CYGNUS SOUTH WEST MARINE SEISMIC SURVEY

ENVIRONMENT PLAN SUMMARY

Spectrum Geo Pty Ltd

May 2017

ABBREVIATIONS

Abbreviation	Description
3D	Three dimensional
°C	Degrees Celsius
µPa	Micropascal
AA	Access Authority
ACF	Australian Conservation Foundation
ADIOS	Automated Data Inquiry for Oil Spills
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AHO	Australian Hydrographic Office
AHS	Australian Hydrographic Service
AIMS	Australian Institute of Marine Science
AIS	Automatic Identification System
ALARP	As Low as Reasonably Practicable
AMOSC	Australian Marine Oil Spill Centre
AMSA	Australian Maritime Safety Authority
APPEA	Australian Petroleum Production and Exploration Association
AQIS	Australian Quarantine Inspection Service
AUD	Australian Dollars
BACI	Before-after-control-impact
BIAs	Biologically Important Areas
CEO	Chief Executive Officer
CFA	Commonwealth Fisheries Association
Cmlth	Commonwealth
CMR	Commonwealth Marine Reserve
COLREG	International Regulations for Preventing Collisions at Sea 1972
CSA	Cetacean Sighting Application
Cui	Cubic inch
CV	Company values
DAFF	Department of Agriculture, Fisheries and Forestry (Cmlth)
DAHs	Dissolved Aromatic Hydrocarbons
dB	Decibels
DER	Department of Environmental Regulation
DMAC	Diving Medical Advisory Committee
DMP	Department of Mines and Petroleum (WA)

Abbreviation	Description
DoD	Department of Defence
DoF	Department of Fisheries (WA)
DoT	Department of Transport (WA)
DPaW	Department of Parks and Wildlife (WA)
DoE	Department of Environment (Cmlth)
ECR	Environmental Compliance Register
EMBA	Environment that May Be Affected
EP	Environment Plan
EPA	Environmental Protection Authority
EPBC	Environment Protection and Biodiversity Conservation
EPO	Environmental Performance Outcome
EPSs	Environmental Performance Standards
ERA	Environmental Risk Assessment
ESD	Environmentally Sustainable Development
GHG	Greenhouse gas
GIP	Good Industry Practice
HFO	Heavy Fuel Oil
HSE	Health Safety Environment
HSE MS	Health Safety Environment Management System
Hz	Hertz
IAPP	International Air Pollution Prevention
ICT	Incident Control Team
IFO	Intermediate fuel oil
IMS	Invasive Marine Species
IMT	Incident Management Team
IOPPC	International Oil Pollution Prevention Certificate
ISPPC	International Sewage Pollution Prevention Certificate
IUCN	International Union for Conservation of Nature
JHA	Job Hazard Analysis
JRCC	Joint Rescue Coordination Centre
JSA	Job Safety Analysis
KEF	Key Ecological Feature
Khz	Kilo hertz
km	Kilometre
km/hr	Kilometres Per Hour

Abbreviation	Description
km^2	Square Kilometres
L	Litre
LCS	Legislation, Codes and Standards
m	Metres
m/h	Metre per hour
m/s	Metres Per Second
m^3	Cubic Metres
MARPOL	International Convention for the Prevention of Pollution from Ships
MC	Measurement criteria
MEER	Maritime Environmental Emergency Response
MGO	Marine Gas Oil
mm	Millimetres
MMA	Marine Management Area
MFO	Marine Fauna Observer
MNES	Matters of National Environmental Significance
MOC	Management of Change
MP	Marine Park
MSS	Marine Seismic Survey
NEBA	Net Environmental Benefit Analysis
NES	Matters of national environmental significance
NOPTA	National Offshore Petroleum Titles Administrator
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NOx	Oxides of Nitrogen
NTM	Notice to Mariner
NWMR	North West Marine Region
ODS	Ozone Depleting Substance
OPEP	Oil Pollution Emergency Plan
OPGGSA	Offshore Petroleum and Greenhouse Gas Storage Act 2006
OPGGS (E) R	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
OSCP	Oil Spill Contingency Plan
PERR	Post-survey Environmental Review Report
PJ	Professional Judgement
PPA	Pearl Producers Association
PPE	Personnel Protective Equipment
PMS	Planned Maintenance System

Abbreviation	Description
ppm	Parts Per Million
psi	Pounds per square inch
PTS	Permanent Threshold Shift
QHSE	Quality, Health, Safety and Environmental
QPAR	Quarantine Pre-arrival Report
RBA	Risk Based Analysis
RCC	Rescue Coordination Centre
SDS	Safety Data Sheet
SEA	Survey Environmental Advisor
SEEMP	Ship Energy Efficiency Management Plan
SEL	Sound Exposure Level measured as dB re 1 µPa^2·s
SIMOPs	Simultaneous Operations
SITREP	Marine Pollution Situation Report
SMPEP	Shipboard Marine Pollution Emergency Plan
SNA	Safe Navigation Area
SOLAS	Safety of Life at Sea
SOM	Safety Operations Manual
SOP	Standard Operating Procedure
SOPEP	Shipboard Oil Pollution Emergency Plan
SOx	Oxides of Sulphur
SPA	Special Prospecting Authority
SPL	Sound Pressure Level measured as dB re 1 µPa
STCW	Standards of Training, Certification & Watchkeeping
SV	Societal Values
SW	Southwest
TTS	Temporary Threshold Shift
WA	Western Australia
WAFIC	Western Australian Fishing Industry Council
WDCS	Whale and Dolphin Conservation Society
WWF	World Wildlife Fund

Table of Contents

1 INTRODUCTION

The geophysical company Spectrum Geo Pty Ltd (Spectrum) proposes to acquire a multi-client three-dimensional and two-dimensional marine seismic survey (Cygnus SW MSS) within the Browse basin offshore from Western Australia (WA).

1.1 Purpose

The content of this Environment Plan (EP) Summary has been developed to address all of the elements required by the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 OPGGS (E) R following the Guideline for Environment plan summaries (N04750-GL1566) released by NOPSEMA in July 2016.

1.2 Details for Spectrum's Nominated Liaison Person

Details for Spectrum's Nominated Liaison Person for the activity are as follows:

Name:	Danny Chan
Business address:	105 St Georges Terrace, Perth
Telephone number:	08 9322 3700
Email address:	danny.chan@spectrumgeo.com

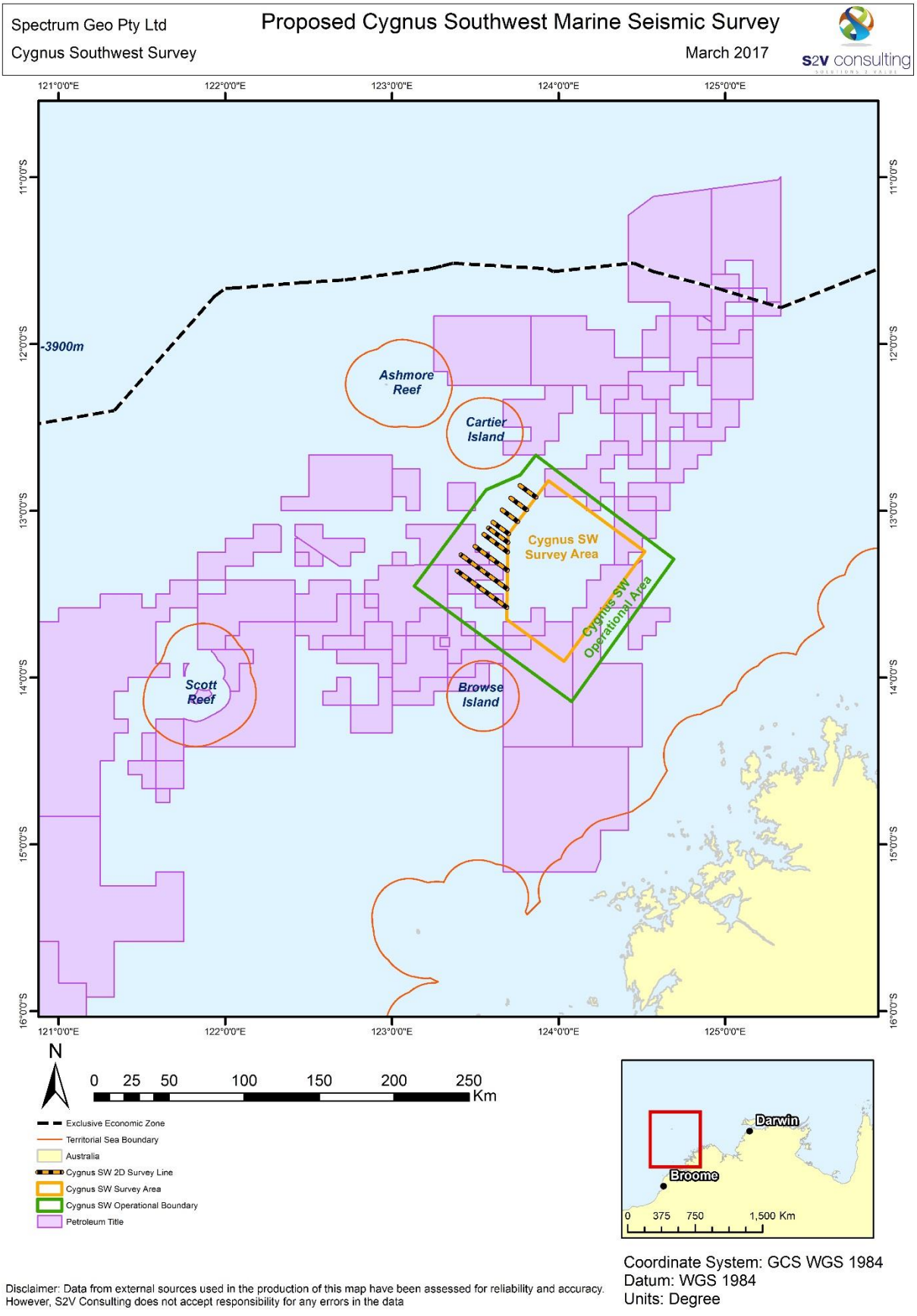


Figure 1-1: Cygnus SW MSS Location Map

2 DESCRIPTION OF THE ACTIVITY

2.1 Location of the Activity

The area of the approved EP covers Petroleum Exploration Permits and open acreage areas. For the purpose of this survey Spectrum will obtain the relevant Special Prospecting Authority (SPA) and Access Authority (AA) to enable Spectrum to assume the role of the titleholder for the survey. The operational area is located solely in Commonwealth waters adjacent to Western Australia. The MSS will consist of a 'survey area' and a larger 'operational area' (**Figure 1-1**).

The Cygnus SW MSS may be acquired as a single survey, or as separate surveys (not concurrently) dependent on weather, vessel availability and regulatory and operator financial approvals with the total acquisition time taking 3 months.

2.1.1 Survey Area

The maximum survey area extent is approximately 6,331km^2 over the 3D survey area, and includes a total of 191 km over the nine identified 2D sail lines as shown in **Figure 1-1**. The survey is located entirely within Commonwealth waters. The survey area is defined by that area which contains seismic coverage for the purpose of imaging the subsurface (i.e. the seismic source is discharged at full power within the survey area and along the 2D survey lines only). The survey vessel will not enter State waters at any point during the activity.

Water depths in the survey area are in the range of 3 to 430 m, although the vessel will not fire the seismic source in water depths less than 50 m, with the shallowest water depths located around Heywood shoal.

The survey area shown in **Figure 1-1** indicates the area within which 3D seismic will occur. In addition, the 2D lines shown will be acquired. The vessel will traverse the pre-determined 2D sail lines with the streamers deployed, and the source shut down when at the end of the line, the vessel will then turn and return to the 3D survey area or to the start of the next 2D line. A soft start will then be commenced.

2.1.2 Operational Area

The operational area is used for conducting operations ancillary to achieving full-fold coverage within the survey area. Activities conducted in the Operational Area include: acoustic emissions below full power for the purpose of 'soft start' or 'fauna alert' procedures; miscellaneous maintenance operations; and, vessel turns at the end of each sail line, necessary for the vessel to change to a new sail line. The distances from the nearest land and Commonwealth Marine Reserves are provided in Table 3-2.

2.1.3 Exclusions

During the activity both spatial and temporal exclusion zones will exist with regard to the location of the activity in the following areas:

- Seismic source will not be fired in less than 50 m water depth
- Seismic source will not be fired within 200 m of the identified Heywood Shoal 50m bathymetry contour
- The Cygnus SW MSS will not be conducted during 1st January to 30th April inclusive
- During the peak turtle nesting period of 1st November to last day of February (as identified in **section 5.6.2**) vessels shall not acquire the four northernmost 2D sail lines closest to the Cartier Island CMR, therefore maintaining a minimum distance of 45km from the Cartier Island CMR boundary within which the seismic source is fired at full power.

+ No refuelling will take place within 26 km of the Cartier Island CMR

2.2 Activity Duration and Timing

The activity could take place at any time between May 2017 and December 2019; except for during the period 1st January-30th April inclusive. To allow for contingency in event of shut down periods, weather or equipment/vessel issues, a duration of 90 days is assessed for in this EP. If the survey is conducted in phases, there may be a period of time between the activities being undertaken, however, the total duration of the separate surveys will take 3 months. If this does occur, this will trigger new commencement notifications to stakeholders as per **Section 9**.

2.3 Seismic Programme

2.3.1 Survey Parameters

The MSS proposed is a typical 2D and 3D survey similar to most others conducted in Australian marine waters (in terms of technical methods and procedures). No unique or unusual equipment or operations are proposed. The survey will be conducted using a purpose-built seismic survey vessel.

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

Given the geology and depth of the environment in the operational area, it is considered that to achieve the survey objectives the most suitable operating pressure of the seismic energy source will be approximately 2,000 pounds per square inch (psi) with the source deployed in two to three arrays firing in a flip-flop or flip-flop-flap configuration, with each source carrying a volume of up to 3,090 cubic inch (cui).

The seismic receiver array is intended to comprise approximately 10-12 streamers, with a length of approximately 9 km each. The streamers are towed side by side with a spacing of 100 -125 m between each streamer. Streamer depth will be approximately 8 – 30 m. The 2D component of the MSS will be acquired using the same parameters as the 3D survey along the defined 2D sail lines. A summary of the seismic survey parameters are provided in the table below.

Table 2-1: Cygnus SW MSS acquisition parameters

Parameter	Value
No. of streamers	10-12
Streamer length	9,000 m
Streamer tow depth	12-30 m
Size of airgun array	≤3,090 cui
Operating pressure	2,000 psi
Source interval	12.5 m
Source depth	5-10 m
Streamer spacing	100-125 m

Parameter	Value
Peak source sound pulse (SPL)	228 dB re 1 µPa-m (at 1 m)
Frequency range	10-2,000 Hz (most energy <650 Hz)

The Cygnus SW MSS will be conducted in water depths ~50 m to 430 m with the shallowest water depths located around the identified Heywood shoal. Therefore, it is unlikely that any of the towed equipment will make contact with the seabed or benthic communities.

2.4 Vessels

Spectrum proposes to conduct the MSS using a suitable survey vessel that will have all necessary certification/ registration and will be fully compliant with all relevant MARPOL and SOLAS convention requirements for a vessel of this size and purpose.

One support vessel will accompany the survey vessel, which will provide logistical, safety and equipment management support and will be rigged and capable of towing the seismic vessel in the case of an emergency. The support vessel will also manage interactions with other vessels in the vicinity such as fishing/commercial vessels, charter/diving operators, etc. A chase vessel will be utilised in addition to a support vessel to provide additional assistance in managing these interactions, and other safety-related duties as required.

The support or chase vessel may enter State waters for example to chase a third party vessel, retrieve dropped objects (floating) or for other safety reasons.

2.5 Survey Vessel Refuelling

Vessel refuelling (with marine gas oil (MGO)) at sea may occur during the activity. Refuelling will only occur within daylight hours and providing weather and sea state conditions are suitable, and at the discretion of the Vessel Master. There will be no refuelling within State waters or within 26 km of Cartier Island CMR. Helicopters will be used to transfer crew and assist in HSE or operational emergencies as required. Crew changes are expected to occur every 35 days by helicopter.

3 DESCRIPTION OF THE ENVIRONMENT

3.1 Environment That May Be Affected (EMBA)

The area that may be affected will encompass the environment that could be affected by unplanned events as this provides for the largest potential area that could be impacted. This area is derived from modelling worst case scenarios which are attributed to spills.

Three credible spill scenarios were identified to help inform the environment that may be affected (EMBA) as outlined in **Table 3-1** below.

Table 3-1: Summary of largest credible hydrocarbon spill scenarios

Scenario	Hydrocarbon Type	Maximum Credible Volume	Comment	Section
Hydrocarbon spill (MGO) during refuelling	Marine Gas Oil (MGO)	37.5 m^3	Maximum credible volume based on 15 minutes of flow at a pumping rate of 150 m^3/hr.	6.5
Hydrocarbon spill (MGO) from vessel collision		365 m^3	Maximum credible volume based on largest fuel tank on survey vessel.	6.6
Non-hydrocarbon release (surface) liquid	Lube oil/chemicals	1 m^3	Stern lube oil from the vessel thruster/propeller	6.4

The worst case credible spill scenario (loss of inventory in 1 fuel tank due to vessel collision) has been modelled (Section 6.6.2) to identify the worst case environmental extent that may be affected by this activity. The extent of the EMBA is shown in **Figure 3-2**. Prior to acquiring the survey vessel for the proposed Activity, the largest volume fuel tank will be confirmed to ensure the risk assessment is appropriate.

3.2 Physical Environment

The slope is relatively flat, but includes a number of large canyon heads that were probably excavated during and after continental break-up by sediment and water movements (DEWHA, 2007).

There a number of reefs and islands in the Kimberley system of the NWMR within (Heywood Shoal) and adjacent to the Cygnus SW MSS operational area as summarised below. For further description of the benthic habitats associated with shoals in the region see section 3.3.4. Bathymetry of the operational and survey area is provided in Figure 3-1.

The proposed operational area lies entirely in Commonwealth marine waters of the North West Marine Region (NWMR) covering water depths between approximately 3 m to 430 m, although the seismic source will not be fired in water depths less than 50m. The distance from the operational and survey areas to the nearest features are provided in Table 3-2.

Table 3-2: Distances from operational and survey area

Feature	Distance from Operational Area	Distance from Survey Area
Cartier Island CMR	29	45
Browse Island	31	49
Cartier Island	33	50
Ashmore Reef CMR	74	95
Ashmore Reef	78	104
Seringapatam Reef	119	176
Nearest mainland	133	152
Scott reef	143	191
Adele island	180	201
Nearest turtle BIA (green)	14	31
Nearest Whale BIA (pygmy blue)	18	47
Nearest seabird BIA	Overlaps - Greater Frigatebird - Lesser Frigatebird - Red-footed Booby - White-tailed Tropicbird - Wedge-tailed Shearwater	1.7km - Greater Frigatebird - Red-footed Booby
Nearest fish BIA (Whale shark)	Overlaps	Overlaps

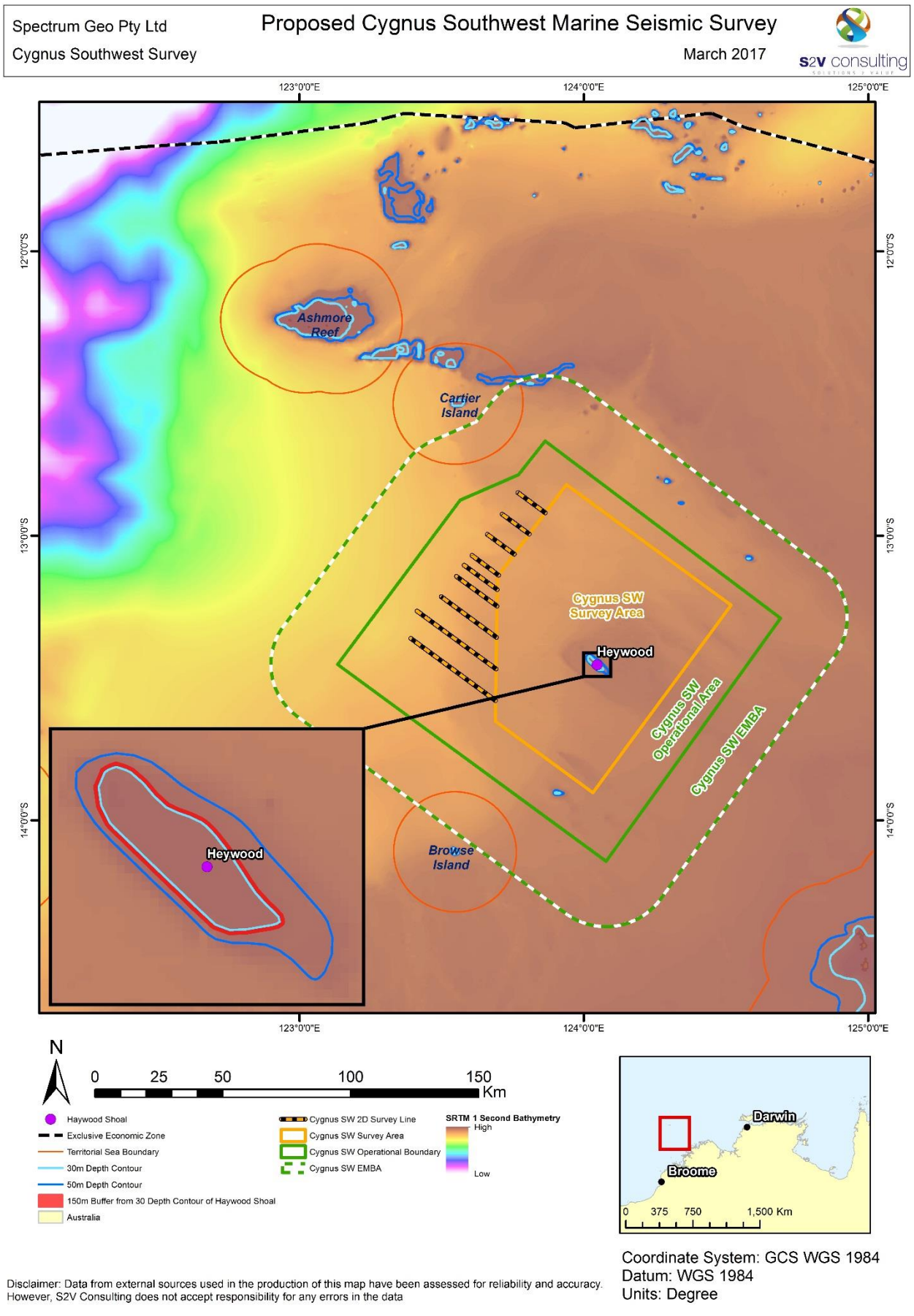


Figure 3-1: Bathymetry in the operational and survey area

3.3 Biological Environment

3.3.1 Marine Bioregions

The operational area lies within the Northwest Marine Region (NWMR). The area potentially impacted by planned and unplanned events during the activity covers four bioregions; the Northwest Shelf Province, the Northwest Transition, the Northwest Shelf Transition and The Timor Province and are described below (DSEWPAC, 2008).

3.3.1.1 Northwest Shelf Province

The Northwest Shelf Province Bioregion is located primarily on the shelf between North West Cape and Cape Bougainville. The bioregion has a total area of 238,759 km2 and contributes to 19.6 % of the total area of the North-west Marine Region. Water depths within the bioregion range from 0-200 m, with more than 45% of the bioregion having a depth of 50-100 m (DSEWPaC, 2008).

The Northwest Shelf Province is located almost entirely on the continental shelf, except for a small area to the north of Cape Leveque that extends onto the continental slope. The shelf gradually slopes from the coast to the shelf break, but displays a number of seafloor features such as banks/shoals and holes/valleys. The dynamic oceanic environment influences sediment distribution throughout the bioregion. The seafloor of this bioregion is particularly strongly affected by cyclonic storms, long-period swells and large internal tides, which can resuspend sediments within the water column as well as move sediment across the shelf (DSEWPaC, 2008).

