly have a higher level of encounter and impact potential compared with the MSS vessel.

Adopted Control Measures

Controls which are adopted to prevent collisions with marine mammals during the survey period include the following:

- All MSS vessel operations conform to proximity distances and management measures contained in EPBC Regulations 2000 (Part 8) for cetaceans (includes dolphin and porpoises) in the operational survey area;
- Support Vessel Masters observe ‘dolphin’ speed restrictions and proximity distances as required in the EPBC Regulations 2000 (Part 8) for pinniped species; and
- All crews will complete an environmental induction covering these requirements.

Environmental Risk Assessment

Cetaceans and pinnipeds are known to transit through the Lightning MSS area and may have a presence in the area during the MSS period. Cetaceans and pinnipeds (to a lesser degree) will avoid the areas around the operating MSS vessel and vessels with high sound signatures. A vessel strike to a cetacean has been assessed as a significant consequence (Consequence 3), however with the control measures implemented (low speed, proximity distances and vessel sound deterrents) the likelihood of collision is assessed as very unlikely. On this basis the residual environmental risk is assessed as **low.**

[85] Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S., & Podesta, M., 2001 – Collisions between Ships and Whales, Marine Mammal Science, Vol. 17, Issue 1, pp35-75

6 Summary of Arrangements for Ongoing Monitoring of Environmental Performance

Bight Petroleum, as the Titleholder for petroleum activities within EPP-41 and EPP-42, is responsible for ensuring the Lightning MSS activity is managed in accordance with the accepted Lightning MSS Environment Plan (EP) such that environmental performance outcomes (EPOs) are achieved. The selected seismic contractor will undertake the survey operations on Bight Petroleum's behalf and, under contractual arrangements with Bight Petroleum, will implement and comply with all environmental controls and procedures nominated in this EP.

To achieve this outcome, at contract award, Bight Petroleum will review the management system of the Seismic/Vessel Contractor against ISO14001 requirements as it relates to the implementation of commitments within the accepted EP (i.e. a gap analysis). Key aspects of this assessment will include contractor organisational roles and responsibility review; environmental hazard and risk assessment processes; emergency (oil) response arrangements; operational procedures available to support environmental management of hazards; management of changes procedures; crew training needs analysis and associated records; vessel induction requirements; work activity assessment processes; incident reporting, investigation and corrective action management; inspection procedures; emissions and discharge monitoring; and audit and review processes. Bight recognises that due to the short duration of this MSS activity and the crew's familiarity with the ship-based systems, contractor processes should be utilised wherever possible. However, to ensure that the specific requirements of the Lightning MSS EP are integrated and implemented into contractor systems, gaps identified during the assessment of the contractor's management system, will be documented and implemented via a bridging document which will define the agreed procedures and additional/supplemental requirements to be adopted during Lightning MSS activity.

Particular attention will be paid in the bridging document to:

- Utilise Bight Petroleum's Risk Management Framework for the assessment of environmental risk for the Lightning MSS activity;
- Identify crew positions responsible for the implementation of control measures identified within this EP (i.e. control measure 'custodians') to inform on required control measure performance standard, notification requirements and delivery of records to verify performance;
- Identify 'reportable incidents' to be observed for the Lightning MSS and the internal notification/reporting requirements to meet regulatory timeframes and content requirements;
- Identify vessel inspection programs included as a 'control measure' in this EP, ensuring the scope of the inspection addresses the relevant performance standard requirement;
- Identify EPOs for the Lightning MSS and the required reporting, via the vessel's incident management process, where EPOs are not achieved;
- Identify crew positions who maintain records which quantify emissions and discharges and the requirement to provide these records to the Bight Offshore Representative;
- Ensure all corrective actions/opportunities for improvement arising from incidents, audits, inspections, monitoring events are documented in the Vessel's on-board Vessel Action Tracking System and monitored for closure;
- Identify events associated with the survey which may result in a change which may trigger a revision to the NOPSEMA-accepted EP and the processes to be implemented to assess for necessary document revisions;
- Oil spill response arrangement for the Lightning MSS which must be observed and the pre-survey exercise activities to be conducted.

Bight shall adopt the following methodology to ensure compliance with, and deliver EPOs listed within, the accepted Lightning MSS EP:

- Pre-survey audits/information provision from the seismic contractor will determine 'hardware' and procedural compliance of the contractor and vessels engaged to the EP standard requirements prior to survey commencement;

- The existing Contractor management systems will be bridged with specific Lightning EP requirements. Control measure 'custodians' will be identified for relevant control measure implementation and a daily report provided to the Bight Offshore Representative on compliance and effectiveness (as relevant);

- An environmental induction program will advise all survey personnel of relevant environmental sensitivities; identified environmental hazards, their EPOs and relevant incident reporting requirements if not achieved; and 'reportable incidents';

- The Bight Offshore Representative shall collate daily environmental parameters (e.g. waste streams, maritime compliance, cetacean mitigation and incident reporting outcomes) to determine EPO attainment and control measure implementation;

- The Bight Offshore Representative will undertake an EP Compliance Audit and an EP implementation review against the Lightning Project Specific Bridging Plan to determine the effectiveness of the 'bridged' Bight requirements into the Contractor's management system; and

- The Bight Offshore Representative will obtain all relevant records to provide verification of discharges, incidents, etc. at the completion of the survey

Bight Petroleum adopts a philosophy of continuous improvement. Learnings from seismic survey performance, incident investigations and field activity reviews will be documented and incorporated as improvement actions for future MSS activities.

7 Oil Pollution Emergency Plan Response Arrangements Summary

The Lightning MSS, as a petroleum activity in Commonwealth waters, has prepared an Oil Pollution Emergency Plan (OPEP) as part of the Environment Plan which will be implemented in the event of an oil spill during the Lightning MSS activity.

All vessels engaged for the Lightning MSS will carry approved Shipboard Oil Pollution Emergency Plans (SOPEPs) as required by MARPOL 73/78 Annex I. The SOPEP is the principle working document for the vessel's crew in the event of a marine oil spill and details specific management response actions to mitigate and combat oil spills originating from vessels. SOPEPs recognise, and integrate with, the divisions of responsibility defined under the Australian National Plan for Maritime Environmental Emergencies (NATPLAN). The Australian Maritime Safety Authority (AMSA) is the legislated Combat Agency[86] for any vessel-based spill in Commonwealth waters including vessels involved with the Lightning MSS. In the event of a spill, the affected Vessel Master will notify and take direction from AMSA to respond to the spill.

Bight Petroleum under the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* is responsible for oil spill incidents from petroleum activities, however recognises AMSA's legislated responsibilities. In the unlikely event of an oil spill during survey activities, Bight Petroleum will monitor and liaise with AMSA, the affected Vessel Master, Seismic Contractor and Offshore Bight Representative and provide assistance as required. Bight Petroleum will undertake all necessary statutory notifications under the OPGGSA. An immediate action checklist is provided within the OPEP.

Prior to survey activity commencement, a campaign-specific oil pollution emergency drill will be undertaken by all parties with an interest in the vessel operation (i.e. Bight Petroleum, Seismic Contractor and engaged vessels) to ensure that oil spill response arrangements are fully understood, tested and all supporting resources are available.

During an oil spill, operational monitoring will be undertaken to provide information to the spill response, to identify environmental impacts and determine when response termination criteria have been achieved. In the event of a Tier 2 oil spill (>10tonnes) from Lightning MSS vessels, Bight Petroleum will monitor for oil impacts to environmental sensitivities and if oil is detected at levels which may cause environmental impact to the particular sensitivity undertake any additional scientific monitoring considered necessary (e.g. wildlife, water quality).

[86] The Combat Agency has responsibility to take operational control and respond to an oil spill in the marine environment.

8 Consultation Details

Stakeholder consultation associated with the Lightning 3D MSS commenced in 2011 and throughout 2012 and 2013. All stakeholder comments and records obtained over that period have been provided and assessed to NOPSEMA as part of this Environment Plan acceptance.

8.1 Details of Consultation Undertaken

Consultation associated with the Lightning MSS has involved the following phased process:

- An initial stakeholder listing was identified through:
  - A review of relevant legislation applicable to Commonwealth waters petroleum and marine activities;
  - Identification of marine user groups in the area (possible recreational/commercial fisheries, fishing industry groups, merchant shipping, eco-tourism providers);
  - Identification of marine 'interest groups' (i.e. technical and scientific entities); and
  - Industry/Company support groups.
- Initial targeted consultation commenced in October 2011 with the following process adopted:
  - Stakeholder letters containing information describing the proposed survey, together with background information related to seismic surveys, was originally sent in late October/early November 2011. Bight Petroleum sent out consultation letters to all identified persons or organisations that it considered had functions or activities which might be affected by the survey activity (i.e. those responsible for various aspects of regulation in the area and those having activities in the area such as the fishing industry and researchers), in addition to persons and organisations which might consider themselves as having interests in the area (e.g. Environmental Non-Government Organisations (eNGOs)).