3.3.1.2 Northwest Transition

The Northwest Transition is located off the shelf between the Dampier Archipelago and Lacepede Islands. The majority (52 per cent) of the Northwest Transition bioregion occurs on the continental slope, with smaller areas in the north-west of the bioregion located on the Argo Abyssal Plain and continental rise. Other topographic features within the bioregion include areas of rise, ridges, canyons and apron/fans. The bioregion also has reefs such as Mermaid, Clerke and Imperieuse reefs, which are collectively known as the Rowley Shoals.

The benthos of the deep ocean areas of the Northwest Transition is likely to support meiofauna. Mobile benthic species, such as deepwater sea cucumbers, crabs and polychaetes are likely to be associated with the seafloor, and the bioregion may support sparse populations of bentho-pelagic fish and cephalopods in low densities.

The Rowley Shoals are a hotspot for biodiversity in this bioregion and contain intertidal and subtidal coral reefs. The reefs are important stepping stones in the maintenance of gene flow among the north-west Australian coral reefs.

3.3.1.3 Northwest Shelf Transition

The Northwest Shelf Transition extends from Cape Leveque to the eastern end of Melville Island (in the North Marine Region). The majority of the Northwest Shelf Transition is located on the continental shelf, with only a small area extending onto the continental slope. Consequently, water depths throughout the bioregion are shallow, ranging between 0–330 m, but the majority of the bioregion has water depths of 10–100 m (Baker *et al*. 2008). The shelf includes a diversity of topographic features, such as submerged terraces, plateaux, sand banks, canyons and reefs.

The Northwest Shelf Transition contains a number of geomorphic features that are largely absent from other areas of the North-west Marine Region. In particular, this bioregion contains 90 per cent of the Region's carbonate banks/shoals (Baker *et al*. 2008). The complex seafloor topography of the Northwest Shelf Transition is reflected in its sedimentology. Sediments in this bioregion are characteristically different from other areas of the Region, as they tend to be dominated by soft muds,

which are the result of relict mud deposition as well as modern carbonate and terrigenous mud deposition (DEWHA 2008).

3.3.1.4 Timor Province

The Timor Province is located on the continental slope and includes topographic features such as the Scott Plateau, the Ashmore Terrace, and part of the Rowley Terrace, as well as a portion of the Argo Abyssal Plain. The Scott Plateau is a significant geomorphic feature. It occurs in water depths of 2000–3000 m and is fringed by numerous spurs and valleys. It is separated from the Rowley Terrace by canyons including the Bowers Canyon. These canyons are believed to be up to 50 million years old and were excavated by sediment and water movements during the long evolution of the Region (DEWHA 2008).

3.3.2 Key Ecological Features and Protected Areas

A summary of the CMRs, Marine Parks and KEFs overlapping with the operational area and the EMBA potentially impacted by unplanned events is given in **Table 3-3** below and shown in **Figure 3-3** and **Figure 3-3**, with further description in the sections that follow.

Table 3-3: KEFs and Protected areas overlapped by Cygnus SW MSS and EMBA

Feature	Survey area	EMBA
Commonwealth Marine Reserves (CMR)	None	None
State Marine Parks	None	None
Key Ecological Features (KEFs)	+ Ancient coastline at 125 m depth contour 3D survey area only) + Continental Slope Demersal Fish Communities (2D lines only)	+ Ancient coastline at 125 m depth contour + Continental Slope Demersal Fish Communities

3.3.2.1 Marine Reserves

The operational area is in close proximity (29 km) with the boundary of Cartier Island CMR although the operational area and EMBA do not overlap with the CMR as described in **Table 3-4** and **Figure 3-3**. Ashmore Reef CMR is located 60 km north west of the CMR. The management plan for Ashmore Reef and Cartier Island CMRs expired on 25 June 2009. Until a new management plan comes into effect there will be no changes to management arrangements for the renamed Cartier Island Marine Reserve and Ashmore Reef National Nature Reserve (DoEE, website accessed 28 Feb 2017). As such, mining activities (including seismic surveys) are prohibited to be carried out within the CMRs as per the 2002 Management plan of the Ashmore Reef and Cartier Island CMRs.

A description of the CMRs highlighted in **Table 3-4**, and the environmental sensitivities within them, is provided below as well as the management objectives of the marine reserve.

Table 3-4: Management Objectives of Relevant Commonwealth Marine Reserves

Commonwealth Marine Reserve	IUCN Zone	Management Objective	How Survey Meets Requirement
Ashmore Reef	IUCN II Recreational Use Zone	Protected and managed to preserve its natural condition	Seismic vessel will not conduct activities described within this EP within 60 km of reserve therefore no planned or unplanned impacts could occur within the designated area of the CMR including the wetlands, reefs and beaches.

Commonwealth Marine Reserve	IUCN Zone	Management Objective	How Survey Meets Requirement
	IUCN Ia Sanctuary Zone	Managed primarily for scientific research or environmental monitoring	Seismic vessel will not conduct activities described within this EP within 60 km of reserve therefore no planned or unplanned impacts could occur within the designated area CMR including the wetlands, reefs and beaches.
Cartier Island	IUCN Ia Sanctuary Zone	Managed primarily for scientific research or environmental monitoring	Seismic vessel will not conduct activities described within this EP within 29 km of the CMR boundary therefore no planned or unplanned impacts could occur within the designated area. Noise modelling does not predict that sound pressure levels will be above behavioural thresholds for turtles or cetaceans at the CMR boundary, further detailed in Section 5.6

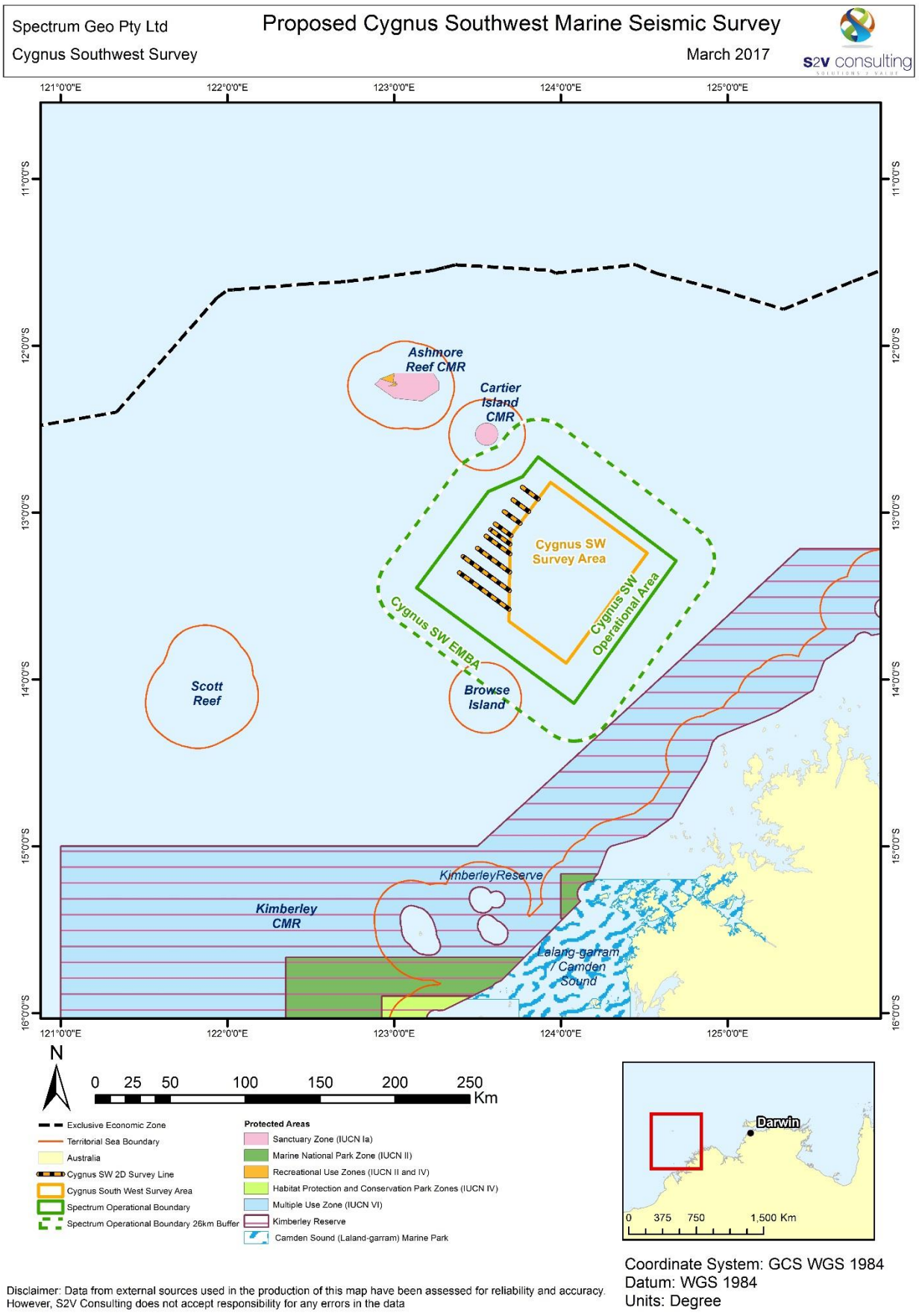


Figure 3-2: Commonwealth and State Marine Parks and Reserves in the vicinity of operational area and EMBA

Cartier Island Commonwealth Marine Reserve

Located in the North West network covering an area of 172 square kilometres, Cartier Island Marine Reserve is an IUCN Ia sanctuary zone that includes an un-vegetated sand island (Cartier Island) and the area within a four nautical mile radius of the centre of the island, to a depth of one kilometre below the sea floor. The area around the island includes a variety of habitats including a mature reef flat, a small submerged pinnacle, known as Wave Governor Bank and two shallow pools to the north-east of the island. The unvegetated island at Cartier supports large populations of nesting marine turtles.

Cartier Island has large numbers and a high diversity of hard and soft corals, gorgonians (e.g. sea fans), sponges and a range of encrusting organisms. The reef crests are generally algal dominated, while the reef flats feature ridges of coral rubble and large areas of seagrass that are important for dugong and sea snake species. The sand flat habitats support a range of species including feeding dugongs, turtles, stingrays, echinoderms, molluscs and crustaceans and migrating shorebirds (Director of National Parks 2013a).

Major conservation values of the Cartier Island Commonwealth Marine Reserve are:

+ Ecosystems, habitats and communities associated with:
  - the North West Shelf
  - emergent oceanic reefs
+ The islands are important areas for the following protected species:
  - Cartier Island is internationally significant for its abundance and diversity of sea snakes.
  - large and significant feeding populations of green, hawksbill and loggerhead turtles occur around the reefs.
  - the islands support some of the most important seabird rookeries on the North West Shelf including colonies of bridled terns, common noddies, brown boobies, eastern reef egrets, frigatebirds, tropicbirds, red-footed boobies, roseate terns, crested terns and lesser crested terns.
+ Cartier Island is important staging points/feeding areas for many migratory seabirds
+ Cultural and heritage sites:
  - Historic shipwreck the ‘Ann Millicent’
+ One key ecological feature—Ashmore Reef and Cartier Island and surrounding Commonwealth waters.

Ashmore Reef Commonwealth Marine Reserve

Located in the North West network, the marine environment at Ashmore includes two extensive lagoons, mobile channelled carbonate sand flats, shifting sand cays and an extensive reef flat. The reef front at Ashmore has large numbers of many different types of robust hard and soft corals, gorgonians (e.g. sea fans), sponges and a range of encrusting organisms. The reef crests are generally algal dominated, while the reef flats feature ridges of coral rubble and large areas of seagrass that are important for dugong and sea snake species. Ashmore is thought to be the greatest number of reef building species of any reef area off the West Australian coast.

The sand flat habitats support a range of species including feeding dugongs, turtles, stingrays, echinoderms, molluscs and crustaceans and migrating shorebirds. The lagoons at Ashmore support corals, sponges, burrowing shrimp and a range of holothurians (e.g. sea-cucumbers), echinoderms, molluscs (shellfish) and polychaetes (worms) on and beneath the sand.

The reefs provide varied structural habitat that attracts a diverse range of primary and secondary consumers including sea cucumbers, small pelagic fish, parrot fish, and groupers. These, in turn, attract higher order consumers such as trevally, coral trout, emperors, snappers, dolphinfish, marlin and sailfish, as well as cetaceans and seabirds.

The Ashmore islands provide important nesting habitat for many species, including marine turtles and a number of seabirds and migratory shorebirds. Despite the small size of the islands, Ashmore supports some of the most important seabird rookeries on the North-west Shelf and is an important staging point for migratory wetland birds. It was designated a Ramsar Wetland of International Importance in 2003 due to the importance of its islands providing a resting place for migratory shorebirds and supporting large seabird breeding colonies (Director of National Parks 2013a).

The critical components and processes of Ashmore Reef Marine Reserve Ramsar Site include (as per Ecological Character Description of Ashmore Reef CMR Ramsar Site, 2013):

- Marine invertebrates: Hard and soft coral, mollusc, echinoderm, sea cucumber, decapod crustacean
- Fish
- Seasnakes
- Turtles: green, hawksbill, loggerhead with green turtles are the most abundant
- Seabirds and shorebirds: wetland dependant birds, migratory birds,
- Dugong

The major conservation values for the Ashmore Reef Marine Reserve are:

- Ecosystems, habitats and communities associated with:
  - the North West Shelf
  - emergent oceanic reefs
- The islands are important areas for the following protected species: sea snakes, marine turtles, dugong, migratory seabirds
- Ashmore Reef is internationally significant for its abundance and diversity of sea snakes.
- Ashmore Reef has been identified as critical nesting and internesting habitat for green turtles, supporting one of three genetically distinct breeding populations in the North-west Marine Region. Low level nesting activity by loggerhead turtles has also been recorded.
- Large and significant feeding populations of green, hawksbill and loggerhead turtles occur around the reefs. It is estimated that approximately 11,000 marine turtles feed in the area throughout the year.
- Ashmore Reef supports a small dugong population of less than 50 individuals that breeds and feeds around the reef. This population is thought to be genetically distinct from other Australian populations.
- the islands support some of the most important seabird rookeries on the North West Shelf including colonies of bridled terns, common noddies, brown boobies, eastern reef egrets, frigatebirds, tropicbirds, red-footed boobies, roseate terns, crested terns and lesser crested terns.
- Ashmore Reef are important staging points/feeding areas for many migratory seabirds
- Cultural and heritage sites:
  - Indonesian artefacts
  - Grave sites

+ Values reflected in the list of Wetland of International Importance under the Ramsar Convention

3.3.2.2 Key Ecological features

Ancient Coastline at 125 m isobath

The shelf of the North-west Marine Region contains several terraces and steps which reflect the gradual increase in sea level across the shelf that occurred during the Holocene. The most prominent of these occurs episodically as an escarpment through the Northwest Shelf Province and Northwest Shelf Transition, at a depth of approximately 125 m. Humpback whales, whale sharks and other migratory pelagic species may use this escarpment as a guide as they move through the Region. The topographic variation of the ancient coastline may also facilitate small localised upwellings as a result of internal tide activity or regional mixing associated with seasonal changes in currents and winds. These areas of enhanced biological productivity could attract baitfish which may provide food for migrating species (North-west Bioregional Profile 2015). The 3D survey area, operational area and EMBA overlap with this KEF.

Commonwealth waters surrounding Ashmore Reef and Cartier Island

The Commonwealth waters surrounding Ashmore Reef and Cartier Island are an area of enhanced biological productivity, feeding and breeding aggregations and high biodiversity.

Ashmore Reef and Cartier Island are regarded as biodiversity hotspots as they support a diverse array of pelagic and benthic marine species. The waters surrounding Ashmore and Cartier are areas of enhanced localised biological productivity in relatively unproductive waters. Localised upwelling and turbulent mixing around the reef systems provide nutrients to the system.

The reefs provide varied habitat that attracts a diverse range of primary and secondary consumers, including a particularly diverse fish fauna. Toothed whales and dolphins are also found around these reefs. The operational area and EMBA do not overlap with this KEF, as shown in **Figure 3-3,** although the EMBA is <2km from the KEF, and the operational area is <28km away.

Continental slope and demersal fish communities

This KEF includes communities with high species diversity and endemism. Demersal slope fish assemblages in the Timor Province, the Northwest Transition and the Northwest Province are characterised by high endemism and species diversity. The level of endemism of demersal fish species in these bioregions is high compared to anywhere else along the Australian continental slope. The slope of the Timor Province and the Northwest Transition contains more than 500 species of demersal fish of which 64 are considered endemic (Last et al. 2005). The Timor Province and Northwest Transition bioregions are the second-richest areas for demersal fish across the entire continental slope. The demersal fish species occupy two distinct demersal community types (biomes) associated with the upper slope (water depths of 225–500 m) and the mid-slope (water depths of 750–1000 m).

The 2D survey lines, operational area and the EMBA overlap this KEF.

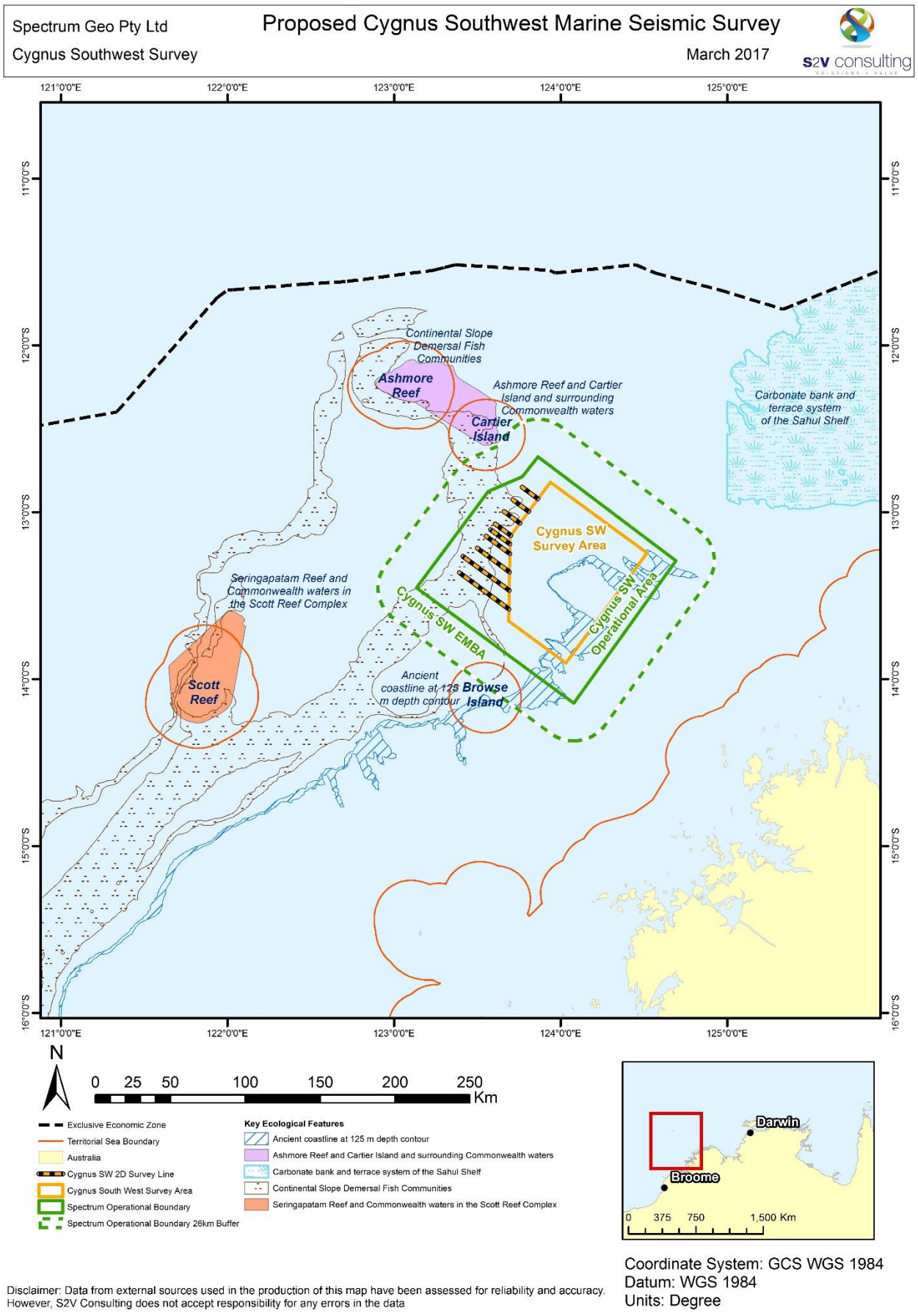


Figure 3-3: Key Ecological Features in the vicinity of operational area and EMBA

3.3.3 Benthic Habitats and Shallow Reefs

Much of the outer mid-shelf is covered by a relatively featureless, sandy-mud seabed with a sparse covering of sessile organisms dominated by filter-feeding heterotrophs such as gorgonians, sponges, soft corals, echinoderms and detritus-feeding crabs and echinoderms (Heyward *et al*., 1997). However, the shallow shoals identified in **Section 3.3.4**, along with benthic habitats associated with Browse and Cartier Islands are likely to be a key benthic feature of this region.

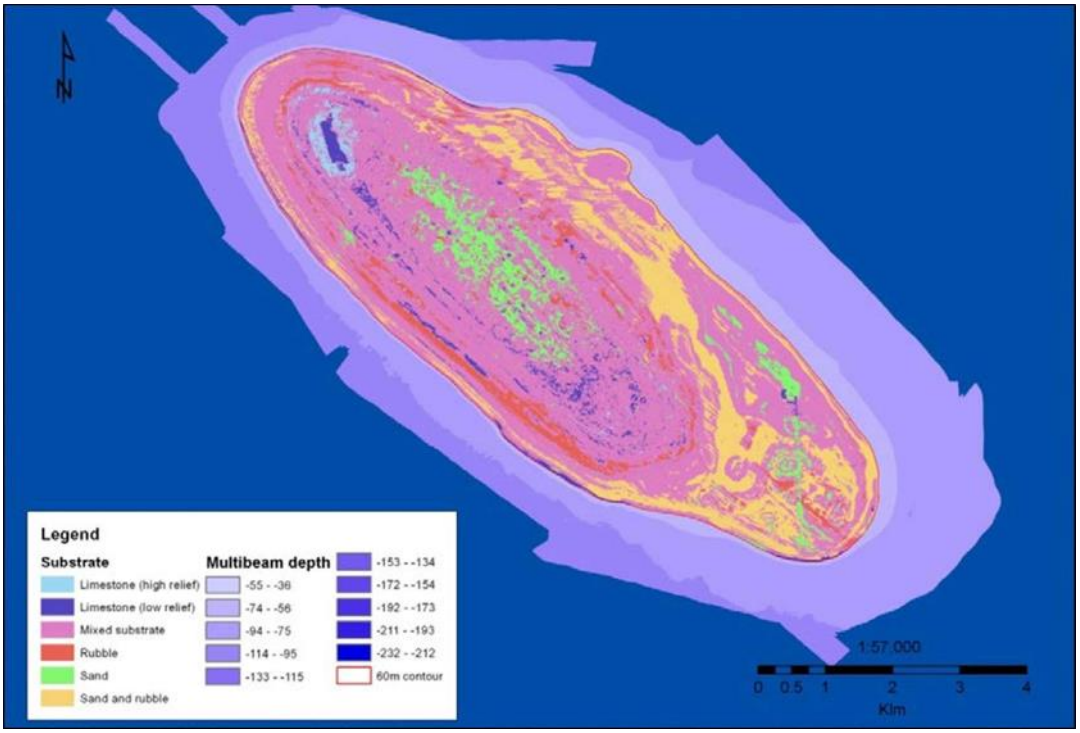
The shallow water depths experienced in the operational area result in a diverse array of benthic habitats and shallow fringing reefs being present. The most notable of these are associated with the shoals identified in **Section 3.3.4** along with Browse and Cartier Islands. These shoals identified are some of the many submerged and emergent reefs and cays along the outer edge of the continental shelf extending from the Lydoch and Troubadour Shoals in the Arafura Sea (north of Darwin) to the Rowley Shoals north-west of Broome (Heyward *et al*. 2013) and together make up the Oceanic Shoals region.

3.3.4 Shoals

A number of shallow submerged features (shoals) are present in the north east of the operational area. Others may be present in the area but have not yet been identified in published literature. The shoals present within the survey area rise steeply from the seabed to shallow depths (~16 m or more) and provide shelter and food for a diverse range of primary and secondary consumers, such as schooling fish (e.g. herring and damsel fish) and parrot fish, which then support higher order consumers such as trevally, dolphin fish and emperors (Brewer *et al*., 2007).