    Most people or organisations having functions or activities in the survey area responded to the introductory letter and consultation has continued with those parties. Persons that Bight Petroleum considered may have functions or activities in survey area who did not respond were subsequently contacted by telephone calls and/or personal visits.

    Many of the persons or organisations that Bight Petroleum considered may have interests in the survey area did not respond. Bight Petroleum did not subsequently seek to make contact with these persons or organisations but did enter into genuine engagement with those that did respond. As a result of this strategy, Bight Petroleum considers that comprehensive consultation has been carried out with all persons or organisations that have functions or activities in the Survey area whereas those persons or organisations that may have interests in the area have been provided with the appropriate level of information to meet their requirements.
  - A second stakeholder letter was sent out in early May 2012. This second letter anticipated that the survey would be acquired sometime between January and April 2013 (this altered timeframe was in response to initial consultation feedback indicating there was a higher likelihood of encountering blue whales in the November-December period. Subsequent to this letter the survey timing was subsequently changed to the March – May period to further accommodate stakeholder feedback).

    Further interaction continued such as face to face meetings, teleconferences or emails and other correspondence (e.g. detailed and lengthy written questions and answers).
  - All stakeholders and members of the public were kept informed about the survey and engaged through the publication of extensive documentation, with invitation for further comment under two EPBC Referral processes, EPBC Referral 2012/6583 and EPBC Referral 2013/6770. Public consultation occurred during the following periods:

- 16-29 October 2012 (EPBC Referral 2012/6583);
- 4-19 March 2013 (EPBC Referral 2013/6770); and
- 21 November – 24 December (EPBC Referral 2013/6770 - Public Comment on Preliminary Documentation).

Preliminary Document provided detailed information about the survey to stakeholders and the general public and included:

- Information providing a rationale and analysis supporting survey planning;
- An assessment of survey alternatives;
- Sound Exposure Modelling for the Bight 3D seismic survey in the eastern Great Australian Bight, South Australia (CMST. Report C2012-36, 23 July 2012);
- Monitoring and Mitigation Measures proposed for Survey, and supporting information supplied to the Department of Environment (DoE) regarding the proposed mitigation and monitoring measures; and
- Documentation and responses to questions relating to mitigation measures, PAM, sound exposure levels at biologically important areas near the survey, and interaction and potential impacts to SBT.

This package was reviewed and assessed prior to publishing by the DoE and advertisements were placed into local, state and national papers inviting feedback and comment advising how stakeholders could access the information. Additional hardcopies of the document (including attachments) were sent to regional libraries and central libraries in Adelaide and Canberra to provide an additional avenue for access. General media also extended the coverage of this publication.

Preliminary Documentation responses were received and collated and a copy of all correspondence received was sent to the DoE for their review. Bight collated a response document to the correspondence received. The response document was reviewed and assessed by the DoE prior to publishing to ensure that all objections had been properly considered. The response document was published on the Bight Petroleum website on 2nd January 2014 with associated general media coverage and all stakeholders advised of its location.

All information received from stakeholders during the initial consultation rounds and the two EPBC processes were utilised in the collation of the Environment Plan which was submitted to NOPSEMA for acceptance.

As a result of this consultation process, the following stakeholders and interested parties have been identified and consulted as part of the stakeholder engagement process for the Lightning MSS:

Commonwealth Department or Agency

- Australian Fisheries Management Authority (AFMA)
- Australian Maritime Safety Authority (AMSA)
- Australian Hydrographic Office (AHO)
- Department of Resources, Energy & Tourism (DRET) (now Department of Industry (DoI)
- Geoscience Australia
- National Offshore Petroleum Safety & Environmental Management Authority (NOPSEMA)
- Department of Agriculture, Fisheries and Forests (DAFF) now Department of Agriculture
- Department of Sustainability, Environment, Population and Communities (SEWPC) (now Department of Environment (DoE))

South Australian Departments or Agencies

- Department of Environment Water and Natural Resources (DENR)
- Department of Primary Industry and Resources of South Australia (PIRSA) (Fisheries)
- Department of Primary Industry and Resources of South Australia (PIRSA) (Petroleum) now Department for Manufacturing, Innovation, Trade, Resources and Energy (DMITRE)
- Department of Transport, Energy & Infrastructure (SA)
- Department of Planning, Transport and Infrastructure (DPTI)
- Kangaroo Island Council
- Council District of Lower Eyre
- Eyre Region Development Board
- Flinders Ports
- Port Lincoln Council
- Ports SA

Fishery-interest Groups

- Australian Southern Bluefin Tuna Industry Association (ASBTIA)
- Great Australian Bight Fishing Industry Association (GABIA)
- SA Recreational Fishing Advisory Council (SARFAC)
- Sardine Fishing Industry Association (SASIA)
- South Australian Rock Lobster Advisory Council (SARLAC)
- SA Aquaculture Council
- Marine Fishers Association of SA
- Individual Fishing Companies (Small Pelagic Concession Holders, SA Marine Fisheries)
- Commonwealth Fisheries Association (CFA)
- South-east Trawl Fishing Industry Association (SETFIA)
- Sustainable Shark Fishing Inc.
- Southern Squid Jig Fishery
- Individual Fishing Companies (Small Pelagic Concession Holders, SA Marine Fisheries)

Scientific Interest Group

- Blue Whale Study Group[#]
- Defence Science and Technology Organisation (DSTO)
- South Australian Research and Development Institute (SARDI)
- Commonwealth Scientific and Industrial Research Organisation (CSIRO)
- SA Museum
- CEBEL – Flinders University

Non-Government Organisations

- Conservation Council of South Australia (CCSA)
- International Fund for Animal Welfare (IFAW)
- Kangaroo Island Eco-action

- Kangaroo Island Dolphin Watch
- Kangaroo Island Marine Action Group (KIMAG)
- Migratory Wildlife Network (MWN)
- Pew Environmental Group
- Australian Conservation Foundation
- Australian Marine Conservation Society
- Greenpeace
- The Wilderness Society
- World Wildlife Fund
- The Nature Conservancy
- Whale and Dolphin Conservation Society (WDCS)
- Wildcatch SA
- Shipping Australia
- Aboriginal Legal Rights Movement
- Port Lincoln Aboriginal Community Council
- SA Chamber of Mines and Energy

Individuals

- Federal Member for Grey
- Federal Member for Mayo
- State Member for Finness
- State Member for Flinders
- State Member for Goyer
- SA Greens Senator – Penny Wright
- SA State Minister for Manufacturing, Innovation, Trade, Resources and Energy
- SA State Minister for Agriculture, Food and Fisheries, Regional Development
- SA State Minister for Sustainability, Environment and Conservation
- Dean Lukin

Recreational Groups

- Boating Industry Association of SA

Feedback obtained from this process has allowed for the development of a communication and engagement strategy for relevant stakeholders to determine the level, type, 'triggers' and schedule of on-going engagement throughout the Lightning MSS. Bight Petroleum will maintain communications with stakeholders identified in this communication and engagement strategy component of the EP to ensure they are informed of relevant aspects of the survey or changes that may affect them. This will include on-going operational liaison through direct contact, and announcement of survey milestones and dissemination of biota sightings via the Bight Petroleum website.

8.2 Merits of Stakeholder Objections and Claims

An assessment of the merits of objections or claims about the adverse impact of the Lighting MSS was made, and where practicable those with merit were incorporated into the survey design. The following objections and claims were identified (note where possible these have been grouped into common themes):