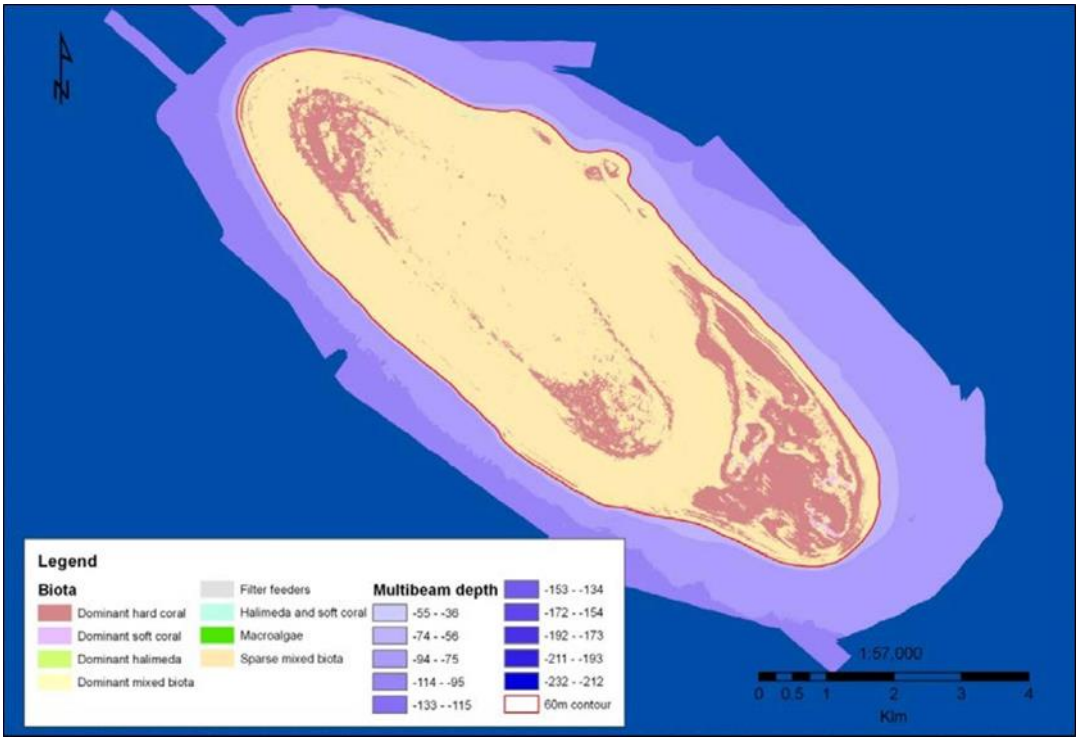
- Heywood Shoal, located in the centre of the operational area, which has a shallowest water depth of ~13 m.
- Echuca Shoal, located in the central southern area of the operational area boundary, which has a shallowest water depth of ~14 m.

Heywood Shoal is one of the more central shoals within the operational area and also has the shallowest minimum water depth of the shoals encountered. As such, while variations are expected between locations, it can provide an indication of the habitats expected at shoals within the operational area along with the fringing reefs of Browse and Cartier Islands. Heywood Shoal is comprised predominantly of a mixed substrate of sand and rubble (See **Figure 3-4**, Source: Heyward *et al*. (2011)), with isolated areas of high and low relief limestone substrate. These substrates support a sparse mixed biota (see **Figure 3-5**), source: Heyward *et al*. (2011)) dominated by algae (Halimeda), with some areas of hard coral (predominantly Poritidae – which reflects the high energy waves and swells generated during tropical storms and cyclones), sponges and soft coral (Heyward *et al*. 2011). Heywood shoal has a distinctive shallower plateau with a minimum water depth of 19m, and another deeper less defined plateau at approximately 40-45 m (to the south-east (**Figure 3-5**). The maximum depth of the shoal is recorded as 49.8m (Heyward *et al*, 2011). The deeper plateau has more hard coral coverage (approximately 50% coverage, compared to the top of the shallower part of the shoal which has higher algal coverage and some coral. Overall, the entire shoal is approximately 9.6% coral and 48.3% algae; the remainder of the shoal being sand/rubble and sponges with sparse mixed biota.



Source: Heyward et al. (2011).

Figure 3-4: Heywood Shoal Benthic substrate and depth map



Source: Heyward et al. (2011).

Figure 3-5: Heywood Shoal biotic habitat and depth map

Heywood shoal showed higher fish diversity and richness on the top of the shoal (shallower area) than in the deeper parts of the shoal. The shoal habitats also provide an additional regional reservoir of megafauna, such as sharks and sea snakes, typically associated with the emergent reefs (Heyward *et al*. 2013).

Location of shoals in the vicinity of Cygnus SW operational and survey area is presented in **Figure 5-1**.

3.4 Marine Fauna

3.4.1 Protected Species

A review of the EPBC Act 1999 database (Protected Matters search tool) held by the DoE was conducted on 7th March 2017 for the operational area polygon. At its closest point, the operational area is approximately 30 km from the nearest land (Browse Island) and 134 km from the nearest mainland shoreline on the West Australian coast. The operational area overlaps 2 KEFs. The search indicates that 19 threatened species, 31 migratory species and 63 listed species may be present.

An additional search including a 26 km buffer to account for the EMBA (as described in **Section 3.1**) was also conducted, which identified an additional 2 migratory species (33 in total within the EMBA) and the same number of threatened species. Further details of the Protected Matters search, indicating species likely to occur within, or adjacent to, the search area (the operational area or the EMBA as defined by the 26 km buffer) are provided below in **Table 3-5** (DoE, 2017).

The majority of the marine species identified are likely to transit through the area, and it is unlikely that the habitats within the operational area are critical to the survival of these species. Biologically Important Areas (BIAs) as identified by the Conservation Values Atlas (DoE, 2014b) which overlap with, or are in proximity to, the search area, are highlighted in **Table 3-5** and **Figure 3-6**, **Figure 3-7**, **Figure 3-8** and **Figure 3-9**.

All listed species are protected under the EPBC Act. The likelihood of their presence in the search area is described in the following sections. The search area is not considered a habitat that is critical to the survival of any listed species. Similarly, there are no EPBC Act-listed threatened ecological communities (TEC) in the vicinity of the search area.

Note that where distances are given throughout this section they refer to the distance from the operational area unless otherwise stated.

Table 3-5: EPBC Act Protected Species that may occur in, or relate to, the operational area and the EMBA

Scientific name	Common name	Status	Presence				Biologically Important Areas in proximity to operational area	
			Operational area	Type of presence	EMBA	Type of presence	Operational area	EMBA
Cetaceans								
Balaenoptera borealis	Sei Whale	Vulnerable, migratory	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	None	None
Balaenoptera physalus	Fin whale	Vulnerable, migratory	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	None	None
Balaenoptera bonaerensis	Antarctic minke whale	Migratory	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	None	None
Balaenoptera edeni	Bryde's whale	Migratory	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	None	None
Balaenoptera musculus	Blue whale	Endangered; Migratory	✓	Species or species habitat likely to occur within area	✓	Migration route known to occur within area	None	BIA for migration overlaps
Megaptera novaeangliae	Humpback whale	Vulnerable, Migratory	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	None	None
Orcaella brevirostris	Irrawaddy dolphin	Migratory	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	None	None
Orcinus orca	Killer whale	Migratory	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	None	None
Physeter macrocephalus	Sperm whale	Migratory	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	None	None
Tersiops aduncus	Spotted bottlenose dolphin	Migratory	✓	Species or species habitat may occur within area	✓	Species or species habitat likely to occur within area	None	None
Sharks/Rays (Fish)								
Rhincodon typus	Whale shark	Vulnerable, Migratory	✓	Foraging, feeding or related behavior known to occur within area	✓	Foraging, feeding or related behavior known to occur within area	BIA for foraging overlaps area	BIA for foraging overlaps area
Isurus oxyrinchus	Shortfin mako, mako shark	Migratory	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	None	None
Isurus Paucus	Longfin mako	Migratory	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	None	None
Manta birostris	Giant manta ray	Migratory	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	None	None
Manta alfredi	Reef Manta Ray	Migratory	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	None	None

Scientific name	Common name	Status	Presence				Biologically Important Areas in proximity to operational area	
			Operational area	Type of presence	EMBA	Type of presence	Operational area	EMBA
Carcharodon carcharias	White shark	Vulnerable, Migratory	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	None	None
Glyphis garricki	Northern river shark	Endangered	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	None	None
Pristis pristis	Freshwater/ Largetooth sawfish	Vulnerable, migratory	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	None	None
Pristis zijsron	Green sawfish	Vulnerable, migratory	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	None	None
Marine Reptiles								
Caretta caretta	Loggerhead turtle	Endangered; Migratory	✓	Species or species habitat likely to occur within area	✓	Species or species habitat known to occur within area	None	None
Chelonia mydas	Green turtle	Vulnerable; Migratory	✓	Species or species habitat known to occur within area	✓	Foraging, feeding or related behavior known to occur within area	None	BIA for internesting overlaps
Crocodylus porosus	Salt-water Crocodile	Migratory	x	N/a	✓	Species or species habitat likely to occur within area	None	None
Dermochelys coriacea	Leatherback turtle	Endangered; Migratory	✓	Species or species habitat likely to occur within area	✓	Foraging, feeding or related behaviour likely to occur within area	None	None
Eretmochelys imbricate	Hawksbill turtle	Vulnerable, migratory	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	None	None
Lepidochelys olivacea	Olive Ridley turtle	Endangered, migratory	✓	Species or species habitat likely to occur within area	✓	Foraging, feeding or related behavior likely to occur within area	None	None
Natator depressus	Flatback turtle	Vulnerable, migratory	✓	Species or species habitat known to occur within area	✓	Congregation or aggregation known to occur within area	None	None
Aipysurus apraefrontalis	Short-nosed seasnake	Critically endangered	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	None	None
Birds								
Anous tenuirostris melanops	Australian lesser noddy	Vulnerable	✓	Foraging, feeding or related behavior likely to occur within area	✓	Foraging, feeding or related behavior likely to occur within area	None	None
Calidris ferruginea	Curlew Sandpiper	Critically Endangered, Migratory	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	None	None
Numenius madagascariensis	Eastern Curlew	Critically Endangered, Migratory	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	None	None

Scientific name	Common name	Status	Presence				Biologically Important Areas in proximity to operational area	
			Operational area	Type of presence	EMBA	Type of presence	Operational area	EMBA
Anous stolidus	Common Noddy	Migratory	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	None	None
Calonectris leucomelas	Streaked shearwater	Migratory	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	None	None
Fregata ariel	Lesser frigatebird	Migratory	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	BIA for breeding and foraging overlaps	BIA for breeding and foraging overlaps
Fregata minor	Great frigatebird	Migratory	✓	Foraging, feeding or related behavior likely to occur within area	✓	Foraging, feeding or related behavior likely to occur within area	BIA for breeding and foraging overlaps	BIA for breeding and foraging overlaps
Phaethon lepturus	White-tailed tropicbird	Migratory	✓	Foraging, feeding or related behavior likely to occur within area	✓	Foraging, feeding or related behavior likely to occur within area	BIA for breeding overlaps in north west	BIA for breeding overlaps in north west
Sula sula	Red-footed booby	Migratory	✓	Breeding known to occur within area	✓	Breeding known to occur within area	BIA for breeding and foraging overlaps in north west	BIA for breeding and foraging overlaps in north west

Source: DoE (2017) Protected Matters Search Tool, 07/03/17.

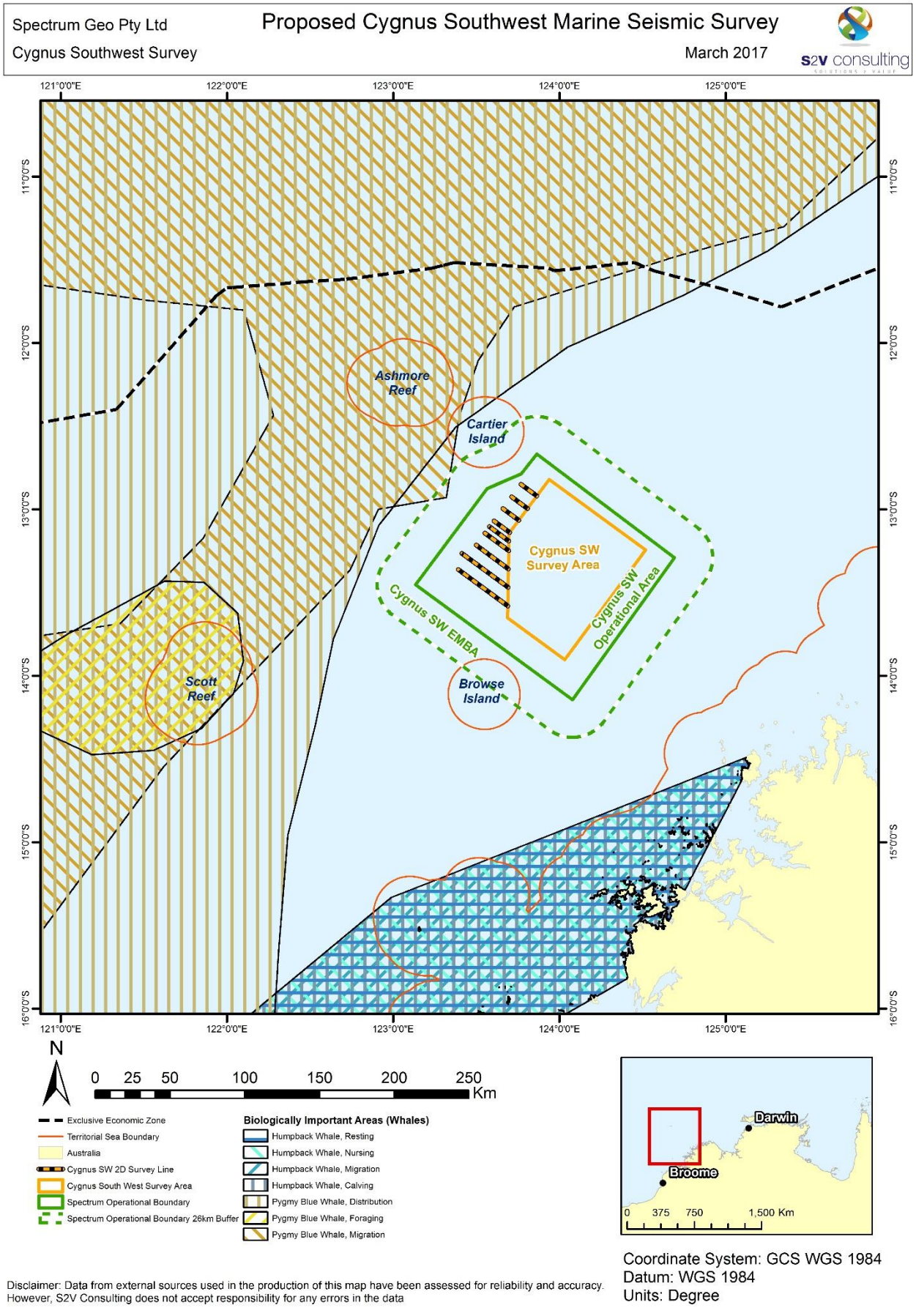


Figure 3-6: The operational area, EMBA and Whale Biologically Important Areas

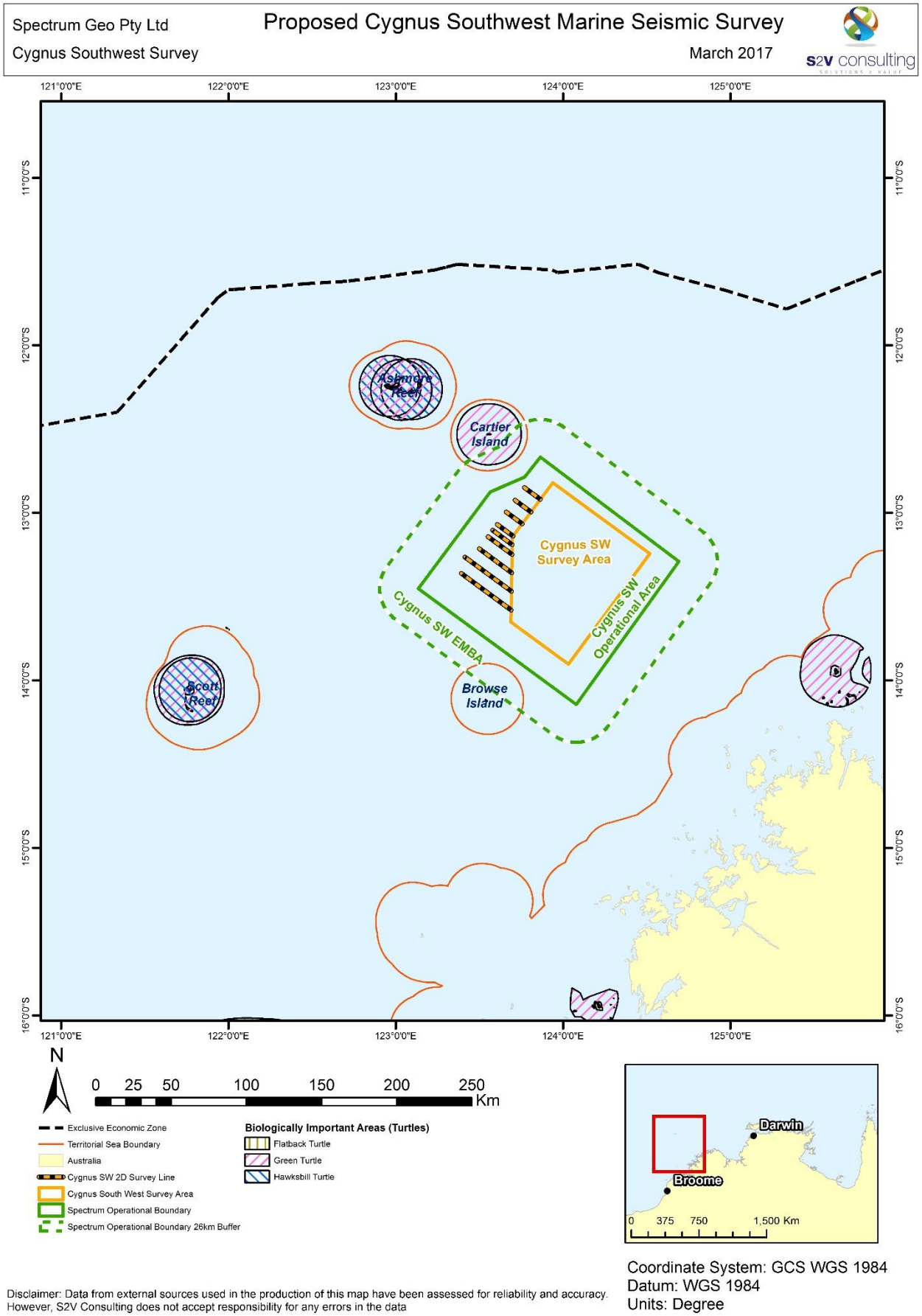


Figure 3-7: Biologically Important Areas for EBPC protected Turtles in the vicinity of operational area and EMBA

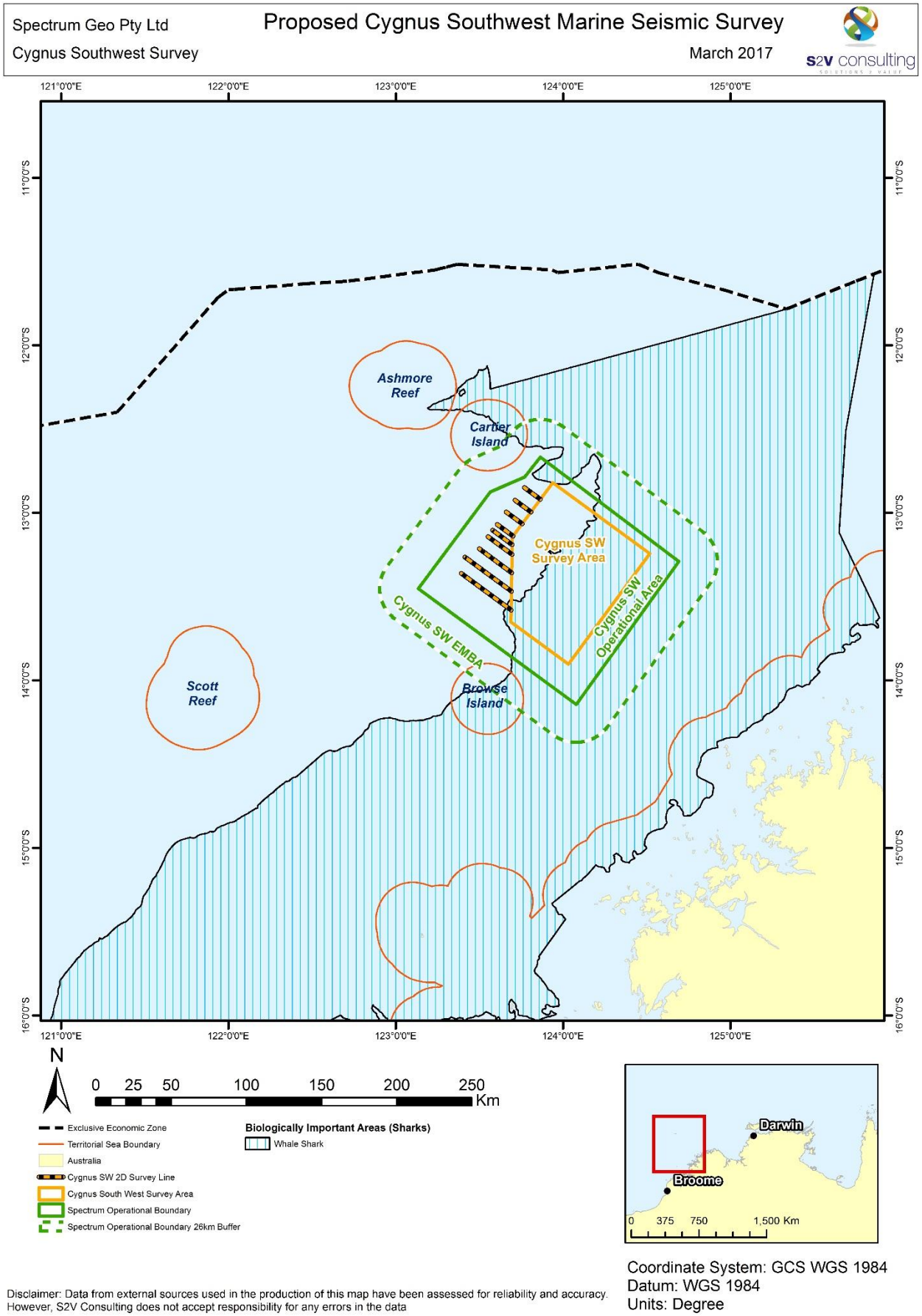


Figure 3-8: Whale shark BIA in the vicinity of the operational area and EMBA

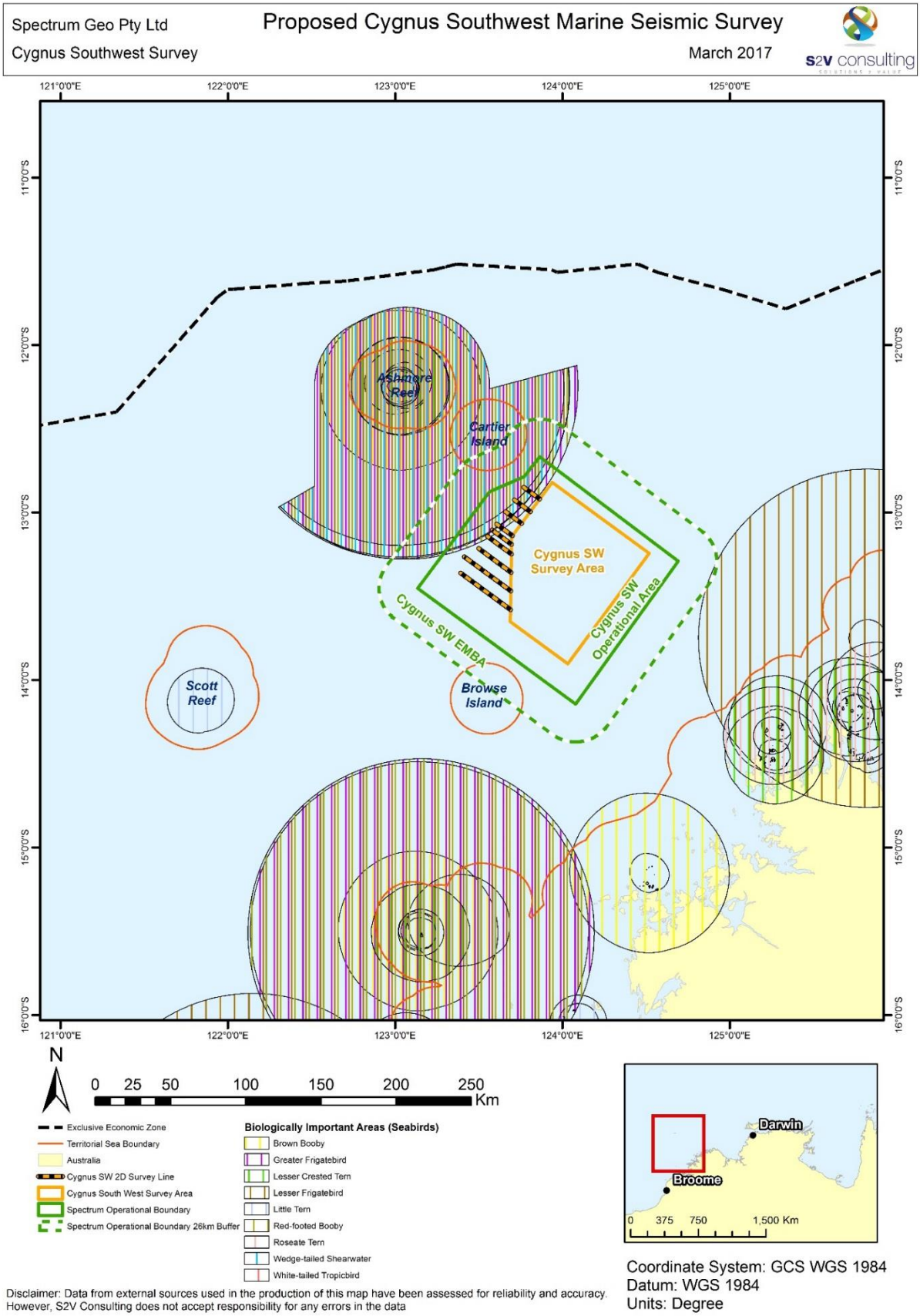


Figure 3-9: Birds BIAs in the vicinity of operational area and EMBA

3.5 Socio-Economic Environment

The operational area is located approximately 290 km north of Cape Leveque and 372 km north of Derby, the closest township. Socio-economic activities that may occur within the operational area and surrounds include commercial fishing and shipping, petroleum activities, and to a lesser extent recreational fishing and tourism.