- **Marine Safety:** A group of stakeholders were concerned about shipping safety and freedom of passage during the MSS activities. All suggested control measures relating to AMSA RCC notification to initiate AusCoast warnings, AHO notification to issue a Notice to Mariners for the activity, vessel utilisation of navigation safety equipment and compliance with the directions provided by maritime regulatory authorities have been adopted to minimise disruption to commercial shipping and maintain freedom of passage to commercial vessels through the survey area (refer **Section 5.2.2** and **Section 5.2.13**).
- **Commercial Fishing:**
    - *SBT Fishing Impacts/Conflicts*: ASBIT had significant issues associated with the proposed survey timing during the January-March timeframe and its possible disturbance to SBT fishing and possible impacts on aerial surveys which determine tuna quotas. Consultation activities with ASBTIA determined suitable controls for the MSS activity to proceed. This included altering the survey to the March-May timeframe with specific controls to be adopted by Bight for MSS activities undertaken during March where there is the possibility of SBT pontoon presence on adjacent shelf areas. These controls have been agreed and incorporated in the **Section 5.2.3**.
    - *Inshore fishery survey timing conflicts*: Inshore fisheries were concerned with fish dispersion associated with the survey and impacts to bi-annual sardine egg production survey if undertaken in January/February 2013. They supported a move to undertake the MSS between October and December. The revised survey timing could not be adopted due to conflicts associated with 'peak presence' of Blue whales in the region during November and December however survey timing was revised to the March-May timeframe to avoid bi-annual sardine egg production survey conflicts. Fish dispersion impacts are unlikely from MSS activities due to the bulk of the sardine catch being undertaken inshore and well away from the MSS area. The altered MSS survey timing is provided in **Section 3**.
    - *General recreational./commercial fishing impacts/conflicts*: Review of available fishing data for the region and feedback from fishing stakeholders has identified that the MSS area, besides SBT fishing, is not heavily fished from a commercial or recreational basis. Additionally, the MSS area is too far from the coastline to have an impact on coastal recreational fishing. Bight remains in communication with the representatives of fishing industry bodies to advise on the progress of survey activities.
- **EPBC Protected Matters Impacts:**
    - *Survey Timing (Impacts to breeding and feeding marine species and seabirds)*: Various activity windows have been assessed with the original timeframe set between November-April (original stakeholder letter). The selected window of time (March-May) considers the varying environmental sensitivities in the area such as Blue Whale peak presence[87] (November to December [peak feeding activities]); Southern Right Whale presence [mid-May to November] and Sperm Whale peak presence (August and September[88]); SBT 'peak' ranching (January to February) and a weather window which is suitable for the vessel to acquire data efficiently. On this basis the window March-May minimises the presence of environmental sensitivities while providing suitable weather conditions to achieve survey objectives. This timing requirement is

[87] A recent survey undertaken by the International Fund for Animal Welfare (IFAW) between 26th April and 8th May 2013 reported no encounters of Blue or Southern Right Whales in the proposed survey area. This corresponds with data from aerial surveys carried out in the survey region during March/April in previous years. Although Sperm Whales were acoustically and not visually detected, the majority of Sperm Whale acoustic detections were off shelf waters in depths greater than 500m.

[88] This season also encounters extreme sea and weather conditions and data acquisition in these conditions would mask the received acoustic signal. Significant OHS risk is also present and due to the limited survival of equipment in these conditions and its constant retrieval, the survey period would be extended considerably.

reflected in the activity scope (refer **Section 3**). Additional control measures to be implemented during the Lightning MSS (refer **Section 5.2.6**) reduce the risk of disturbance to marine species to a level which is both acceptable and as low as reasonably practicable.

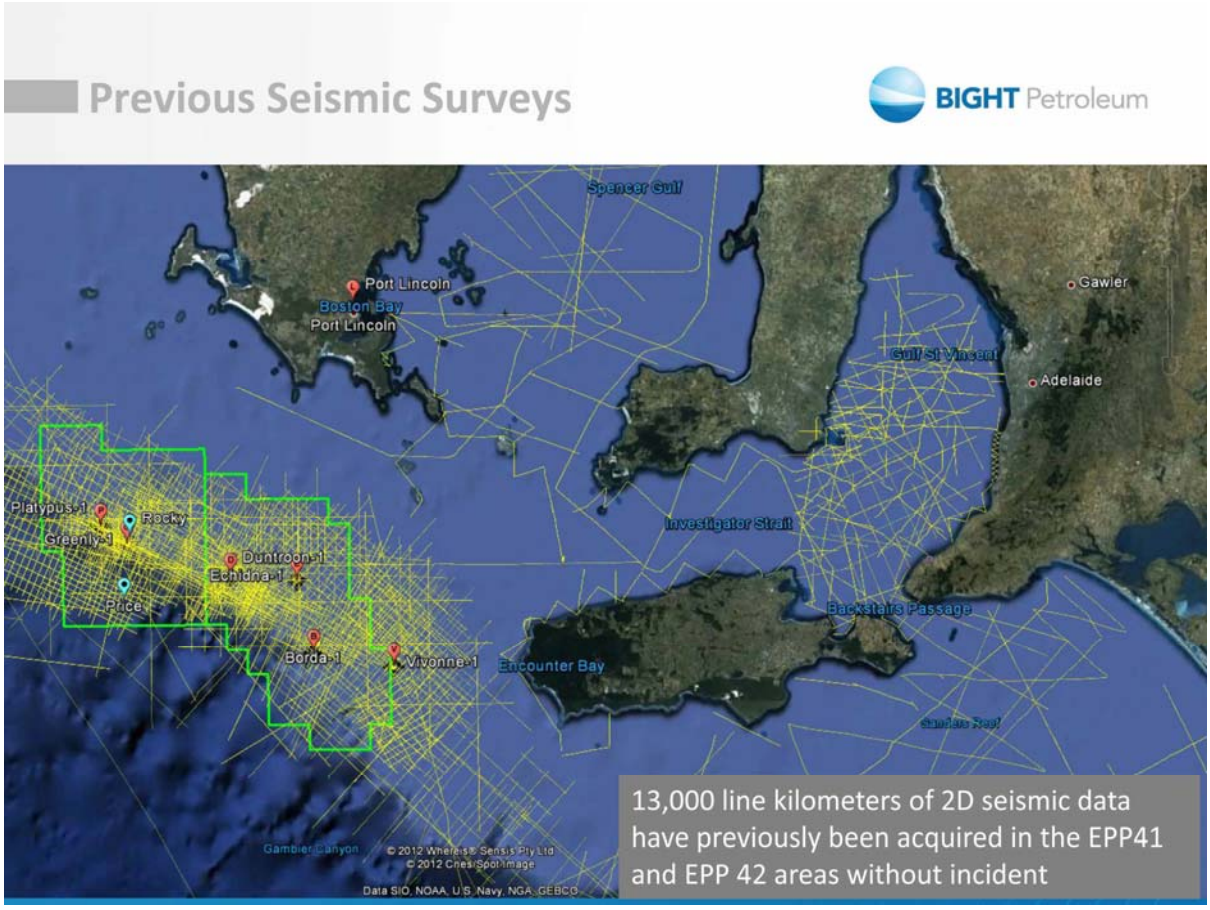
- *Additional Baseline Surveys*: Bight has participated in pre-survey baseline studies during 2011/12 (November-March) to assess for the presence of Blue Whales, other cetaceans and other marine species in the area in preparation for Lightning MSS activities. Further baseline studies were also undertaken by IFAW in 2013 to verify the presence of whales during the April-May period. A collective baseline dataset has been established which has been used for MSS planning and will be supplemented by observations made during the Lightning MSS. *No further baseline monitoring is considered warranted.*
- *Additional Aerial Surveillance during MSS activities:* The Lightning MSS will adopt vessel-based surveillance surveys with support/escort vessels (with MMOs on-board) during the survey however one aerial survey will be undertaken at the commencement of the survey to inform the adaptive management strategy for the survey. Vessel-based surveillance with MMOs are considered an effective way of identifying the presence of whale species particularly with the proposed adaptive management measures of scanning ahead of the survey vessel and surveillance in areas of night-hour acquisition. Additionally, vessels are always present in the survey area, whereas aerial surveillance is limited by weather conditions and endurance of the aircraft selected. These controls are reflected in **Section 5.2.6**. *On this basis, additional aerial surveillance during the survey is not considered to add sufficient value nor be a superior option to the vessel-based surveillance and will not be adopted for the survey.*
- *Enhanced Mitigation Measures (i.e. use of PAM):* The use of PAM for this survey has been assessed. Towed PAM has been used to detect whales that vocalise at high frequencies/intensities such as Sperm Whales during seismic surveys and can enhance the effectiveness of visual monitoring. PAM systems adopted during non-seismic surveys, can also assist in detection of long-period deep-diving species, which do not have a surface presence as do the Baleen Whales. Additionally, PAM has the advantage of potentially detecting cetaceans during night hours and periods of poor visibility when they cannot be visually detected. PAM has been incorporated as a control within **Section 5.2.6**.
- *Acoustic Seabed Loggers*: This equipment was considered for the MSS and could be deployed on the seabed in the vicinity of key sites such as Southern Right Whale calving areas to gather information about the sound environment. However, based on modelling previously carried out and empirical measurements available along other Southern Margins continental shelf MSS activities, sound arrivals at biologically important areas inshore are going to be at ambient conditions. All sea-bed acoustic logger measurements, conducted on the Southern margins continental shelf showed rapid attenuation towards the coast (refer **Section 5.2.6**). It is noted that this is not considered a management or mitigation measure as it will not inform the survey activities. *No seabed logging is proposed for this survey.*
- *Sonobuoys*: Stakeholder feedback suggested that sonobuoys should be considered as a management measure to detect baleen whales in the vicinity of the moving MSS vessel during survey activities. Bight has evaluated the potential for deployment of sonobuoys over the survey area to detect baleen whales in the vicinity of a moving platform and has discussed this issue with the Australian Antarctic Division (AAD) and other researchers. Bight's has assessed this measure to be highly research oriented with the procurement and deployment of such equipment difficult (perhaps impossible). The operational logistics of deploying large numbers of sonobuoys is significant and Bight is concerned about environmental issues of allowing them to sink to the seabed after their operational life. Additionally, it is foreseeable that there would be significant issues in transmitting signals recorded at the sonobuoy to the seismic vessel in real time given they are detecting low frequency, long time series vocalisations for use in rapidly implementing management measures. *Accordingly the survey will not to deploy sonobuoys as a management measure during the Lightning MSS.*