Table 3-6 identifies the relevant State and Commonwealth fisheries that overlap the Operational Area. Active fisheries are identified in consultation with Western Australia Fishing Industry Council (WAFIC) and Department of Fisheries (DoF). **Table 3-8** presents the socio-economic values and sensitivities within the Operational Area.

Table 3-6: State and Commonwealth Fisheries in the vicinity of the operational area

Value/Sensitivity	Description	Operational Area presence	Relevant events within the Operational Area and EMBA
Commonwealth Managed Fisheries			
North West Slope Trawl	Extends from 114° E to approximately 125° E off the WA coast between the 200 m isobath and the outer limit of the Australian Fishing Zone (AFZ).	✓	The operational area overlaps with the north east of the fishery, however this area contains partial closure and while it has seen activity in recent years, relative intensity has been low. Areas that have seen moderate and high relative levels of activity in recent years are outside (south west) of the area that may be impacted by unplanned events.
Southern and Western Tuna and Billfish Fishery	Extends westward from Cape York Peninsula (142°30' E) off Queensland to 34° S off the WA west coast. It also extends eastward from 34° S off the west coast of WA across the Great Australian Bight to 141° E at the South Australian–Victorian border. No current effort on NWS	✓	Recent fishing intensity has focused within the Perth Canyon region, and no fishing activity recorded in the North West. As a result of the vast WTBF fishing area, of which the operational area overlaps, and the low fishing effort in the vicinity of the survey, impacts on the fishery are not expected.
Western Skipjack Tuna Fishery	No current effort on NWS	✓	Although the survey overlaps the fishery, the inactive status of the fishery since 2009 suggests the proposed operations will not impact the fishery.
Southern Bluefin Tuna	No current effort on NWS	✓	The operational area overlaps with the Southern Bluefin Tuna Fishery management area. However, the overlap is with the spawning ground rather than an area of concentrated fishing effort which are located in South Australia and New South Wales so interference with vessels is not anticipated.
State Managed Fisheries (Whole of State)			
Marine Aquarium Fish Fishery	All year During the past three years the fishery has been active in waters from Esperance to Broome with popular areas being around Perth, Geraldton, Exmouth and Dampier.	✓	Disruption to fishing activities unlikely given water depths operated within. Unplanned events which may occur in the EMBA could disrupt fishing activities, however the likelihood of these events is low.

Value/Sensitivity	Description	Operational Area presence	Relevant events within the Operational Area and EMBA
	Effort within the Operational Area and EMBA is unknown, but is unlikely due to the depth and the dive based method of collection		
Specimen Shell Managed Fishery	All year Concentration of effort is reported in areas adjacent to population centres such as Karratha, Carnarvon, metropolitan Perth, Mandurah, Bunbury and Albany. Effort within the Operational Area and EMBA is unknown, but it is unlikely due to the depth and the dive based method of collection Unlikely to occur	✓	Although it overlaps, the area of the proposed survey is not an area of high concentration effort, therefore impacts of the survey on the fishery will be minimal.
Mackerel Managed Fishery	Trolling or handline. Near-surface trolling gear from vessels in coastal areas around reefs, shoals and headlands	✓	The majority of the catch is taken in the Kimberley Area and therefore disruption is unlikely
Abalone Managed Fishery	The commercial fishery harvest method is a single diver working off a 'hookah' (surface-supplied breathing apparatus) using an abalone 'iron' to prise the shellfish off rocks.	✓	Zone 8 of the Abalone managed fishery overlaps the operational area and EMBA, however this zone is currently closed until further notice (DoE, 2014t) and as such the operation will not interfere unless fishing effort is recommenced.
State Managed Fisheries (North Coast Bioregion)			
Pearl Oyster Managed Fishery (Zone 3)	Mostly operate March to June Operational Area and EMBA overlap with the boundaries of the fishery, but is restricted to shallow diving depths.	✓	Given the water depths of the operational area, disruption to fishing activities are unlikely to occur Unplanned events which may occur in the operational area and EMBA could disrupt fishing activities, however the likelihood of these events is low.
Northern Demersal Scalefish Managed Fishery	The Northern Demersal Scalefish Managed Fishery (NDSF) operates off the northwest coast of Western Australia in the waters east of 120° E longitude.	✓	Unplanned events which may occur in the operational area and EMBA could disrupt fishing activities, however the likelihood of these events is low.
South West Coast Salmon Fishery	The two fisheries are separated at Cape Beaufort – the South Coast Salmon Managed Fishery and the South West Coast Salmon Managed Fishery. No specified fishing season, but fisheries target a westward spawning migration in February-May (main season) and some years an eastward "back run" in May-August.	✓	Given the water depths of the operational area, disruption to fishing activities are unlikely to occur. Unplanned events which may occur in the operational area and EMBA could disrupt fishing activities, however the likelihood of these events is low.

Value/Sensitivity	Description	Operational Area presence	Relevant events within the Operational Area and EMBA
West Coast Deep Sea Crustacean Managed Fishery	The fishery operates North of latitude 34° 24' S (Cape Leeuwin) and west of the Northern Territory border on the seaward side of the 150m isobath out to the extent of the AFZ, mostly in 500 to 800 m of water.	✓	Year round. Significant disruption unlikely to occur due to vast area fished. Unlikely to occur due to depths fished
North Coast Prawn Managed Fishery (Broome and Kimberley)	The boundaries of the Broome Prawn Managed are 'all Western Australian waters of the Indian Ocean lying east of 120° east longitude and west of 123°45' east longitude on the landward side of the 200 m isobath'. The boundaries of the Kimberley Prawn Managed Fishery are 'all Western Australian waters of the Indian Ocean lying east of 123°45´ east longitude and west of 126°58´ east longitude'. The boundaries of the OPMF are 'all the Western Australian waters between the Exmouth Prawn Fishery and the Nickol Bay prawn fishery east of 114º39.9' on the landward side of the 200 m depth isobath'. The boundaries of the NBPMF are 'all the waters of the Indian Ocean and Nickol Bay between 116°45' east longitude and 120° east longitude on the landward side of the 200 m isobath'	✓	Unplanned events which may occur in operational area and the EMBA could disrupt fishing activities, however the likelihood of these events is low.
North Coast Shark Fishery	The Western Australian-managed sector of the northern shark fishery was closed by a Section 43 order under the Fish Resource Management Act 1994 in 2005. No reported fishing effort in the northern shark fisheries in 2011/12	✓	No significant impacts upon operations are expected due to no reported fishing effort in operational area
Traditional Indonesian Fishing			
Traditional Indonesian Fishing	The Cygnus Southwest MSS operational area overlaps with the Australia-Indonesia Memorandum of Understanding (MoU) Box where traditional Indonesian fishing activities occur. The MOU Box is an area of Australian water in the Timor Sea where Indonesian traditional fishers, using traditional fishing methods only, are permitted to operate. Most Indonesian fishers travel to Scott Reef between July and Oct, although a few Rotenses make the journey in the early season between April and June.	✓	the operational area is greater than 100km from Scott Reef, therefore interaction with Indonesian fishers is not expected and there is no risk of impact to divers or to the fishery catch from seismic. Traditional fishing around Cartier Island is possible, but given the distance (29km) of the operational area from the CMR boundary, it is unlikely the survey vessel will encounter traditional fishermen in the vicinity.

During consultation with the WA Department of Fisheries (**Section 9**) the following fish were identified as key commercial species in the area, of which Goldband Snapper and Red Emperor are discussed in more details below:

Table 3-7: Peak spawning / aggregation times for key commercial fish species in the North Coast Bioregion[1]

Bioregion	Key Fish Species Within Zone	Spawning / Aggregation Times
North Coast	Blacktip Shark (*Carcharhinus tilstoni & C. limbatus*)	Nov – Dec
	Goldband Snapper (*Pristipomoides multidens*)	Jan – April
	Rankin Cod (*Epinephelus multiinotatus*)	Aug – Oct
	Red Emperor (*Lutjanus sebae*)	Jan – Mar and Oct
	Pink Snapper (*Pagrus auratus*) (rare)	May – Jul
	Sandbar Shark (*Carcharhinus plumbeus*)	Oct – Jan
	Spanish Mackerel (*Scomberomorus commerson*)	Aug - Nov

Goldband Snapper

Goldband Snapper is widely distributed throughout northern Australia and the tropical Indo–West Pacific. Goldband snappers are deepwater fish inhabiting tropical and sub-tropical waters in depths of 40 – 275 m (Fry *et al*., 2006). They are schooling fish and live in areas of hard, rocky and uneven sea floor and steep off islands. They feed on fishes, shrimps, crabs, lobsters, stomatopods, squids, gastropods and urochordates.

The major performance measures for Goldband Snapper in the Kimberley biological stock are estimates of spawning stock levels in the Northern Demersal Scalefish Managed Fishery (Western Australia). The target level of spawning biomass is 40 per cent of the unfished (1980) level. The limit level is 30 per cent of the initial spawning biomass. The spawning biomass of Goldband Snapper was estimated to be 35 per cent of the unfished level in the Kimberley biological stock in 2014 (between the target and the threshold level). Goldband Snapper catches from the NDSMF (Kimberley biological stock) from 2008–14 have been relatively stable, ranging between 457 and 524 tonnes. This evidence indicates that the current level of fishing pressure is unlikely to cause the stock to become recruitment overfished. The Kimberley (Western Australia) biological stock is classified as a sustainable stock (DoF, 2016)

Suitable spawning and nursery habitats for demersal species (including goldband snappers) are usually in shallow and sheltered waters, such as coastal embayments, inshore reefs, estuaries, seagrass beds and mangroves (DOF 2004; Kailola et al. 1993; Prokop 2006; Castro 1996; Grubbs et al. 2007; DL 2015; Bray 2011) rather than offshore waters. They can be found in depths of 40m to 250m and therefore may be found within the operational area, although their spawning habitat is likely outside of the area given the preference for shallow, sheltered waters.

Red Emperor

The Red emperor inhabits largely coastal and inshore reefs and depth of capture is typically from 5 to 50 m (Choat *et al*., 2008). The major performance measures for the Kimberley biological stock of Red Emperor relate to spawning stock levels. The target level of spawning biomass is 40 per cent of the unfished (1980) level. Catch levels of Red Emperor in the NDSF 2010–14 have been stable,

[1] As advised by Department of Fisheries, also note that consultation with the Northern Demersal Scalefish Fishery also included October as a time of spawning for red emperor

ranging between 128 and 142 t. The most recent assessment estimates that biomass in 2015 was 38 per cent of the unfished (1980) level. The stock is not considered to be recruitment overfished. The biological stock is classified as a sustainable stock (DoF, 2016). Little is known of their spawning behaviour but they are likely to favour the shallow sheltered waters (similar to goldband snapper) for spawning.

Table 3-8: Socioeconomic Activities in the vicinity of the operational area

Value/ Sensitivity	Description	Operational Area presence	Relevant events within Operational Area	Relevant Events within EMBA
Shipping	The busiest areas of vessel activity close to the operational area are to the north west of Browse Island and across a line running east to west, approximately 10 km south of Cartier Island. Other light vessel traffic might occur throughout the operational area. Due to the difference in vessel speed between the survey vessel and commercial fishing, the survey vessel has potential to lead to necessary avoidance action being taken by shipping vessels.	✓	Planned Interactions with other marine users	Unplanned Hydrocarbon release from vessel collision
Tourism and recreational fishing	Recreational fishing may be undertaken in the area, but given the distance from the nearest mainland shoreline (approximately 134 km) and population centres (372 km north of Derby) significant disturbance is not expected. It is possible low levels of recreational fishing and tourism may occur around Heywood Shoal within the operational area however this would be expected to be low level given the distance to the mainland shoreline and the exclusion of fishing within IUCN sanctuary zones around Cartier Island and Ashmore reef.	✓	Planned Interactions with other marine users	Unplanned Hydrocarbon release from vessel collision
Defence	No known defence areas in the vicinity have been advised by the Department of Defence.	-	N/A	N/A
Shipwrecks	1 shipwreck (Ann Millicent) within the EMBA.	-	N/A	Unplanned Hydrocarbon release from vessel collision
Oil and gas	Petroleum exploration has been active in the Browse Basin since the 1980s, with several commercial discoveries since that time. Subsequently a number of wells have been drilled in the survey area. These may be associated with infrastructure in the area. The Front Puffin, Skua Venture, Challis Venture and Jabiru Venture Facilities are present in the north east of the operational area (AMSIS, 2015). The Inpex Ichthys and Shell Prelude developments are two significant developments in the area. Possible pipeline works and associated vessel presence may be associated with this development within the survey area.	✓	Planned Interactions with other marine users	Unplanned Hydrocarbon release from vessel collision
Cultural Heritage	No known sites of Aboriginal Heritage significance within the operational area or EMBA.	-	N/A	N/A

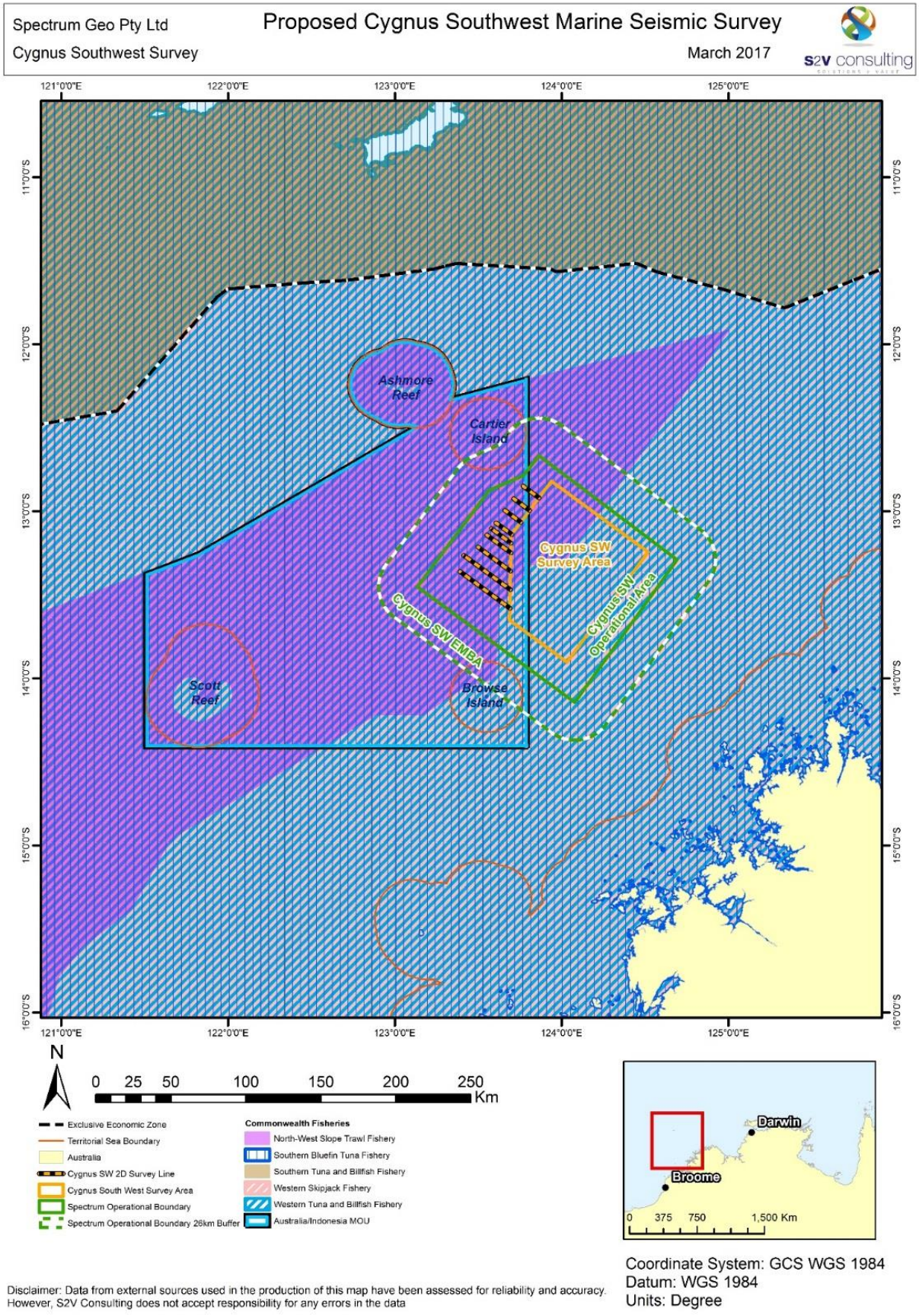


Figure 3-10: Commonwealth fisheries in relation to Operational Area and EMBA

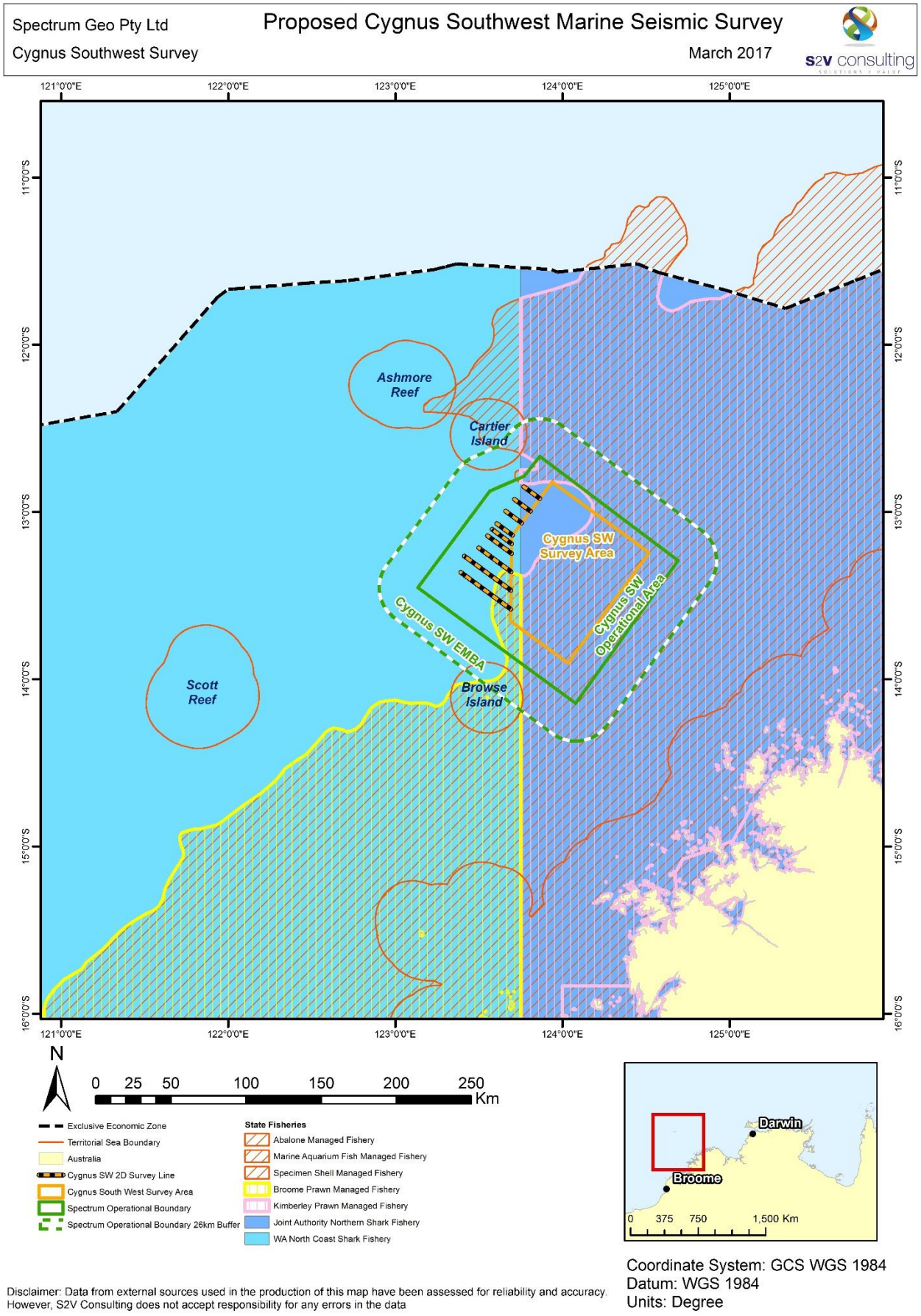


Figure 3-11: State fisheries in relation to Operational Area and EMBA (Map 1 of 2)

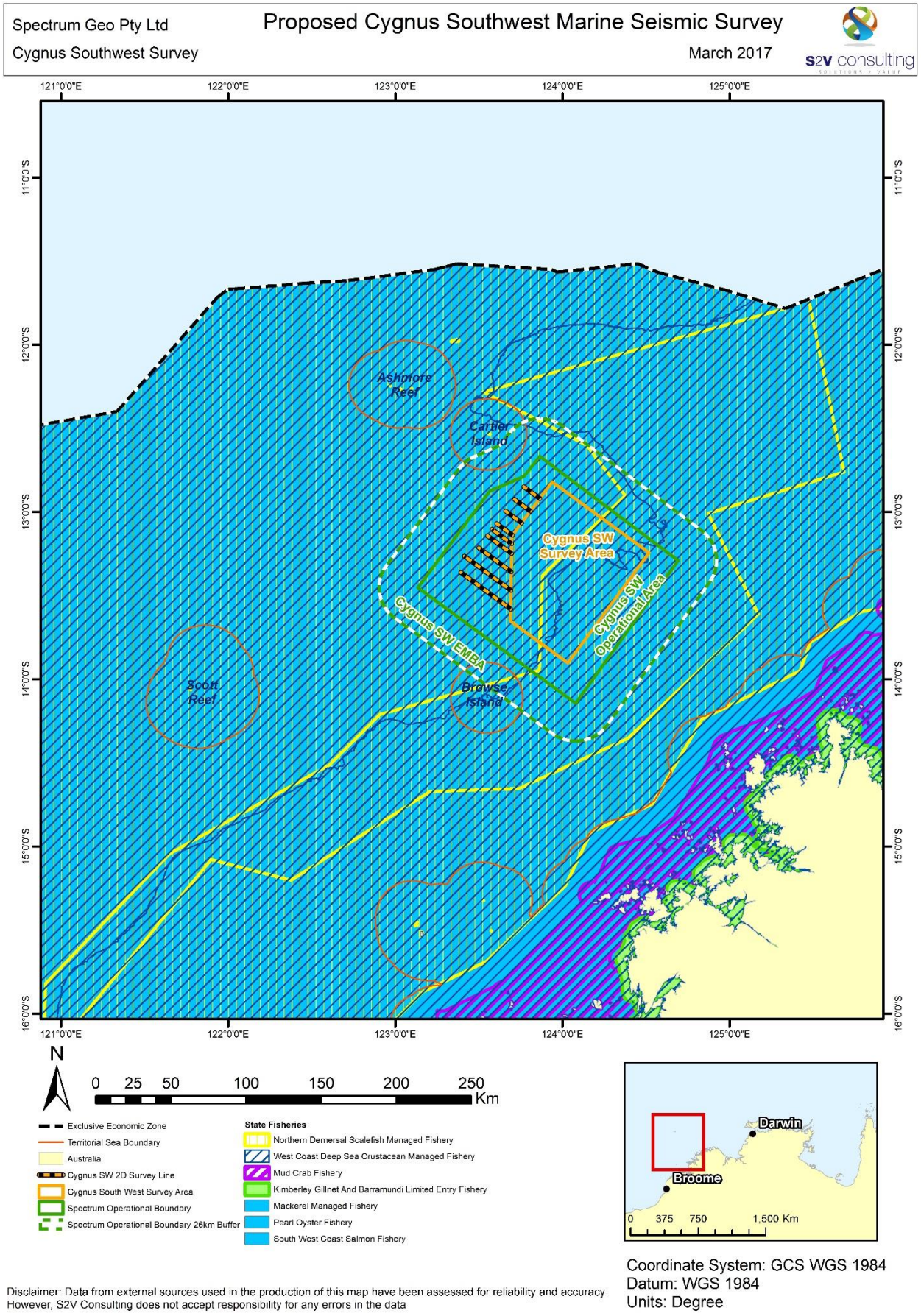


Figure 3-12: State fisheries in relation to Operational Area and EMBA (Map 2 of 2)

3.6 Windows of Sensitivity

Table 3-9: Timings of sensitivities associated with the proposed Survey Area

CATEGORY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Plankton												
Fish/Sharks	Timing of spawning activity varies between species.											
Southern Blue Fin Tuna												
Whale shark foraging and migration												
Hawksbill turtle nesting, interesting and hatching												
Flatback turtle mating, nesting and hatching												
Green turtle mating, nesting and hatching												
Loggerhead turtle mating, nesting and hatching												
Humpback whale migration						northern			southern			
Blue whale migration							northern			southern		
Seabird nesting: terns, shearwaters												
Migratory shorebirds												

KEY / NOTES	
	Peak activity, presence reliable and predictable
	Lower level of abundance/activity/presence
	Negligible activity occurring

4 ENVIRONMENTAL RISK ASSESSMENT

An Environmental Risk Assessment (ERA) has been undertaken to understand and manage the environmental impacts and risks associated with the Cygnus SW MSS. This ERA is designed to provide:

+ details of the environmental impacts and risks for the survey;
+ an evaluation of all the impacts and risks, appropriate to the nature and scale of each impact or risk; and
+ details of the control measures that will be used to reduce the impacts and risks of the activity to ALARP and to an acceptable level.

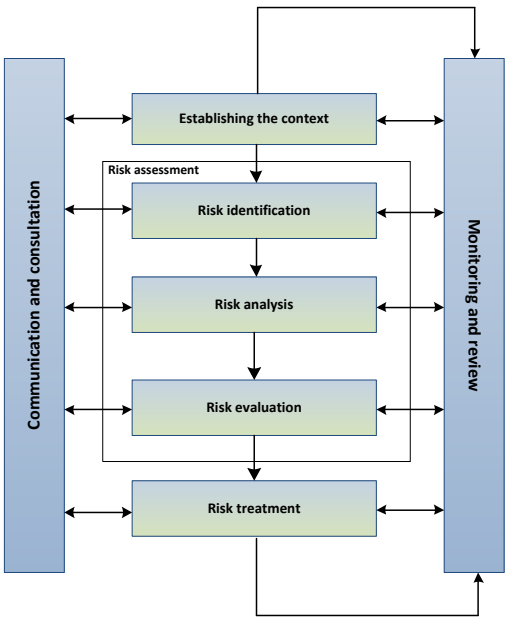
4.1 Risk Assessment Methodology

The ERA methodology applied is consistent with the Australian/New Zealand Standard AS/NZS ISO 31000:2009 Risk management–Principles and guidelines, Handbook HB 203:2012 Managing environment-related risk, and Handbook HB 89-2012 Risk management - Guidelines on risk assessment techniques. The risk assessment has been undertaken to identify the sources of risk (aspects) and potential environmental impacts associated with the activity and to assign a level of significance or risk to each impact. The risk management methodology provides a framework to demonstrate:

+ that the identified impacts and risks are reduced to ALARP; and
+ the acceptability of impacts and risks.

The risk has been measured in terms of likelihood and consequence, where consequence is defined as the outcome or impact of an event, and likelihood as a description of the probability or frequency of the identified consequence occurring.

The key steps used for the risk assessment are shown in **Figure 4-1**.



Source: modified from *AS/NZS ISO 31000:2009 Risk management*.

Figure 4-1: Key steps used for risk assessment

4.1.1 Risk Identification and Analysis

The environmental risks associated with the proposed MSS within the Cygnus SW operational area have been assessed by a methodology that:

- identifies the activities and the environmental aspects associated with them;
- identifies the values/attributes at risk within and adjacent to the operational area;
- defines the potential environmental effects of the activities;
- identifies the likelihood of occurrence and potential consequences; and
- determines overall environmental risk levels using a likelihood and consequence matrix.

Risks were identified during the ERA for both planned (routine and non-routine) and unplanned (accidents/incidents) activities. Potential environmental impacts are then determined based on the stressor type.

Risk analysis further develops the understanding of a risk by defining the impacts and assessing appropriate controls. Risk analysis for the Cygnus SW MSS considered previous risk assessments for similar activities, review of relevant studies, review of past performance, external stakeholder consultation feedback and review of the existing environment and key sensitivities/values.

The following key steps were undertaken for each identified risk during the risk assessment:

- identification of decision type in accordance with the decision support framework;
- identification of appropriate control measures (preventative and mitigation) aligned with the decision type; and
- determination of the residual risk rating.

These steps have been described in the following sections.

4.1.2 Decision Making Framework

To support the risk assessment process, the Guidance on Risk Related Decision Making (Oil & Gas UK 2014) has been utilized to determine the level of supporting evidence that may be required to draw sound conclusions regarding risk level and whether the risk is ALARP and acceptable.

This is to ensure:

- activities do not pose an unacceptable environmental risk;
- appropriate focus is placed on activities where the risk is demonstrated to be ALARP and is anticipated to be acceptable; and
- appropriate effort is applied to the management of risks based on the uncertainty of the risk, the complexity and residual risk rating.

Determining whether risks have been reduced to ALARP requires an understanding of the nature and cause of the risk to be avoided and the sacrifice (in terms of safety, time, effort and cost) involved in avoiding that risk.

Decision Making Tools

The following framework tools are applied, as appropriate, to assist with identifying control measures based on the decision type described above:

- Legislation, Codes and Standards (LCS) – identifies the requirements of legislation, codes and standards which are to be complied with for the activity.

- Good Industry Practice (GIP) – identifies further engineering control standards and guidelines which may be applied over and above that required to meet the legislation, codes and standards.
- Professional Judgement (PJ) – uses relevant personnel with the knowledge and experience to identify alternative controls. When formulating control measures for each environmental impact or risk, the 'Hierarchy of Controls' philosophy, which is a system used in the industry to minimise or eliminate exposure to impacts or risks, is applied. The Hierarchy of Controls are, in order of effectiveness (**Table 4-1**):
  - Eliminate; Substitute;
  - Engineer;
  - Isolate;
  - Administrative; and
  - Protection.
- Risk Based Analysis (RBA) – assesses the results of probabilistic analyses such as modelling, quantitative risk assessment and/or cost benefit analysis to support the selection of control measures identified during the risk assessment process.
- Company Values (CV) – identifies values identified in Spectrum's HSE Policy.
- Societal Values (SV) – identifies the views, concerns and perceptions of relevant stakeholders and addresses relevant stakeholder concerns as gathered through consultation.

Note: *administrative controls are included, where applicable, under Legislation, Codes and Standards and Good Industry Practice.*

Although commonly used in the evaluation of occupational health and safety (OHS) hazard control, the Hierarchy of Controls philosophy is also a useful framework to evaluate potential environmental controls to ensure reasonable and practicable solutions have not been overlooked.

Table 4-1: Hierarchy of Controls

Control	Effectiveness	Seismic survey examples
Eliminate		*Get rid of the impact or risk.* Excess chemicals are returned to shore rather than discharged overboard.
Substitute		*Change the impact or risk for a lower one.* Substitute a large airgun array for a smaller one.
Engineering		*Engineer out the impact or risk.* Use solid streamers rather than fluid-filled streamers.
Isolation		*Isolate people or the environment from the impact or risk.* Avoid acquiring data near sensitive turtle nesting beaches during nesting season.
Administrative		*Provide instructions or training to people to lower impact or the risk.* The use of procedures (e.g. at sea refuelling procedures) and pre-work job hazard analysis (JHAs) to assess and minimise the environmental impacts or risks of an activity.
Protective*		*Use of protective equipment.* The provision and use of personnel protective equipment (PPE).

***Note**: *Not used in this ERA – related to safety rather than environment.*

4.2 Residual Risk Rating Process

The residual risk rating process is undertaken to assign a level of risk to each impact measured in terms of consequence and likelihood. The assigned risk level is the residual risk (i.e. risk with controls in place) and is therefore determined following the identification of the decision type and appropriate control measures. The risk rating process considers the environmental impacts and where applicable, the social and cultural impacts of the risk.

4.2.1 Categorisation of Environmental Consequences

Environmental consequences arising from potential environmental aspects of the survey have been categorised from Slight to Catastrophic (**Table 4-2**).

4.2.2 Assessment of Likelihood Occurrence

The next step in the risk analysis process is to identify the likelihood of occurrence for the potential environmental impacts and risks. The likelihood of occurrence (from Remote to Highly Likely) for the potential environmental impacts from the proposed seismic survey have been estimated based on industry incident reporting, previous ERA and professional judgement (**Table 4-2**).

Table 4-2: Environmental event potential matrix

		LIKELIHOOD LEVEL					
CONSEQUENCE LEVEL		Rare	Highly Unlikely	Unlikely	Possible	Likely	Highly Likely
	Catastrophic	2	2	1	1	1	1
	Massive	3	2	2	1	1	1
	Major	3	3	2	2	1	1
	Moderate	4	3	3	2	2	1
	Minor	4	4	3	3	2	2
	Slight	4	4	4	3	3	2

4.3 Risk Evaluation

Environmental risks cover a wider range of issues, multiple species, persistence, reversibility, resilience, cumulative effects and variability in severity. The degree of environmental risk and the corresponding threshold for acceptability has been adapted to include principles of ecological sustainability (given as an objective in the Environment Regulations and defined in the EPBC Act), the Precautionary Principle and the corresponding environmental risk threshold decision-making principles used to determine acceptability.

4.3.1 Demonstration of ALARP

As outlined in **Table 4-1**, impacts and risks are reduced to ALARP where:

- The residual risk is LOW:
  - good industry practice or comparable standards have been applied to control the risk, because any further effort towards risk reduction is not reasonably practicable without sacrifices grossly disproportionate to the benefit gained.
- The residual risk is MEDIUM or HIGH:
  - good industry practice is applied for the situation/ risk; or
  - alternatives have been identified and the control measures selected to reduce the impacts and risks to ALARP. This may require assessment of Company and industry benchmarking, review of local and international codes and standards, consultation with stakeholders etc.

4.3.2 Demonstration of Acceptability

The following process has been applied to demonstrate acceptability (as illustrated in **Table 4-3**):

- LOW residual risks are 'Broadly Acceptable', if they meet legislative requirements, industry codes and standards, regulator expectations, the Spectrum HSE Policy and industry guidelines.
- MEDIUM and HIGH residual risks are 'Broadly Acceptable' if ALARP can be demonstrated using good industry practice, risk based analysis, if societal concerns are accounted for and the alternative control measures are disproportionate to the benefit gained.
- SEVERE residual risks are 'Intolerable' and therefore 'Unacceptable'. Risks will require further investigation and mitigation to reduce the risk to a lower and more acceptable level. If after further investigation the risk remains in the severe category, the risk requires appropriate business sign-off to accept the risk.

Table 4-3: Residual risk levels and associated decision making tools and principles

Residual Risk Level	Environmental Threshold	Decision Making Tools	Environmental Decision Principles
LOW Broadly Acceptable Zone	No substantial risk (i.e. negligible risk) of harm to species or communities	Comparison to codes and standards, good oilfield practice and professional judgement are used to assess risk acceptability	If the environmental risk of the hazard has been found to be 'Broadly Acceptable' and the control measures are consistent with applicable standards and good industry practice then no further action is required to reduce the risk further. However, if a control measure that would further reduce the impact or risk is readily available, and the cost of implementation is not disproportionate to the benefit gained, then it is considered 'reasonably practicable' and should be implemented.
MEDIUM / HIGH ALARP Zone	Likely to cause, or substantial risk of causing serious harm to non-listed species or communities	Risk based analysis are used in addition to comparison to codes and standards, good oilfield practice and professional judgement to assess risk acceptability.	An iterative process to identify alternative / additional control mechanisms has been conducted to reduce the risk to the 'Broadly Acceptable' zone. However, if the risk cannot be reasonably reduced to the 'Broadly Acceptable' zone without grossly disproportionate sacrifice; then the mitigated environmental risk is considered to be ALARP.
SEVERE	Likely to cause, or substantial risk of causing significant	All of above decision making tools apply plus	If the environmental impact or risk has been found to fall within this zone then the activity should not be carried out. Work to reduce the

Residual Risk Level	Environmental Threshold	Decision Making Tools	Environmental Decision Principles
Intolerable Zone	impact to protected species or communities	consideration of company values and societal values	level of risk should be assessed against the Precautionary Principle with the burden of proof requiring demonstration that the risk has been reduced to the ALARP Zone before the activity can be commenced.

A range of criteria have been considered when evaluating the acceptability of environmental impacts and risks associated with the Cygnus SW MSS. This evaluation works at several levels, as outlined in **Table 4-4**.

Table 4-4: Acceptability criteria

Criteria	Question	Acceptability demonstrated
Policy compliance	Is the proposed management of the impact or risk aligned with the Spectrum HSE Policy?	The impact or risk must be compliant with the objectives of the company policies.
Management System compliance	Is the proposed management of the impact or risk aligned with the Spectrum HSE Policy and the Spectrum ISM Safety Management System?	Where specific Spectrum procedures and work instructions are in place for management of the impact or risk in question, acceptability is demonstrated.
Social acceptability	Have stakeholders raised any concerns about activity impacts or risks, and if so, are measures in place to manage those concerns?	Stakeholder concerns must have been adequately addressed and closed out.
Laws and standards	Is the impact or risk being managed in accordance with existing Australian or international laws or standards, such as EPBC Policy Statements, MARPOL, AMSA Marine Orders, Marine Notices etc.?	Compliance with specific laws or standards is demonstrated.
Industry best practice	Is the impact or risk being managed in line with industry best practice, such as APPEA Code of Environmental Practice, IAGC guidelines etc.?	Management of the impact or risk complies with relevant industry best practice.
Environmental context	Is the impact or risk being managed pursuant to the nature of the receiving environment (e.g. sensitive or unique environmental features generally require more management measures to protect them than environments widely represented in a region)?	The proposed impact or risk controls, EPO and EPS must be consistent with the nature of the receiving environment.
Environmentally Sustainable Development (ESD) Principles	Does the proposed impact or risk comply with the APPEA Principles of Conduct (APPEA 2003), which includes that ESD principles be integrated into company decision-making.	The Cygnus SW MSS is consistent with the APPEA Principles of Conduct.
ALARP	Are there any further reasonable and practicable controls that can be implemented to further reduce the impact or risk?	There is a consensus that residual risk has been demonstrated to be ALARP.

5 PLANNED ACTIVITIES (ROUTINE AND NON-ROUTINE)

Table 5-1: Risk evaluation summary of planned activities

Planned event	Residual risk	Acceptability of residual risk
Noise emissions (non-seismic)	Low	Broadly Acceptable
Light emissions	Low	Broadly Acceptable
Physical disturbance to benthic habitats due to deployment and retrieval of anchors	Low	Broadly Acceptable
Interaction with commercial fisheries and shipping	Medium	Acceptable if ALARP
Ballast water discharge, and biofouling of vessel hull, other niches and immersible equipment	Low	Broadly Acceptable
Underwater noise emissions from discharge of airgun array	Medium	Acceptable if ALARP
Reduced air quality from air emissions	Low	Broadly Acceptable
Discharge of bilge water, sewage and food waste	Low	Broadly Acceptable

Control measures to manage the potential environmental impacts and risks are included in Section 10.

5.1 Noise Emissions (non-seismic) from helicopter and vessel

5.1.1 Description of Risk

Noise emissions will occur on the surface and subsea through helicopter and vessel activities.

Vessels will emit noise from propeller cavitation, thrusters, hydrodynamic flow around the hull, and operation of machinery and equipment. 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 noise (Ross, 1987; 1993 in Skjoldal *et al*., 2009). Most sounds associated with vessels are broadband, though, tones are also associated with the harmonics of the propeller blades (Ross, 1987; 1993 in Skjoldal *et al*., 2009). McCauley (1998) examined the noise from a 64 m, 2,600 tonne rig tender vessel underway, which had a broadband source level of 177 dB re 1µPa. Usually, the larger the vessel or the faster a vessel moves results in more noise (Richardson *et al*., 1995). Depending on the vessel, source levels can range from less than 160 dB (trawlers) to over 200 dB re 1µPa @1m (super-tankers) (Simmonds *et al*., 2004). Noise contribution by support vessels is expected to be confined to the immediate vicinity of the vessels and within a radius of a few hundred meters.

Strong underwater sounds are detectable for only brief periods when a helicopter is directly overhead (Richardson *et al*., 1995). 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. Reports for a Bell 214 (regarded to be one of the noisiest) indicated that noise is audible in the air for 4 minutes before the helicopter passed over underwater hydrophones. The helicopter was audible underwater for only 38s at 3m depth and 11s at 8m depth (Greene, 1985a; cited in Richardson *et al*, 1995). Noise levels reported for Bell 212 helicopter during fly-over is 162dB re 1µPa and for Sikorsky-61 is 108dB re 1µPa at 305m (Simmonds *et al*., 2004).

5.1.2 Potential Environmental Impacts

Reactions of cetaceans to circling aircraft (fixed wing or helicopter) are sometimes conspicuous if the aircraft is below an altitude of 300m, uncommon at 460m and generally undetectable at 600m (NMFS, 2001). Baleen whales sometimes dive or turn away during over-flights, but sensitivity seems to vary depending on the activity of the animals. The effects on cetaceans seem transient, and occasional over-flights probably have no long-term consequences on cetaceans. Observations by Richardson and Malme (1993) indicate that, for bowhead whales, most individuals are unlikely to react significantly to occasional single-pass low-flying helicopters transporting personnel and equipment at altitudes above 150m. Leatherwood *et al*. (1982) observed that minke whales responded to helicopters at an altitude of 230m by changing course or slowly diving. Other fauna that may be in the vicinity of the survey and chase vessels that may react to helicopter or vessel noise include turtles and whale sharks, as indicated by the presence of BIA's (refer **Section 3.4.1**).

Noise emitted by vessels and helicopters during the activity will be short in duration and is likely to be reduced to background levels within kilometres to tens of kilometres. As such, any potential related marine fauna behavioural impacts are expected to be temporary and short ranged.

Underwater noise will also be generated from the survey vessel and from the chase vessel. Studies of underwater noise associated with petroleum operations have generally reported that the main source of noise relates to the use of thrusters to maintain vessel position, rather than cruising. Noise characteristics and levels vary considerably between vessel types and the particular activity being conducted.

The survey and chase vessels will slow down within certain distances of cetaceans, turtles or whale sharks and will generally be operating at slow operating speeds (generally 4-5 knots unless in an emergency). In addition, the source data indicates that vessel noise emissions from routine operations do not have the intensity and characteristics likely to cause physiological damage to marine fauna, which is further supported by the fact that the noise emitted from moving vessels is generally of a lower intensity in comparison to stationary vessels utilising dynamic positioning (DP).

5.2 Light emissions

5.2.1 Description of risk

During the activity, safety and navigational lighting on the vessels will generate light emissions that may potentially affect marine fauna behaviour.

Lighting typically consists of bright white (metal halide, halogen, fluorescent) lights.

Minimum lighting is required for safety and navigational purposes on board the vessel so it cannot be eliminated if the proposed activity is to proceed.

5.2.2 Potential Environmental Impacts

Artificial lighting has the potential to affect marine fauna, notably turtles, fish and seabirds. Behavioural responses to light can alter foraging and breeding activity in turtles, seabirds, fish and dolphins, conferring competitive advantage to some species and reducing reproductive success and/or survival in others.

It is possible that seabirds may fly over the operational area, particularly due to overlap with seabird BIAs for both foraging and breeding (**Table 3-5**) and the presence of emergent features in relatively close proximity to the operational area for potential seabird resting. The potential impacts of light emissions to fish from seismic vessels are expected to be restricted to localised attraction, temporary disorientation and increased predation. Since the seismic vessel will be continuously moving, any

impacts arising from light emissions will be temporary only and are considered to be minor and restricted to a small proportion of the population. While fish spawning may occur in the operational area there is no known significant spawning or aggregating habitat for any of the fish species identified in **Table 3-5**, and it is unlikely that these species would use this area for any significant period of time. Although the operational area overlaps the Continental Slope Demersal Fish Communities KEF, given the depth of the feature, light impacts are not considered credible.

Light pollution reaching turtle nesting beaches is widely considered detrimental owing to its ability to alter important nocturnal activities including choice of nesting sites and orientation/navigation to the sea by post-nesting females and hatchlings (Witherington and Martin, 2003). Once in the ocean, hatchlings are thought to remain close to the surface, orient by wave fronts and swim into deep offshore waters for several days to escape the more predator-filled shallow inshore waters. During this period, light spill from coastal port infrastructure and ships may 'entrap' hatchling swimming behaviour, reducing the success of their seaward dispersion and potentially increasing their exposure to predation via silhouetting (Salmon *et al*., 1992).

The seismic vessel will be continually moving and will have 24hour operations. Therefore, any potential light disturbance to marine turtles will be very temporary. The introduction of light from the proposed survey is not expected to cause disturbance to marine turtles given the distance from emergent features where turtles nest (>30 km away). The risk of population level impacts to marine turtles from light associated with the survey vessel is considered very low. Furthermore, during the peak of the nesting season for green turtles in the region (between 1 November and last day of February), there will be no seismic acquisition along the four northernmost 2D sail lines closest to the Cartier Island CMR. This will further minimise the likelihood of any artificial lighting impacts on turtle hatchlings as the survey vessel acquiring data will be >30km away from the boundary of the CMR during key periods for turtles (mating, aggregating, nesting)

5.3 Physical disturbance to benthic habitats due to deployment and retrieval of anchors

5.3.1 Description of Risk

Anchor deployment and retrieval has the potential to cause minor localised physical damage to benthic habitats and biological communities described in **Section 3.4**.