- *Independent Monitoring during Survey*: Stakeholder feedback suggested that independent monitors for marine fauna impacts should be considered for the survey activities. Independent monitoring of marine fauna impacts during survey activities 'at sea' will be undertaken by the MMOs present on all survey vessels. This information will be provided at the end of the survey to both the DoE and NOPSEMA together with an assessment of environmental performance against the control measures adopted. *No additional independent monitoring is considered warranted for the survey.*

- **Impacts to Eco-tourism**: A thorough assessment of all environmental impacts associated with the Lightning MSS identifies little to no risk to eco-tourism within the region. This has been conveyed to stakeholder groups in the "Response to Public Comments regarding EPBC Referral 2013/6770" (refer **Section 5.2.5**, **Section 5.2.6** and **Section 5.2.13**). .
- **Cumulative Seismic Impacts**: Bight has considered the cumulative impacts from proposed simultaneous survey activities in the Bight Basin (which are separated by 120km) and provides the following:
  - Given the distances involved between the two survey activities, residual sound arriving in the Lightning MSS area from the adjacent survey will be at ambient sound levels and not considered to contribute any additional sound impacts to the sound generated by the Lightning MSS activities. Additionally as the Lightning MSS is limited in timeframe, the area will quickly return to background levels of sound (e.g. routine ship sounds ~190dB re 1µPa);
  - In other areas of the world where seismic exploration activity occurs at greater frequencies and in closer proximity to each other (i.e. Gulf of Mexico, North Sea or North West Shelf), "time-sharing" occurs (generally when the surveys are within 40km of each other depending upon transmission losses in the area) so the seismic signals from one survey do not impact on data collected from the other survey. This is because the returning signals of interest in a survey (i.e. signals which have travelled through the seabed and reflected from geological horizons) are not significantly greater than ambient sound levels in the ocean. Often, returning signals could be at or below ambient sound levels in some sea conditions and this often triggers weather standby in survey activities. On the basis that sound level interference between two seismic surveys is considered unacceptable[89] at lower sound levels than those established to impact on marine life, it is considered that cumulative sound impacts to marine species from adjacent survey activities is not significant (i.e. negligible).
- **Oil Spills from well fault activation:** MSS activities are undertaken with compressed air and will not affect geological fault seals. Naturally occurring seeps within the GAB remain unaffected by the Lightning MSS activity. This has been conveyed to stakeholder groups in the "Response to Public Comments regarding EPBC Referral 2013/6770".
- **Inadequate Consultation:** As identified in **Section 8-1** significant levels of consultation have been undertaken for this activity. Concerns and issues arising from this consultation have been thoroughly assessed and adopted into this EP where practicable and relevant.
- **Objection to Hydrocarbon Exploration**: Feedback from a number of stakeholders identified a general opposition to hydrocarbon exploration in the region, despite these activities having been conducted in the area for the past 40 years (refer **Figure 8-1** for past survey activity in the area). A 'do nothing' approach by Bight Petroleum (i.e. no survey) does not align with obligations contained in work-plans approved as part of the permit release with the Australian Government and cannot be considered.

[89] This is due to the deterioration of quality of the seismic data.

Figure 8-1: Previous MSS Activity in EPP-41 and EPP-42



9 Contact Details

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