5.3.2 Potential Environmental Impacts

Benthic habitats vary throughout the survey area as described in **Section 3.3.3**. They include sparse benthic assemblages, isolated shallow shoals and diverse coral reef.

Benthic species richness is greatest in shallow water environments and at the deeper depths it can be assumed that there will be lower levels of species richness as a result of lower light infiltration to the seabed, resulting in a sparser benthic habitat.

The potential impacts to benthic habitats through anchoring include:

- Mortality of benthic fauna; and
- Indirect disturbance to benthic habitats and associated marine fauna by sedimentation through increased turbidity of the near-seabed water column.

The potential and significance of impacts caused by anchoring is dependent on the type of receiving environment, the size of the anchor and chain and the frequency of anchoring. Soft sediment benthic habitats of the operational area are relatively devoid of sensitive habitats (coral reefs, seagrass meadows) other than in identified sensitive areas such as Cartier Island and Heywood shoal. Anchoring typically causes minimal disruption to soft sediment and, given the widely distributed

benthic inflora and fauna found within these areas, would have a minimal impact to the benthic fauna and inflora communities. Furthermore, anchoring would only impact a highly localised area of seabed.

With respect to routine operations during the proposed survey, impacts are unlikely to occur since anchoring within the operational area is not planned. Anchoring would only occur in emergency circumstances and the seismic and support vessels are fitted with highly sophisticated dynamic position fixing equipment.

5.4 Interaction with Commercial fisheries, Tourism and Shipping

5.4.1 Description of Risk

The vessel(s) will be operating 24 hours a day, seven days a week for the duration of the proposed survey. The physical presence of vessels in the operational area is a potential hazard to other marine users including commercial fisheries, tourisms and shipping.

5.4.2 Potential Environmental Impacts

5.4.2.1 Commercial Fisheries

There is a range of commercial fishery activity in the area of the proposed survey. Disruption to commercial fisheries in the area could result from:

- direct effects of underwater noise disturbance on target fish populations;
- indirect effects of underwater noise disturbance on fish prey species;
- restriction of access to fishing grounds due to vessel movements and operations;
- seismic equipment loss and subsequent interference with fishing gear (entanglement);
- loss of fishing gear e.g. buoyed fish traps, cray pots; and
- recreational take of finfish species from the survey vessel.

Fisheries potentially impacted by the activities are discussed in **Section 3.5**, the majority of which show limited fishing activity within the operational area and therefore impacts are considered minimal.

To reduce interactions with the proposed survey activities, fishing companies and individual license holders operating in the operational area and EMBA have been contacted by Spectrum directly and via the appropriate peak fishing industry organisations, and informed of the proposed location and timing of the seismic survey (see **Section 9**). Spectrum will continue to engage with commercial fisheries on a regular basis (i.e. every six months) and before a survey commences, provide as much advanced notice as possible, including both three-week and 7-10 day forecasts.

Consultation undertaken with commercial fisheries resulted in one response from the Northern Demersal Scalefish fishery (NDSF) stating that surveys should be conducted outside the spawning windows of the key indicator species in their fishery (goldband snapper and red emperor). These windows were identified by the NDSF as Jan-April and October. In response, Spectrum agreed to not undertake the MSS in Jan-April inclusive (but not October, affected period when the red emperor also spawns), even though this results in a much shortened window within which the survey can take place. Consultation with the Department of Fisheries identified the spawning periods for these species as Jan-April and there is a sparsity of information on the exact areas where these species spawn. The habitat where demersal fish species spawn is usually in shallow sheltered waters which are not evident within the operational area. The only place that may offer sheltered habitat is around Heywood shoal.

Spectrum have conducted noise modelling for the survey to understand the potential impacts to sensitive receptors, including fish from seismic arrays and this modelling has also been used to directly inform the buffer provided around Heywood Shoal to reduce potential impacts to site attached fish. Considering the likely spawning habitats of fish species, the shoal may be an area where spawning occurs as it is the only area of shallower water with rocky shoals present. The spatial buffer of 200m from the 50m depth contour implemented is to avoid potential impacts to fish at thresholds identified by the most recent research (Popper *et al* (2014) (refer Section 5.6). Throughout the rest of the survey area, the water depths are >50m and unlikely to provide suitable spawning habitat for demersal fish species. By avoiding the majority of the spawning season and implementing additional spatial buffers around the areas where these species may spawn, the potential impacts are reduced. Given the sparsity of knowledge on where these particular species spawn, there is not enough evidence to avoid specific areas at specific times.

Prior to survey commencement, Spectrum will consider any new information pertaining to red emperor spawning ground locations within the Survey Area in October and take reasonable steps to mitigate this impact.

Given the proposed buffers in place around Heywood shoal which includes no seismic fired within 200 m of the 50m contour, and the inclusion of EPS-108, an additional requirement to avoid the shoal during October is not considered ALARP for a number of reasons.

- The spawning period for red emperor is unlikely to be significantly disrupted by the survey given the fish are not site attached and will only be exposed to the seismic source for short periods of time when the vessel is passing by the shoal.
- Additionally, Heywood shoal is not noted to be particularly important for this species and, as stated in the EP, it is considered highly unlikely that it is a spawning ground as scientific literature suggests this species prefers shallow inshore reefs, and it is considered more likely that adults may forage rather than spawn there. The period of October identified by the NWSA was not identified by the DoF in consultation as a key period for red emperor species, and no further evidence has been provided by the NWSA that this area is key for this species.
- The proposed race track pattern for the survey is efficient and allows for the implementation of other temporal controls (along the 2D tie in lines). Amending the survey lines to avoid Heywood shoal in October would result in extension of the survey duration and consequently result in additional impacts to other marine fauna, whilst significantly increasing the cost of the survey. Although the survey is not located within migration corridors for whales, the survey is likely to take place during migration season (given the temporal exclusions in place) potentially resulting in higher numbers of individual whales in the area. Although the survey is not predicted to have significant impacts to migrating whales (given the distance from BIAs and the controls in place), increasing the survey duration increases the potential for disturbance to other marine fauna.
- Further modelling would be recommended to determine the potential received SPL that may result in behavioural impacts to fish (the modelling focused on the injury thresholds only) and thus justify the required buffer around Heywood shoal to avoid behavioural disturbance in October. This would incur additional costs and approval delays whilst modelling is obtained, interpreted and implemented.

5.4.2.2 Shipping

There are no known designated commercial shipping routes through the operational area. Should commercial vessels need to deviate from planned routes to avoid the survey vessel, this may slightly increase transit times and fuel consumption.

The presence of the survey vessel and towed array represents a potential navigational hazard and other vessels will need to avoid the survey vessel to prevent vessel collisions, entanglement of/damage to the streamer and other components of the towed array, and other incidents. The highest potential risk will be during slow speed turning of the survey vessel during line changes, or when it is moving perpendicular to the normal passage of commercial shipping.

There will be a need to be active and maintain clear and effective communication with all shipping within the vicinity of the survey vessel whilst the towed array is deployed and normal seismic acquisition operations are underway. There may be a considerable speed difference between commercial shipping and the survey vessel whilst the latter is conducting operations. Any avoiding or diversionary action that may have to be taken by a non-survey related commercial vessel will have to be taken without compromising navigational safety and as such, the survey vessel Master will have to establish communications early with any potential vessel that may be approaching.

A Safe Navigation Area (SNA) or exclusion zone will be in place for the duration of proposed survey activities. The extent of this SNA will be specific to the survey vessel and extent of the towed array, covering at least a 10-km radius from the survey vessel to account for the length of the towed streamer array (i.e. 8,100 m for the MSS). A support/chase vessel will implement the SNA if approaching vessels fail to heed navigational warnings (e.g. NAVAREA X warnings, Notices to Mariners (NTM), beacons, lights, radio contact, etc.).

Furthermore, based on consultation with AMSA (**Section 9**), Spectrum will notify AMSA's Joint Rescue Coordination Centre (JRCC) for AUSCOAST warning broadcasts 24-48 hours before survey operations commence. Additionally, the Australian Hydrographic Service (AHS) will be contacted no less than three working weeks before survey operations commence for the promulgation of related NTM. At the conclusion of the survey, Spectrum will contact AMSA and provide comments on the survey operations and the interactions (if any) with commercial shipping during the survey (i.e. any lessons learned). This information will be communicated to AMSA via a marine traffic log, whereby any close encounters and communications are commented upon.

5.4.2.3 Tourism

Tourism activities are expected to occur infrequently in the operational area given the water depths. Activities such as diving and recreational fishing may occur around the Ashmore Reef and Cartier Islands, and traditional or subsistence fishing within the MoU box however interaction with these activities and the survey vessel are unlikely to occur given the minimum distance from the islands/reef will be 31km.

One historical shipwreck, the Ann Millicent, is located within the operational area, however due to strong currents and swells and remote location, diving here is dangerous and therefore the wreck is not a popular dive site. As such, impacts to tourism are not expected. If identified through pre-survey notification and consultation with DPaW and the Director of National Parks that proposed survey operations overlap within 10 km of charter diving operations, a risk assessment shall be undertaken and a simultaneous operations (SIMOPS) plan developed jointly, if required, with individual operators. The Diving Medical Advisory Committee guidelines on *Safe Diving Distance from Seismic Surveying Operations* (DMAC 12) were developed for commercial dive operations. Each of these guidelines was assessed for acceptability to the proposed survey activities and will be adopted accordingly to reduce potential impacts on recreational diving

5.5 Ballast Water Discharge, and Biofouling of Vessel Hull, Other Niches and Immersible Equipment

5.5.1 Description of Risk

Invasive Marine Species (IMS) are marine plants or animals that have been introduced into a region beyond their natural range and have the ability to survive, reproduce and establish founder populations. Species of concern are those that are not native to the region; are likely to survive and establish in the region; and are able to spread by human mediated or natural means.

In the case of Spectrum's proposed activities during the Cygnus SW MSS, the key vectors requiring management attention include:

+ discharge of high risk ballast water taken up at international or domestic sources;
+ biofouling on vessel hulls and other external niches (e.g. propulsion units, steering gear and thruster tunnels);
+ biofouling of vessel internal niches (e.g. sea chests, strainers, seawater pipe work, anchor cable lockers and bilge spaces etc.); and
+ biofouling on equipment that routinely becomes immersed in water.

5.5.2 Potential Environmental Impacts

5.5.2.1 Ballast Water

Ballast water is responsible for 20–30% of all marine pest incursions into Australian waters, however, research indicates that biofouling (the accumulation of aquatic micro-organisms, algae, plants and animals on vessel hulls and submerged surfaces) has been responsible for more foreign marine introductions than ballast water (DAFF, 2011). IMS, if they successfully establish, can out-compete native species for food or space, preying on native species or changing the nature of the environment and can subsequently impact on fisheries or aquaculture. These direct or indirect impacts have the potential to threaten a range of sectors including commercial fisheries and aquaculture, the tourism industry, human health, shipping and infrastructure.

If an IMS is introduced, they have been known to colonise areas outside of the areas they are introduced to. Subsequently there is the potential for an introduction. In the event that an IMS is introduced into the operational area, given the lack of diversity and extensiveness of similar benthic habitat in the region, there would only be a minor reduction in the physical environment.

Given the depth of the operational area (3 – 430 m), and the distances maintained from shallower areas at Cartier Island and Heywood Shoal along with additional controls for ballast water exchange (occurring in waters >200m deep) it is unlikely that an IMS would be able to successfully translocate from the operational area to surrounding shallower habitats. With controls in place to reduce the risk of introduction of IMS the likelihood of introducing an IMS is considered low.

5.5.2.2 Biofouling

Biofouling on vessel hulls and other external niche areas, biofouling on internal niches and biofouling on equipment routinely immersed in water all pose a potential risk of introducing IMS into Australia. Under the National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Commonwealth of Australia, 2009) a risk assessment approach is recommended to manage biofouling.

The potential biofouling risk presented by the survey and support vessels selected to acquire the survey will relate to the length of time that these vessels have already been operating in Australian waters or, if they have been operating outside Australian waters, the location/s of the surveys they has been undertaking, the length of time spent at these location/s, and whether the vessels have

undergone hull inspections, cleaning and application of new anti-foulant coating prior to returning to operate in Australia.

5.6 Underwater Noise Emissions from Discharge of Airgun Array

5.6.1 Description of Risk

The proposed Cygnus SW MSS will utilise a seismic source consisting of a single airgun array with a maximum capacity of 3,090 cui, which will be used to generate acoustic pulses by periodically discharging compressed air into the water column as the vessel transits along planned survey lines within the Cygnus SW operational areas. The airgun array will produce at source (within one metre of the centre of the array) sound pressure levels (SPL) broadside in the order of 228 dB re 1µPa-m at 1m (see **Section 2.3.1**).

The primary environmental risk from seismic surveys is the potential adverse impacts to marine fauna from sound emissions caused by the discharge of underwater seismic pulses. The level of impact to marine fauna depends on multiple factors, such as sound intensity and duration, distance from the source, fauna species and the mitigation measures employed. Potential impacts range from physical or acute damage from close exposure to high sound levels, to various behavioural responses such as area avoidance or changed direction (McCauley 1994). **Section 5.6.2** provides an overview of the survey and acoustic source parameters.

Spectrum will use the smallest possible sound source to ensure efficiency of data collection and reduction of environmental risk to levels considered ALARP and acceptable. To ensure conservatism however, the maximum source that may be used (3,090 cui) is assessed in the EP.

Noise modelling

Noise modelling (JASCO, 2017) was commissioned for the proposed Cygnus MSS with a focus on potential impacts to receptors within the Cartier Island CMR and around Heywood Shoal. and a summary provided here. JASCO's peer-reviewed, acoustic models were verified with in-field data measured from over 20 underwater acoustic programs around the world, thus providing sufficient verification that the results presented in this EP are accurate and reliable.

Two sites were selected based on the proposed operational area.

Site 1: The closest operational location to the Cartier Island CMR, which is the end of a 2D tie in line. The water depth is 206 m.

Site 2: The shallowest operational location at Heywood shoal which is 250 m from the 30 m bathymetry contour. The water depth is 36 m.

Given the restriction on acquisition of the four northernmost 2D sail lines closest to the Cartier Island CMR during turtle nesting season (1st November to 28th February), these months were excluded from the modelling scope. The month of July indicates conditions would likely favour sound propagation, therefore to ensure precautionary estimates in the noise modelling results, this month was used.

Noise modelling results and sound source attenuation estimates are used to assess potential impacts to marine fauna, based on species specific threshold criteria sourced from available literature. Impact assessment for marine receptors are detailed below in **Section 5.6.2**.

<u>Site 1</u>

The noise modelling results from site 1 intend to determine if received noise levels at the CMR boundary are below thresholds of concern for identified marine fauna (specifically cetaceans and turtles). Table 5-2 provides the maximum over-depth sound levels received at the Cartier Island

CMR boundary enabling impact assessment on the potential receptors within the CMR to be conducted. As the modelling site selected was the one closest to the CMR boundary (>20 km away), at the end of a 2D sail line, the SEL and SPL at the CMR boundary will be lower than this throughout the rest of the survey and physiological or behavioural impacts to fauna are considered very unlikely.

Table 5-2: Site 1: maximum over depth sound levels at the CMR boundary

Metric	Sound Level
SEL (dB re 1µPa2s)	127.3
SPL (dB re 1µPa)	133.5

Site 2

The noise modelling results from Site 2 indicate the potential impacts to fish associated with the Heywood shoal. This site was initially chosen as it represented the shallowest operational limit in the survey, however further refinement has led to the vessel being further from Heywood shoal, and therefore these results are considered very conservative. The vessel will be at least 200 m from the 50m bathymetry contour at all times, and the modelling results show that the maximum distance from the vessel at this location that fish may potentially be impacted is 150 m. Therefore, no significant impacts to site-attached fish would be expected.

Table 5-3: Site 2: maximum horizontal distances from array to modelled seafloor peak pressure levels

Relevant animal type	Peal Pressure Level threshold (dB re 1µPa)	Distance R_{max} (m)
Fish: no swim bladder	213	90
Fish: Swim bladder not involved in hearing, swim bladder involved in hearing Turtles, fish eggs and larvae	207	150

5.6.2 Potential impacts

Background

Underwater noise has the potential to affect marine fauna in three main ways:

+ Injury to hearing or other organs. Hearing loss may be temporary (temporary threshold shift (TTS)) or permanent (permanent threshold shift (PTS));
+ Disturbance leading to behavioural changes or displacement of fauna. The occurrence and intensity of disturbance is highly variable and depends on a range of factors relating to the animal and situation; and
+ Masking or interfering with other biologically important sounds (including vocal communication, echolocation, signals and sounds produced by predators or prey).

Receptors with the potential to be impacted by underwater noise include:

+ Marine mammals (cetaceans);
+ Marine reptiles (turtles, seasnakes);
+ Elasmobranchs;
+ Fish, fish eggs and larvae (including plankton); and
+ Benthic invertebrates.

Temporary and Permanent Threshold Shifts

Temporary threshold shifts (TTS) in hearing occurs when an animal's hearing threshold is temporarily increased during and immediately after an exposure event to a loud sound source (Richardson *et al*. 1995). Permanent threshold shifts (PTS) occurs when an animal experiences a shift in their hearing threshold caused by prolonged or repeated exposure to high sound levels and resulting in permanent and irreversible damage (Richardson *et al*. 1995). Accurately measuring PTS is difficult and not always possible, and thus TTS measurements over time are used to predict likely occurrences of PTS.

5.6.2.1 Baleen Whales

TTS Threshold – Behavioural impact

Criteria suggested by Wood *et al* (2012) following collation of studies with Southall suggested a graded probability of response with 10% response likelihood at an SPL of 140 dB re 1µPa, 50% at an SPL of 160 dB re 1µPa, and 90% at an SPL of 180 dB re 1µPa for most marine mammals. As recommended by Jasco (2016), the threshold adopted for behavioural impacts is that which results in sound levels that exceed those that could disturb a marine mammal, and for impulsive sounds this is an SPL of 160 dB re 1µPa.

In addition, EPBC Policy Statement 2.1 determines suitable exclusion zones with an unweighted per pulse SEL threshold of 160 dB re 1µPa^{2}s (DEWHA, 2008). This threshold minimises the likelihood of TTS in large toothed cetaceans.

PTS threshold – Potential injury

Criterion used by the NMFS for potential injury is an SPL of 180 dB re 1µPa for cetaceans and is applied to impulsive and non-impulsive sounds. This threshold is a conservative estimate of the minimum threshold that could cause PTS and is adopted in this risk assessment.

Impact assessment

Based on noise modelling completed, sound exposure levels are expected to reduce to below 180 dB re 1µPa within 0.3 km of the source and below 160 dB re 1µPa within 3km of the source. The relevant modelling point is located approximately 17 km from the nearest BIA where migrating blue whales are expected. However, individuals may be present within the survey area and therefore may be closer to the source. It is expected that there will be negligible behavioural impacts in the event whales are within 3km of the survey vessel, given the implementation of the 500m shut down zone, PTS impacts are not considered credible. A low power zone of 2km is considered ALARP to mitigate against potential behavioural disturbances from underwater noise although behavioural disturbance thresholds may occur up to 3km radius from source. Due to the implementation of temporal controls to reduce potential impacts on values of the CMR (turtles) and fish spawning in the region, it is considered likely that the survey will be conducted during migration periods for whales. Although the survey does not overlap with the BIAs for whales, some individuals may still be expected in the area. Marine mammals are expected to display avoidance behaviour from the source and with the implementation of the 3km observation zone and 2km low power zone, they are well outside of a range that could cause physical or temporary physical impact. Acceptable levels of impact to individual whales are to have no injury to fauna, but behavioural impacts are expected and are considered acceptable given the lack of critical habitat for whale species in the area.

As there are no critical habitats for whales within the vicinity of the operational area, behavioural impacts are considered acceptable. As cetaceans will not be exposed to SPL above the threshold for injury due to implementation of the 500m shut down zone, and the low source size used resulting

in SPL reducing quickly within the 500m zone, only behavioural level impacts are expected. As behavioural level impacts are considered acceptable during the survey, increasing the low power zone to 3km is not considered appropriate as this could lead to increased duration of the survey due to the extended duration if whales are within the low power zone. Given the temporal restrictions already in place (no acquisition Jan-April, no acquisition Nov-April within 45 km of the Cartier Island CMR), this increases the likelihood of extending the survey into phases as there will be the potential for delayed start-ups which increases the costs associated with the survey. Surveying in phases also increases the potential for exclusion of fishers from the area for an extended period, additional emissions for mobilisation, and the risk of not completing the survey if a vessel is not available for the second phase. Through the implementation of increased shut down zones (EPBC Policy Statement 2.1, part B.6, this provides a higher level of protection to those whale species within the area in times of low visibility or numerous sightings. As described above, behavioural impacts to whales are considered acceptable during the survey given the lack of critical habitat for these species in the operational area.

5.6.2.2 Toothed Whales

Physical damage to the auditory system of cetaceans may occur at pulsed sound levels of about 230 to 240 dB re1µPa peak and 198 dB re: 1 µPa2-s SEL (Gausland, 2000; Southall et al 2007), which is equivalent to a distance of very short range within tens of metres from the energy source. Risk of physical injury is considered very low. As recommended by Jasco (2016), the threshold adopted for behavioural impacts is that which results in sound levels that exceed those that could disturb a marine mammal, and for impulsive sounds this is an SPL of 160 dB re 1µPa.

Thresholds

For the purposes of conducting a risk assessment, the most recent reviews are considered the most relevant and the thresholds adopted for impact assessment of toothed whales are 195 dB re 1µPa (SPL) for TTS and 160 dB re 1µPa (SPL) for behavioural impact (Gordon *et al*, 2003; NMFS, 2014).

Impact Assessment

Noise modelling (Jasco 2017) suggests that sound pressure levels will reduce to below 195 dB re 1 µPa within 0.08 km from source (. Mitigation measures and adherence to Policy Statement 2.1 will ensure that the likelihood of whales being within a metre of the source is highly unlikely. Therefore, the potential for TTS is considered low and risk of impact is ALARP. Behavioural disturbance may occur within 3km from the source and is expected to be temporary and at an individual level.

5.6.2.3 Marine Turtles

PTS and TTS Thresholds

For the purposes of conducting a risk assessment, the thresholds adopted for impact assessment of turtles are 207 dB re 1µPa (SPL) for physiological impact and 166 dB re 1µPa (SPL) for behavioural impact (DEWHA, 2008). This behavioural threshold has also been adopted by the NMFS in the Arctic Programme EIS following consideration of other studies (Jasco, 2017). Given the importance of the Cartier Island CMR to marine turtles, the impact assessment is focused on behavioural impacts to turtles within the CMR as potential injury to turtles is not considered acceptable.

Impact Assessment

Noise modelling conducted (Jasco, 2017) indicates that noise levels will be less than 160dB re 1µPa within 3 km of the source closest to the CMR boundary. At the CMR boundary itself, the levels will be 133.5dB re 1µPa, well below the threshold for behavioural impacts to marine turtles.

In addition, as the four northernmost 2D sail lines closest to the Cartier Island CMR will not be acquired during peak turtle nesting season (1st November – 28th February), even turtles that leave the CMR during the peak period are highly unlikely to be behaviourally impacted. The minimum distance that the source will be fired during turtle nesting will be 45 km, the distance between the survey area and the CMR boundary.

This temporal buffer is adopted in line with the Recovery Plan for marine turtles in Australia, which identifies Ashmore Reef and all waters within a 20 km radius as habitat critical to the survival of green turtles. Given the proximity of Ashmore Reef CMR to Cartier Island CMR, it is recognised that significant numbers of green turtles may also be encountered in the CMR. Seasonal exclusions from turtle nesting areas during nesting season will prevent any possible behavioural disturbance from affecting nesting success within all waters 20km of the CMR.

5.6.2.4 Sea snakes

As mentioned in **Section 3**, Cartier Island CMR has been recognised for the high diversity and density of sea snakes, including the two critically endangered species Short-nosed seasnake (*Aipysurus apraefrontalis*) and Leaf-scaled seasnake (*Aipysurus foliosquama*) (Commonwealth of Australia, 2012). Marine Reptiles Report Card stated that Sea snakes are vulnerable both to direct impacts of trawl fishing (bycatch) and to indirect impacts due to habitat destruction and disruption of the trophic structure (Commonwealth of Australia, 2012). However whilst noise pollution from seismic activities is evidenced as a potential concern for turtles, impacts to seasnakes from seismic operation is unknown due to either data deficient or impacts not assessed (Commonwealth of Australia, 2012).

No studies have investigated the behavioural response of sea snakes to noise. However, a research project is being undertaken by University of Adelaide to investigate the impact of seismic surveys on threatened sea snakes in Australia's North West Shelf.

According to this project, three characteristics suggest that sea snakes might be especially vulnerable to air gun impacts include:

- Sealed nostrils and an air-filled lung extending the length of the body, plus slower swimming speeds than other marine vertebrates, might mean they are unable to avoid tissue damage at close range.
- Scale sensillae that allow sea snakes to detect the vibrations of their prey show peak sensitivity to low frequencies that overlap those produced by air guns, this may disrupt feeding (via acoustic masking) and provoke avoidance behaviour.
- Translocation (a common response to air guns) is associated with high mortality in sea snakes; habitat displacement might have long term consequences for highly isolated NSW populations[2].

Thresholds

Until the outcome of the project is available, no thresholds can be determined. It is expected that sea snakes generally move away from acoustic emissions similar to turtles (EPA, 2007). Therefore the threshold for behavioural disturbance is assumed to be 166 dB re 1µPa (SPL). Following publication of this research (or other relevant papers), an appropriate threshold for seasnakes may be determined. If this is the case, a review of the impact assessment conducted on seasnakes will be undertaken in accordance with **Section 4**.

Impact Assessment

[2] http://www.apscience.org.au/projects/APSF_12_5/apsf_12_5.html

Sea snakes are generally found in the shallow waters of the reef flats where they forage, therefore it is considered unlikely they would be frequently observed in the outer boundary of the CMR. However, the SPL at the CMR boundary from the location closest to the boundary is 133.5 re 1µPa (SPL) which is well below the behavioural level of impact for marine turtles and therefore assumed to be similar for seasnakes.

5.6.2.5 Fish

In 2006, the Working Group on the Effects of Sound on Fish and Turtles was formed to continue developing noise exposure criteria for fish and turtles, work begun by a NOAA panel two years earlier. The resulting guidelines included specific thresholds for different levels of effects and for different groups of species (Popper et al. 2014). These guidelines defined quantitative thresholds for three types of immediate effects as summarised in **Table 5-4** based on multiple studies, these most recent guidelines have been used to determine appropriate thresholds.

Table 5-4: SEL (dB re 1 µPa^2.s) and peak (dB re 1 µPa) thresholds for mortality, recoverable injury and TTS in fish species with different hearing physiology

Fish type	Mortality /potential fatal injury	Recoverable injury	TTS
No swim bladder	>219 dB re 1 µPa^2.s or >213 dB re 1 µPa	>216 dB re 1 µPa^2.s or >213 dB re 1 µPa	>>186 dB 24 h SEL
Swim bladder not involved in hearing	210 dB re 1 µPa^2.s or >207 dB re 1 µPa	203 dB re 1 µPa^2.s or >207 dB re 1 µPa	>>186 dB 24 h SEL
Swim bladder involved in hearing	207 dB re 1 µPa^2.s or >207 dB re 1 µPa	203 dB re 1 µPa^2.s or >207 dB re 1 µPa	186 dB 24 h SEL

Thresholds

Given the most recent studies collated and reviewed by Popper et al, the thresholds identified for both PTS and TTS are considered appropriate for impact assessment as provided in Table 5-4. The key fish receptors are considered to be those associated with Heywood shoal and the Continental Slope Demersal Fish Community KEF.

Impact Assessment

The noise modelling (Jasco, 2017) indicates that there is the potential for fish with no swim bladder to be exposed to SPL of 213 dB re 1 µPa (PTS) within 90 m of the source, and those with a swim bladder to be exposed to an SPL of 207 dB re 1 µPa within 150 m of the source. Therefore there is the potential for fatal injury within 150 m of the seismic source when in proximity to the Heywood Shoal (Figure 5-1). Through the implementation of a 200 m buffer around the 50 m bathymetry, the SPL at the shoal is reduced further and it is considered very unlikely that injury thresholds would be reached. The impact to other fish within the survey area could be of a similar distance (depending on bathymetry and environmental conditions), however there are no other identified features that are known for fish aggregations. In addition, the vessel is constantly moving and therefore the received noise levels will increase as the vessel gets closer and then decrease as the vessel moves away rather than firing at the same location for extended periods. This reduces the potential for cumulative effects on species. As advised in DOF's Guidance statement on undertaking seismic surveys in

Western Australian waters (2014), identified mitigation measures to reduced potential impacts on fish are summarised in **Table 5-5** below.

Table 5-5: Mitigation measures to reduced potential impacts on fish as recommended in DOF's Guidance statement on undertaking seismic surveys in Western Australian waters

Key Mitigation Measures Identified	Incorporation of mitigation measure	Relevant EP section
Avoid key times of year	As advised by DoF and NDSF, the key periods of spawning in Jan-April will be avoided. Avoidance of seismic surveys all year round is not considered appropriate As identified through consultation with WAFIC, NDSF and DoF, fish spawning occurs all year round in this region (Table 3-7), therefore it is not considered feasible to avoid all of the species spawning periods identified. Given the avoidance of acquisition of the four northernmost 2D sail lines closest to the Cartier Island CMR in November – Feb it is likely that the survey would be conducted April-October (although it is still possible the 3D survey would be conducted at any time of year) and therefore the majority of the spawning season would be avoided. Review of literature does not indicate impacts to commercial fishery catches due to MSS.	Section 5.6 and 10
'Soft starts' for every event	Soft starts procedures should be used each time the acoustic sources are initiated, following EPBC Policy Statement 2.1	Section 5.6 and 10
Avoid restricting movement of fish away from the source of seismic sounds	There are no obstructions to fish movement within the operational area. Site attached fish on Heywood shoal may be restricted in their movements, but implementation of the buffer around Heywood shoal will avoid mortality or physical injury to fish.	N/a
Minimise the sound intensity and exposure time of surveys	The seismic source selected is as small as it can be to meet the proposed seismic survey objectives.	Section 2.3
Address specific advice from WAFIC, Recfishwest and individual fishers	Specific advice has been reviewed and included in this EP.	Section 9

With regard to the Continental Slope Demersal Fish Communities KEF, the upper slope depth at which this begins is 225 m. As the source will be towed at a depth of ~10 m there is likely to be a minimum separation distance of greater than 200 m between the source and demersal fish associated with the KEF, a distance at which SPLs are not expected to exceed thresholds demonstrated to have long term irreversible impacts (Table 5-3).

Therefore while site attached species may demonstrate avoidance and behavioural responses due to an approaching or passing source, long term physical injury or impacts at a population level are not expected. Literature has not indicated significant impacts on commercial fisheries as a result of seismic activities.

Figure 5-1 shows the indicative vessel sail lines around Heywood Shoal. The source is towed directly astern of the vessel at a short distance and can be assumed to follow the vessel sail lines. The deviated sail lines are shown to overlap each other, but as the vessel will be steered subject to operational and HSE requirements, the extent of the overlap may not exactly match these indicative sail lines. Regardless, at all times, the vessel will maintain a minimum distance of 200m from the 50 m bathymetry contour around Heywood shoal. To traverse the length of the shoal (approximately 12 km long) the vessel will take about 1.5 hours, and will take approximately 24 hours to return to the same point.

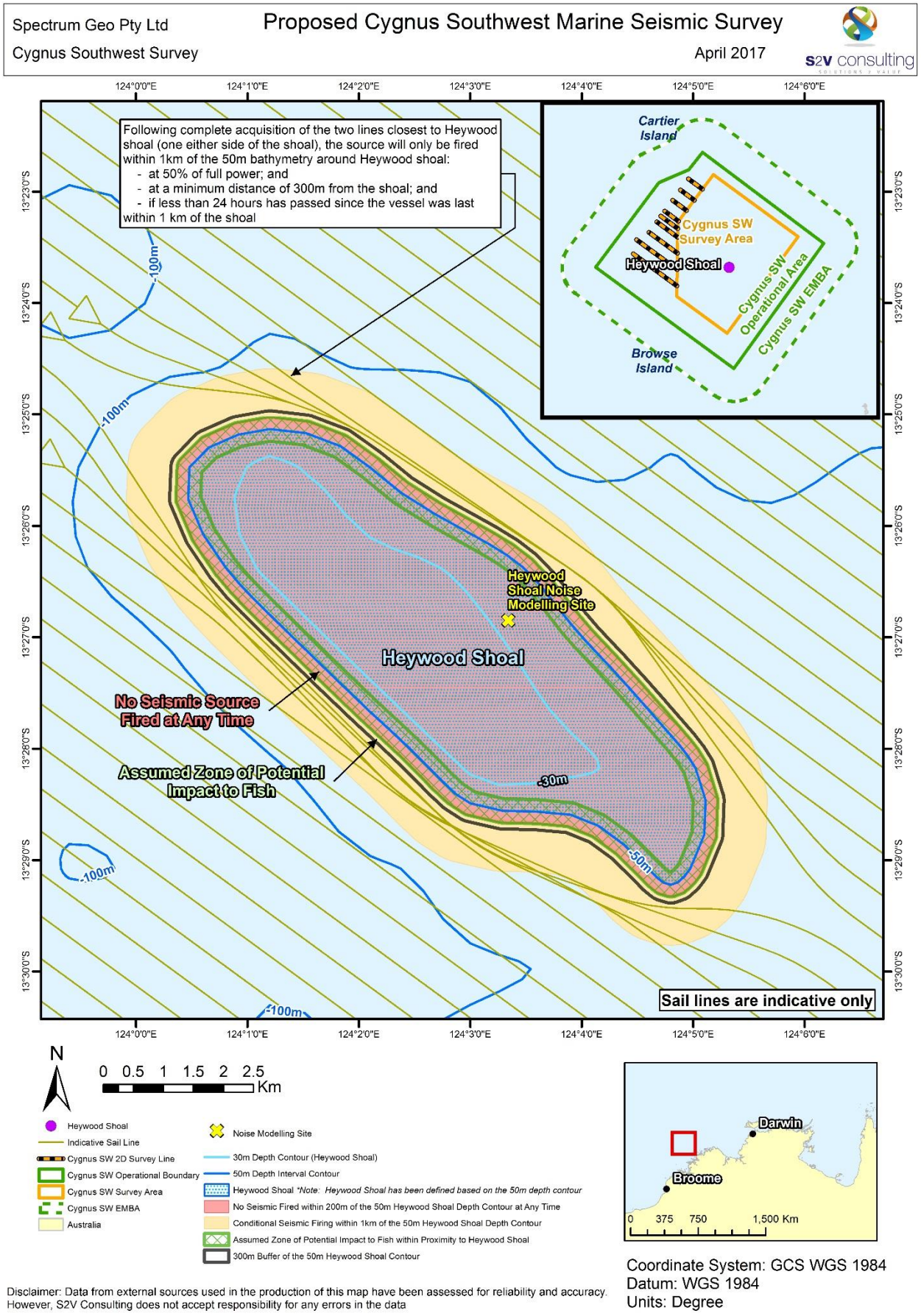


Figure 5-1: Heywood Shoal buffer and potential impact zone for fish

5.6.2.6 Elasmobranchs (sharks and rays)

Limited research has been conducted specifically on elasmobranch responses to MSS.

Trauma from acoustic sources to fish species appears dependent of the presence of a swim bladder, a gas filled chamber which assists with buoyancy or aids in hearing. Elasmobranchs (sharks and rays), many pelagic fish (e.g. mackerel), flatfishes and lizardfish (McCauley, 1994) do not have swimbladders and are therefore less likely to experience trauma. It must also be mentioned that fish attacks on seismic streamers from large pelagic species is not uncommon as evidenced by damaged hydrophone streamers (Colwell & Coffin, 1987; cited in McCauley 1994) indicating limited sensitivity to acoustic noise.

Thresholds

The thresholds adopted for impacts to sharks have to be assumed as the same as for fish with no swim bladder as described above.

Impact Assessment

The operational area and EMBA overlap with a BIA for migrating whale sharks and therefore individuals may transit the area. Peak migration, and therefore the highest probability of encounter, occurs in April although individuals may occur year round. No aggregation areas are known within the EMBA, with the nearest being Ningaloo Reef >200 km from the operational area. The great white shark and grey nurse sharks (*Carcharias taurus*) are regionally widespread and are believed to be in the waters surrounding the Cygnus SW MSS. There is no recognised critical habitat within the vicinity of the survey area for the listed threatened great white shark or grey nurse shark and therefore they are not expected in significant numbers.

It could be expected that impacts to fish with no swim bladder could occur within 90 m of the survey vessel (**Table 5-3**), however given the low likelihood of large numbers present, and the evidence that sharks have attached streamers, significant impacts at the population level are not expected.

5.6.2.7 Invertebrates

Few marine invertebrates have sensory organs that can perceive sound pressure, but many have organs or elaborate arrays of tactile ‘hairs’, called mechanoreceptors, that are sensitive to hydro-acoustic disturbances (McCauley, 1994). Close to a seismic source, the mechano-sensory system of many benthic crustaceans will perceive the ‘sound’ of compressed air pulses, but for most species such stimulation would only occur within the near-field or closer, perhaps within distances of several metres from the source (McCauley, 1994).

Decapod crustaceans have a variety of external and internal sensory receptors that are potentially responsive to sound and vibration. However, the exoskeleton and body plan of aquatic decapods are more capable of responding to particle displacement components of an impinging sound field than pressure changes. The limited acoustic sensitivity of decapods is also related to their lack of any gas-filled spaces such as those associated with pressure detection in fishes. However, many decapods have extensive arrays of hair-like receptors both on and inside their exoskeleton that most probably respond to water- or substrate-borne displacements, and they also have many proprioceptive organs that may perceive vibrations (Christian *et al*.,2004).

Recent studies have indicated that offshore MSS activity has no effect on catch rates of crustaceans in the surrounding area (Andriguetto-Filho *et al*., 2005; Parry and Gason, 2006). Wardle *et al*. (2001) observed little effect on invertebrate (crustaceans, echinoderms and molluscs) populations inhabiting a reef that was exposed to air gun noise. While the impact of MSS to crustaceans and

molluscs has not been investigated to the same extent as impacts to fish a number of studies provide some information upon which to assess impacts from seismic surveys.

+ Conclusions from these field experiments:
  - ► Seismic surveys are unlikely to result in immediate large-scale mortality in rock lobster fisheries including at embryo stage. Although the exposure to air gun signals did result in alterations to some aspects of lobster biology, none were observed at embryo stage. Ecological effects cannot be determined from the study conducted.
  - ► The study indicates that mass mortality of rock lobster, and therefore other crustaceans is not expected from MSS and therefore impacts at a population level are not expected and fisheries would not be impacted. However behavioural and sub-lethal effects could be expected. Scallop fisheries could be impacted by large MSS, although mass mortality was not observed, it is possible that biological implications could occur as the scallops could be stressed and therefore more susceptible to mortality.
  - ► Although the study did not identify mass mortality, the scope, scale and persistence of physiological impacts to scallops from seismic survey suggest that the surveys have the potential to severely impact scallop fisheries, through the loss of capacity for modestatisis.

+ Before-after-control-impact (BACI) study of the short-term effects of MSS on commercial molluscs (scallops) was undertaken within the Bass Strait Central Zone Scallop Fishery (BSCZSF) between February and June 2010 (Harrington *et al*., 2010). No change in the abundance of live adults or macroscopic gonad and meat condition was detected after MSS within either the control, impacted or semi-impacted strata. There was also no observable change in the size frequency distribution in the impacted and semi-impacted strata following MSS (Harrington *et al*., 2010);
+ A study on scallops in the Gippsland Basin indicated no evidence of scallop mortality (2 months after seismic survey), although the target species was not abundant in the survey area and photographs were frequently not of sufficient quality to determine viability. In addition, variation in scallop abundance, distribution, size, condition and assemblages were apparent but were not related to airgun operations. It was stressed that these site specific differences highlighted the importance of experimental design for field based impact studies to include 'before' seismic data collection (Przeslawski *et al*.,2016); and
+ Andriguetto-Filho *et al*. (2005) investigated the effect of MSS on prawn fisheries in relatively shallow waters (2-15 m) in Camamu Bay, north-western Brazil. Catch rates of various shrimp species were measured before and after use of a four component array with a source peak pressure of 196 dB re 1 µPa at 1 m, with catch rates found to be unaffected. It is also noted that the authors carried out histopathological studies on gonadal and hepatopancreatic tissue and reported that there was no damage that could be associated with exposure. This study did not detect any significant deleterious impacts of seismic sources on various penaeid species, suggesting that prawn stocks are resilient to the disturbance by a seismic source under the experimental conditions applied.

In addition to crustaceans and molluscs, the effects of seismic activity on squid has been studied with results revealing that behavioural impacts to sound at a level of 161–166 dB re 1µPa occurs. Sound levels are expected to attenuate below levels recorded to have behavioural disturbance effects, within 3 km from source.

Historical fishing data indicates low fishing effort in the operational area and there is a lack of evidence that crustaceans or fisheries are negatively impacted by MSS; it is therefore unlikely that this fishery would be negatively impacted by the Cygnus SW MSS.

5.6.2.8 Coral

There is limited published literature on the potential impacts of seismic noise emissions on sessile, benthic marine organisms, including hard and soft corals. It is speculated that sound emissions from seismic activity could remove polyps from the calcium carbonate skeleton or that vibrations from pressure pulses propagating through the skeleton could damage polyps, but neither have been reported in the literature. For hard corals, it is anticipated that some protection against sound pressure waves generated by seismic activity is provided by the calcified skeleton surrounding the polyps. As the polyps do not contain voids or internal airspaces, it is thought that any vibration caused by pressure pulses from seismic emissions will not be significant enough to remove or damage polyps from the protection of the calcium carbonate skeleton. Soft corals, because of their flexibility which allows them to minimise stress by reconfiguring in response to fluid forces, are not expected to be injured by sound pulses produced by seismic activity as close as 1m away from the source (Woodside, 2007).

During September 2007 Woodside carried out a field experiment at Scott Reef, to assess the potential impact of seismic activity (at three different exposure (SEL) categories (Category 1 >180 dB re: 1 µPa2.s; Category 2 >187 dB re: 1 µPa2.s; and Category 3 >200 dB re: 1 µPa2.s) on corals. The coral were monitored for signs of damage, physiological stress and changes in species diversity and community structure before and after the field experiment (Woodside, 2007).

The study concluded that seismic noise emissions had no detectable effect on plate corals, *Lobophytum* spp. and *Sarcophytum* spp. soft corals, or on percentage cover of dead/bare coral or red encrusting algae at Scott Reef. There was no evidence of any short term changes in either in degree of breakage following a pass by the seismic array, or of physiological stress in soft coral species as evidenced by withdrawn polyps or general reduction in soft coral rigidity. There was no evidence of longer term changes in community structure – when assessed by examining the relative abundance of major taxa as measured by percentage cover (Woodside, 2007). There is a current paucity of knowledge on the effects of seismic activity on coral gametes or planular larvae in the plankton. However, impacts on other planktonic organisms have been shown to be insignificant and restricted to within 2 m of the seismic energy source (see below). Given the distance from coral reefs is >30km away from the operational area, and the Heywood Shoal buffer is 200 m from the 50m bathymetry, impacts to coral reefs are considered negligible.

5.6.2.9 Plankton

Except for fish eggs, larvae and other minute planktonic organisms within a few meters of an airgun, no planktonic organisms are likely to be affected significantly by airgun array discharges (McCauley 1994). Data presented in **Table 5-6** indicates that the range of pathological effect on fish eggs and larvae is likely to be restricted to less than approximately 2 m. Calculations show that less than 0.02% of plankton in the area would be affected. Maximum possible horizontal distance from the source of 3090 cui array modelled at the seafloor is 150 m (broadside direction) for potential mortal injury (**Table 5-3**).

Any effect on the planktonic organisms from the seismic discharge is insignificant compared with the size of the planktonic population in a survey area or natural mortality rates for planktonic organisms.

As raised by the NDSF representatives during consultation, there is concern that seismic surveys may have an impact on fish during spawning. Through the implementation of the spatial buffer around Heywood shoal, fish that may be spawning on the shoal rather than elsewhere in the operational area where the habitat is ubiquitous will not receive levels of noise that will cause injury mortality, but may be temporarily affected by the noise levels received. This could result in behavioural disturbance during spawning as discussed above (Section 5.6.2.5). If eggs have already been released in the vicinity of Heywood shoal, it is unlikely that these will be affected as the range of impact is predicted to be within 2m of the source. As the source will be at least 200 m away from the 50 m bathymetry, impacts to eggs or larvae are not expected. In addition, the literature does not indicate a significant injury rate when eggs or larvae were exposed to airguns (**Table 5-6**).

Table 5-6: Observed seismic noise pathological effects on fish eggs and larvae

Species	Source	Source level (dB re 1 µPa @ 1m)	Distance from source (m)	Exposure level (dB re 1 µPa)	Observed effect	Reference
Cod (larvae 5 days)	Single airgun	250	1	250	Delamination of the retina	Matishov (1992)
Cod (larvae 2-10 days)	Single airgun	222	1	222	No injuries detected	Dalen and Knutsen (1986)
			10	202	No injuries detected	
Fish eggs (Anchovy)	Single airgun	230 (estimated)	1	230	7.8% of eggs injured relative to control	Kostyvchenko (1973)
			10	210	No injuries detected	
Fish eggs (Red Mullet)			1	230	No injuries detected	
			10	210	No injuries detected	
Dungeness Crab (larvae)	Seven airgun array	244 (estimated	1	233.5	No significant difference in survival rate relative to controls	Pearson *et al*. (1994)
			3	230.9		
			10	222.5		

5.6.2.10 Disturbance to Commonwealth Marine Reserves

The relevant commonwealth marine reserves (section 3.3.2.1) and the potential impacts of underwater noise to associated marine fauna (section 5.6) expected to be encountered within them has already been described. The values of each of the relevant CMRs are as displayed in Table 3-4.

The operational area will not overlap the Cartier Island CMR IUCN Ia and IUCN II (an area to the north west of Ashmore Reef CMR). As stated in section 3.3.2.1, the general approval for the North-west Commonwealth Marine Reserves Network provides for mining activities (including seismic surveys) to be carried out within this zone of the Cartier Island CMRs, however the activity will be conducted >29 km from the CMR boundary at all times (distance of operational area from CMR).

Cartier Island Marine Reserves IUCN Ia

Cartier Island CMR is classified as IUCN Ia zone – Strict Nature Reserve. The characteristics of a strict nature reserve are the Commonwealth reserve or zone contains some outstanding or representative ecosystems, geological or physiological features or species (Commonwealth of

Australia 2002). It is recognised that approaching the Ashmore Reef Ramsar Site may cause concern for adherence to the limit of Acceptable Change (LAC) due to underwater noise from seismic activities, however controls will ensure the survey will be carried out in line with the LAC of the Ramsar site as demonstrated in **Table 5-7**.

Impacts to marine fauna from underwater noise have been described above throughout section 5.6.2. The proposed sound exposure regime is not expected to result in any significant physical injury or behavioural disturbance to key fauna values of the Ashmore Reef and Cartier Island CMRs. The SPL at the Cartier Island CMR boundary is modelled to be 133.5 dB re 1 µPa which is well below the behavioural disturbance thresholds identified for marine mammals or marine turtles. In addition, the sound levels are below any known impulsive noise criteria for behavioural impacts on marine fauna. Therefore impacts to values within the CMR are considered negligible.

To further ensure that habitat important to green turtles is not affected by the survey, the four northern-most 2D sail lines closest to the Cartier Island CMR will not be acquired during turtle nesting season. Therefore, the closest point of that the vessel will be firing the source during this period would be approximately 45 km away (at the survey area boundary). Given that even at the end of the 2D sail line closest to the Cartier Island CMR does not results in SPL at the boundary of the CMR above thresholds for behavioural response, this is considered to reduce potential impact to ALARP and acceptable levels.

Table 5-7: IUCN IA Management Principles of Cartier Island CMR

IUCN IA Management Principles	Principle Met
1.01 The reserve or zone should be managed primarily for scientific research or environmental monitoring based on the following principles.	N/A – responsibility of park management (DoE)
1.02 Habitats, ecosystems and native species should be preserved in as undisturbed a state as possible.	Yes – The distance of the operational area from the CMR boundary is 29km, therefore planned impacts will not occur within the CMR. Additionally, during peak nesting season for green turtles, no acquisition along the four northernmost 2D sail lines closest to the Cartier Island CMR will occur. The potential impacts from a vessel collision could result in a diesel spill entering the CMR, therefore no refuelling will take place within 26 km of the Cartier Island CMR to provide further confidence in negligible impacts. Noise modelling indicates that at the CMR boundary SPL will be below any known impulsive noise criteria for behavioural effects on marine fauna and will be within the expected background levels of noise associated with the NWS marine environment.
1.03 Genetic resources should be maintained in a dynamic and evolutionary state.	Yes – no behavioural impacts expected that would impact on breeding cycles given the temporary nature of the survey. Noise modelling indicates that at the CMR boundary SPL will be below any known impulsive noise criteria for behavioural effects on marine fauna and will be within the expected background levels of noise associated with the NWS marine environment, therefore no change in breeding cycles would be expected.
1.04 Established ecological processes should be maintained.	Yes – no behavioural impacts expected that would impact ecological processes
1.05 Structural landscape features or rock exposures should be safeguarded.	Yes – no anchoring or possible grounding will occur as reserve will not be entered

IUCN IA Management Principles	Principle Met
1.06 Examples of the natural environment should be secured for scientific studies, environmental monitoring and education, including baseline areas from which all avoidable access is excluded	Yes - Reserve will not be entered as per reserve management requirements
1.07 Disturbance should be minimised by careful planning and execution of research and other approved activities.	Yes – survey plan will incorporate management controls to ensure sound exposure levels (SPLs) received in the CMRs will not exceed levels expected to lead to a significant behavioural response. Additional temporal buffers will be in place for turtle nesting preventing 2D sail line acquisition in close proximity to the CMR during peak nesting season and no refuelling within 26 km of the CMR boundary.
1.08 Public access should be limited to the extent it is consistent with these principles.	Yes - Reserve will not be entered, survey plan will incorporate management controls to ensure SELs received in the CMRs will not exceed levels expected to lead to a significant behavioural response.

The vessel will not acquire data within 34 km of Cartier Island CMR at any time, and the results of the noise modelling indicate that SPLs at the marine park boundary will be below identified criteria for behavioural impacts on marine fauna (**Table 5-2**). The potential impacts to marine fauna have been discussed throughout section 5.6.2 above. Key faunal groups present within the Cartier Island CMR (as per the Management Plan) are:

+ Sea snakes
+ Turtles
+ Corals
+ Molluscs
+ Crustaceans

Therefore the level of disturbance that may be received within the marine park is consistent with the IUCN IA values listed in **Table 5-7**, particularly '1.02 Habitats, ecosystems and native species should be preserved in as undisturbed a state as possible'.

While cetaceans are not specifically mentioned in the Cartier Island Management Plan, any interactions with cetaceans that may be present in the area surrounding the Ashmore and Cartier CMRs will be managed by adherence to EPBC Policy statement 2.1 as described in **Table 10-1**).

The controls, combined with the transient nature of the survey meaning a duration of hours to days between adjacent lines means that habitats, ecosystems and native species shall be preserved in as undisturbed a state as possible while meeting the objectives of the survey. This ensures that potential impacts to the species for which the CMR has been established are reduced to ALARP.

Given the distance from the Cartier Island CMR boundary, and the restriction of the acquisition of the four northernmost 2D sail lines closest to the Cartier Island CMR during turtle nesting season, cumulative impacts from SELs of successive shots are not expected to be of a level that will result in cumulative impacts to marine fauna. Further to this, given the time of hours to days between adjacent survey lines, cumulative impacts from successive passes are not expected.

5.6.2.11 Disturbance to KEFs

The two KEF's overlapped by the operational area are seabed features at depth. As described in Section 3, the receptors associated with these that may be susceptible to impacts from seismic

sources include fish and marine mammals, who may use it as a queue for migration. Impacts to these types of receptors are discussed above. It is noted seismic is not noted as a threat to these KEFs as the concern is in relation to a change in habitat which would not result from the seismic source discharge.

5.6.2.12 Summary of potential impacts

For the purposes of conducting an impact and risk assessment, the R_{max} values are utilised as this represents the maximum range at which the given sound level was encountered in the modelled maximum-over-depth sound field. It is noted that the $R_{95\%}$ is recommended in the EPBC Policy Statement 2.1 as appropriate for determining precautionary zones, however to assume a worst case scenario, the R_{max} values are considered. R_{max} is the maximum range at which the given sound level was encountered in the modelled maximum-over-depth sound field.

As described in the sections above, the risk of physical injury to marine fauna from the noise source is restricted to very close ranges from the source. Behavioural disturbance may occur over greater ranges and is expected to be temporary and localised and on an individual level only. Environmental Performance outcomes and mitigation measures outlined in Table 10-1 demonstrate that potential impacts to marine fauna from underwater noise emissions from discharge of airgun array are reduced to ALARP.

5.6.3 Spatial and Temporal Overlap with Critical Habitat and Peak Periods of Activity for Protected Marine Fauna

5.6.3.1 Pygmy blue whales

The Cygnus SW MSS EMBA overlaps the BIA (migration north and south) for pygmy blue whales off the coast of WA (**Figure 3-6**). Consequently, there is the possibility that migrating (and possibly foraging) pygmy blue whales may be encountered in the Cygnus SW operational areas during the survey. Migrating blue whales will be transient and able to move around and away from the survey vessel and acoustic source. The operational area is >100 km from the nearest foraging and feeding area for pygmy blue whales. The likelihood of encountering migrating blue whales in the operational area is higher during 1 July-31 August and 15th Oct-15th December.

5.6.3.2 Marine turtles

BIAs for internesting green turtles overlap the EMBA at Cartier Island in the north west, it is therefore considered likely that green turtles will be present in the vicinity of the survey at any time of year, but peak numbers could be expected November-February. Additional temporal controls in place during internesting include no acquisition along the 4 northernmost 2D sail lines closest to the CMR, and no refuelling within 26 km of the Cartier island CMR boundary to ensure no potential impacts can occur within the CMR itself.

5.6.3.3 Whale shark

The operational area and EMBA overlap with a whale shark BIA. Impacts are likely to be restricted to short-term and temporary behavioural responses of any animals in the immediate vicinity (less than a few hundred metres) of the survey vessel when the full airgun array is being discharged. These behavioural responses are unlikely to be significant at a population level, particularly as there is only a very small area of overlap between the operational area and the BIA.

5.6.4 Cumulative Impact Assessment

In the event of another marine seismic survey taking place in the same vicinity as the Cygnus SW MSS in the same timeframe, cumulative impacts on marine fauna, including Matters of national environmental significance (MNES), could occur. Through the acquisition of access authority from

other permit holders in the area, Spectrum will be informed of any potential surveys that are being planned. At time of EP submission, there are no known MSS that could overlap with the planned MSS. Ongoing consultation with other operators in the area will continue to ensure any potential conflicts with other surveys or petroleum activities are avoided. Spectrum is also aware of other accepted petroleum activity Environment Plans that overlap large areas of the NWS and include permits within the Cygnus SW MSS operational area.

If Spectrum becomes aware of another MSS planned in the vicinity, consultation will be undertaken with the other operator to ensure a minimum distance of 50 km between seismic survey vessels is maintained. This distance provides a "corridor" between seismic sources allowing fauna to travel between areas without becoming confused and potentially moving toward seismic sources instead of away. As the distance at which behavioural impacts could occur to toothed cetaceans is 3 km, this defines the minimum distance from each vessel. For conservatism, 50 km is considered acceptable given the source levels of other vessels is unknown. Spectrum will ensure ongoing consultation with other potential MSS operators and will re-evaluate this distance as required e.g. if the other operator has larger seismic sources.

5.6.4.1 Cumulative impacts over the Cygnus SW MSS area

Spectrum is aware that other MSS have been completed in the vicinity of the Cygnus MSS SW operational area and concerns have been raised by Stakeholders in historic consultation and in general regarding multiple seismic activities occurring in the same area as those previously undertaken. These surveys have not occurred over the exact same area as the planned survey, however it is recognised that similar impacts as described in this EP could have arisen. There are currently no known documented impacts in this region from previous surveys and studies have not identified significant impacts to marine fauna from MSS at the population level (as described above).

5.6.4.2 Cumulative impacts to Heywood Shoal

The potential cumulative impact from impulsive seismic noise is not expected to cause physical injury to fish on Heywood Shoal. The Jasco noise modelling presents the horizontal distance from seismic source that potential physical impacts to fish may occur. The model presents Peak Pressure Level from one shot as 213 dB re 1uPa and 207 dB re 1 uPa occurring 90m and 150m from source, respectively (Jasco 2017). The distance range for potential physical injury using Peak Pressure Level generally always exceeds the range associated with Sound Exposure Level, which considers the intensity and the duration of a noise event, accumulated over a 24hr period (McPherson pers. comms. 2017). Popper et al., (2014) stated that for seismic airguns it is difficult to determine the cumulative sound exposure levels (SEL_{cum}) because the received SEL_{cum} changes from shot to shot since the seismic vessel is moving and at different distances from the fish (as it continues along the sail line). Because of this they noted values ultimately based on the closest peak level or the closest may be more useful than one based on the SEL_{cum}. The range in which physical injury may occur from the seismic source is considered conservative by using the Peak Pressure Level. Potential physical injury to fish are reduced to ALARP through implementation of the 200m buffer zone from the 50m depth contour around Heywood Shoal. Through implementation of controls such as spatial/temporal buffers (as outlined in **Table 10-1**), no permanent impacts to fish will occur on Heywood Shoal.

The noise from the seismic source will ensonify the shoal and may cause TTS to benthic invertebrates, site attached and mobile fish species on Heywood shoal. TTS is a temporary recoverable injury, where recoverable injury is defined as 'injuries including hair cell damage, minor internal or external hematoma, none of these injuries are expected to result in mortality' (Popper et al., 2014). No mortality or potential mortal injury from the cumulative impacts of seismic to site

attached fish on Heywood Shoal would be expected during the survey. Furthermore, the duration between passes will be long enough that each pass can be considered a separate event and fish are expected to recover from TTS between events, and well within 24 hours (if they experience TTS at all) (Popper and Hastings, 2009). In the context of the shoal, temporary impacts from TTS will not affect fish communities on a long-term basis. A recent study of site-attached reef species (at Scott Reef in the NWMR a similar environment to the Heywood shoal area) revealed no significant effect of a 3D seismic survey on overall abundance or the species richness within coral reef fish communities (Miller & Cripps, 2013). Potential noise impacts to fish from the seismic source will not impact life cycle stages or spawning events which occur over days, or communities of fish on a population level as any potential impacts will be temporary and localised to individual level with recovery within 24 hours.

Mobile fish are expected to display avoidance behaviour and move outside the range of potential physical disturbance. For site attached fish and benthic invertebrates, it is acknowledged that physical impact may occur on an individual level, as outlined in Section 5.6.2.5, although through implementation of spatial buffers this is avoided at Heywood shoal. The cumulative impact from overlapping survey lines may introduce an increased risk of physical impacts for these species.

Seismic lines may overlap adjacent to Heywood shoal in order to maintain seismic coverage objectives whilst adhering to a minimum 200m buffer around the 50m depth contour. Each pass of the shoal will take approximately 1.5 hours. A change in sail lines to increase the time between sail lines or avoid overlap around the shoal is difficult to achieve as it would involve altering large portions of the survey pattern, decrease survey efficiency and ultimately increase the overall duration of the survey, possibly even resulting in having to acquire the survey in phases (which is not planned, although is covered in this EP in the event of issues acquiring in one phase). Furthermore, the spatial buffers, soft starts and low source size will reduce potential cumulative impacts to fish to ALARP. It is possible that the vessel will return to a point closest to the shoal within 24 hours. Spectrum cannot commit to a minimum of 24 hours between line passes adjacent to Heywood shoal due to the planned survey area, vessel speed and data acquisition plan. To slow the vessel to a speed whereby the lines are at least 24 hours apart may extend the survey duration, therefore resulting in potential additional impacts to marine fauna in the survey area, and additional vessel costs. Thus to prevent cumulative impacts EPS-108 is included: Following complete acquisition (full coverage) of the two lines closest to Heywood shoal (one either side of the shoal), the source will only be fired within 1km of the 50m bathymetry around Heywood shoal:

- at 50% of full power; and
- at a minimum distance of 300m from the shoal; and
- if less than 24 hours has passed since the vessel was last within 1km of the shoal

By dropping the source level to approximately 50% of the source size required for full acquisition, the potential for TTS is significantly reduced as the source level will be approximately 1550 cui (note that as the gun clusters have fixed volumes, this number cannot be exactly verified at the planning stage, however a maximum source size of 3090 cui for the survey is confirmed, and the source will be dropped to 50% or less). Further, by increasing the distance from Heywood shoal at which the source is fired on subsequent passes, further confidence in not having cumulative impacts to fish species on the shoal is provided. By implementing these controls when the source is within 1 km of the 50m bathymetry contour around Heywood shoal, potential cumulative impacts are reduced. If the vessel returns to within 1km of the shoal after 24 hours, it is considered that if fish had experienced TTS, they would have recovered within this timeframe and therefore reducing the source size and increasing the distance is not considered a requirement. The distance of 1 km from

the shoal has been determined through advice from JASCO and in reviewing the proposed survey acquisition plan to include the lines closest to the shoal.

5.7 Reduced air quality from Air emissions

5.7.1 Description of risk

Atmospheric emissions from the proposed survey include greenhouse gas (GHG), nitrogen oxide (NOx), sulphur oxide (SOx), carbon monoxide (CO) and particulate matter (i.e. dark smoke) emissions from:

- use of survey and support/chase vessel main engines for propulsion
- use of survey and support/chase vessel main and emergency power generation equipment
- use of aviation fuel for transport of personnel via helicopters
- use of marine diesel by the survey vessel workboat
- incineration of oily sludges aboard the survey vessel

Vessels may utilise ozone-depleting substances (ODS) in closed-system rechargeable refrigeration systems.

5.7.2 Potential environmental impacts

Atmospheric emissions generated during the survey will result in a localised and temporary reduction in air quality. Potential environmental effects from these atmospheric emissions are a contribution to GHG emissions (albeit very minor), which may potentially influence climate change and a localised reduction in air quality. Incineration of oily sludges is not expected to generate any significant atmospheric emissions, due to the infrequent nature of the activity and the small volumes of material being burnt during each disposal episode. A very low, relative volume of GHG emissions would result from fuel consumption aboard the survey vessel compared to other sources of GHG emissions in the area (e.g. commercial shipping traffic), and the operational area doesn't overlap with sensitive receptors that could be impacted by atmospheric emissions generated during the proposed survey activities. Furthermore, all vessels will operate in accordance with the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and the *Protection of the Sea (Prevention of Pollution from Ships) (Orders) Regulations 1994*, particularly Marine Orders - Part 97: Marine Pollution Prevention - Air Pollution. Thus, based on the localised and temporary reduction in air quality from release of emissions the environmental risk from potential impacts of atmospheric emissions are expected to be low.

Accidental release and fugitive emissions of ODS has the potential to contribute to ozone layer depletion.

5.8 Discharge of Bilge Water, Sewage and Food Wastes

5.8.1 Description of risk

In order to operate the vessel, a number of routine discharges to the marine environment will be required as outlined below. These discharges will occur at the sea surface.

- Sewage
- Food waste
- Brine
- Cooling water
- Anti-scalant

- Deck drainage; and
- Oily water discharges from vessels

5.8.2 Potential environmental impacts

Planned non-hazardous discharges will be small and continuous, with volumes dependent on a range of variables. The discharge of non-hazardous wastes to the marine environment may result in a localised reduction in water quality. This would be expected to be temporary (minutes to hours), localised and limited to surface waters (<5m). The discharges are expected to be dispersed and diluted rapidly, with concentrations of wastes significantly dropping with distance from the discharge point. Changes to ambient water quality outside of the operational area are considered unlikely to occur.

Specifics of potential impacts to water quality from the discharge of non-hazardous wastes are as follows.

Salinity increases

The desalination of seawater results in a discharge of brine with a slightly elevated salinity (around 10% higher than seawater).

Most marine species are able to tolerate short-term fluctuations in salinity in the order of 20–30% (Walker and McComb, 1990), and it is expected that most pelagic species would be able to tolerate short-term exposure to the slight increase in salinity caused by the discharged brine.

Given the relatively low volume of discharge, low salinity increase and deep, open water surrounding the vessels, impact on water quality in the operational area is expected to be low.

Changes in temperature

Cooling water will be discharged at a temperature above ambient seawater temperature. Upon discharge it will be subjected to turbulent mixing and transfer of heat to the surrounding waters.

Temperature dispersion modelling shows that water temperature of discharged water will decrease rapidly as it mixes with the receiving waters, with discharge waters being less than 1°C above background levels within less than 100 m (horizontally) of the discharge point. Vertically, the discharge will be within background levels within 10 m (Woodside, 2008).

Given the relatively low volume of cooling water, temperature differential, the deep, open water surrounding the vessels, impact on water quality is expected to be low and short-term.

Nutrient enrichment

Discharge of food waste and sewage can cause eutrophication in the surrounding waters resulting in changes to plankton in the immediate area which could subsequently impact on fish and planktonic feeders. In a study of sewage discharge in deep ocean waters, Friligos (1985) reported no appreciable differences in the inorganic nutrient levels between the outfall area and background concentrations suggesting rapid uptake of nutrients and/or rapid dispersion in the surrounding waters. Similar studies (Parnell, 2003) concluded similar results with rapid dispersion and dilution within hours of discharge. Subsequently nutrient enrichment is not expected to affect identified receptors.

Toxicity

In general, dilution after dumping at sea is rapid with results showing 1 in 1,000 dilution within 30 minutes (Costello and Read, 1994). Subsequently acute toxicity to marine fauna is not expected to affect identified receptors at ecologically significant or detectable levels at the discharge site.

Discharge of anti-scalant dosed into the potable water system will be periodic, when maintenance is required. The chemical used for this process is diluted prior to discharge within the potable water system and as only small volumes are released at the sea surface and it is mixed with the water in the system. Acute toxicity is therefore unlikely to occur at ecologically significant or detectable levels.

Oily water discharged from vessels could result in turbidity and toxic effects on marine organisms from hydrocarbons and other contaminants. Oily water discharged from vessels will be treated to a concentration (<15 ppm) that will unlikely lead to any impacts to the receiving environment.

6 UNPLANNED ACTIVITIES (ACCIDENTS/ INCIDENTS)

Table 6-1: Risk evaluation summary of unplanned planned activities

Planned event	Residual risk	Acceptability of residual risk
Collision between Survey vessels/ towed array and Marine fauna	Low	Acceptable if ALARP
Vessel grounding	Low	Acceptable if ALARP
Equipment dragging or loss	Low	Acceptable if ALARP
Accidental release of hazardous or non-hazardous materials	Low	Acceptable if ALARP
Hydrocarbon release caused by Topside (vessel) loss of containment	Low	Acceptable if ALARP
Hydrocarbon release caused by vessel collision between survey vessel and chase vessel or third party vessel and during refuelling	Medium	Acceptable if ALARP

6.1 Collision between Survey Vessels /Towed Array and Marine Fauna

6.1.1 Description of risk

There is the potential for vessels/equipment from the vessels involved in the activity to collide with marine fauna including cetaceans, fish, marine reptiles and seabirds. The main collision risk associated with the activity is through vessel collision or equipment collision with large, slow moving cetaceans; potentially resulting in severe injury or mortality.

6.1.2 Potential environmental impacts

The impact from vessel interactions with marine fauna can be as minimal as temporary, behavioural changes to severe, such as mortality resulting from vessel strikes. Vessel collisions contribute to the mortality of marine fauna, notably turtles (Lutcavage *et al*. 1997, Hazel & Gyuris 2006, Hazel *et al*. 2007) and large cetaceans (Knowlton & Kraus 2001, Laist *et al*. 2001, Jensen & Silber 2003).

The timing and location of the survey within the Cygnus SW operational area may coincide with sensitive periods, such as turtle nesting, pygmy blue whale and whale shark migrations. Given the susceptibility of cetaceans, whale sharks and marine turtles to vessel strikes, only potential impacts on these fauna groups were considered. Other marine fauna (such as birds, fish and sea snakes) are likely to avoid vessels operating in the area and so are considered at low risk of potential strike.

Cetaceans

Vessel/whale collisions at this speed are uncommon, and based on reported data contained in the US National Ocean and Atmospheric Administration database (Jensen & Silber 2003), there were only two known instances of collisions when the vessel was travelling <6 knots. Both of these were from whale-watching vessels that were deliberately placed amongst whales.

Marine seismic surveys involve the use of two or more vessels travelling at slow speed (4-6 knots) and along defined paths. At such speeds, any marine fauna present will likely take avoidance action before a collision. The implementation of management controls outlined in Table 10-1, such as EPBC Policy Statement 2.1, are expected to reduce vessel-fauna interactions and the risk of vessel strike is considered low. Additionally, the observed avoidance behaviour exhibited by marine fauna in response to seismic discharges (see **Section 5.6**), means that cetaceans are likely to avoid any moving vessels further reducing potential risks.

Marine turtles

Marine turtles on the sea surface or in shallow coastal waters avoid approaching vessels by typically moving away from the vessels track, which was suggested as an avoidance behaviour based primarily on visual cues despite the vessel noise being within range of turtle hearing (Hazel *et al.* 2007). Therefore, the success of this behaviour in avoiding a vessel strike is largely dependent on the speed of the approaching vessel and the prevailing water clarity, rather than vessel type. While the potential for vessel strikes at various speeds has not been quantified, the success of avoidance behaviour is a factor of the response time available (i.e. visual observation distance/vessel speed). Hazel *et al.* (2007) suggested that higher vessel speed is more likely to cause impacts, particularly in shallow waters where turtles are abundant. Thus, there is less opportunity for turtles to avoid vessels travelling at higher speeds in turbid waters. Additionally, vessel draft may also contribute to the risk of vessel strikes, as vessels with less draft provide a greater clearance distance between the turtle and the vessel. In the event of a collision, the turtle's carapace provides a level of protection from serious injury, although the type and severity of the injuries would be dependent on the force of the collision, the structure of the vessel and whether the animal was struck by the hull or propellers.

Turtle entrapments within streamer tail buoys can lead to injury or mortality (Ketos Ecology 2007). The use of turtle guards on streamer tail buoys can reduce the risk of turtle entrapment. More recently, developments in the design of tail buoys has resulted in tail buoys that don't represent a turtle entrapment threat. An example of these tail buoys is the PartnerPlast 900L which are designed to skim along the surface with just a single chain extending beneath the surface. If the survey vessel is not fitted with this model of tail buoy, turtle guards will be used to prevent entrapment. However, as the identity of specific survey vessel(s) undertaking the Cygnus SW MSS is not known at this stage, alternative vessels may use this type of tail buoy and therefore, turtle guards would not be required.

The survey will operate outside of 30m chart depth, within which turtles are expected to be most abundant, in shallow reef areas. Turtle encounters are not expected to be high given the avoidance of seismic acquisition along the four northernmost 2D sail lines closest to the Cartier Island CMR in peak turtle nesting season (1 November – 28th February), therefore the vessel will be at least 45 km from the CMR boundary (and therefore the BIA) during this period, and at least 29 km at all other times, and the risk of vessel collision is considered low.

Whale sharks

Although the whale shark's skin is thicker and tougher than any other shark species, the species may be vulnerable to boat strike. As a significant amount of time is spent close to the water surface, several whale sharks bear scars that have probably been caused by boat contact (DEH 2005, Norman 1999DPaW developed a code of conduct for commercial vessels that engage in whale shark watching to minimise the risk of disturbance to normal whale shark behaviour and boat strike (DPaW 2013a). These measures serve as the minimum requirements for vessels within the operational area, and accordingly, vessels shall not approach closer than 400 m from a whale shark.

The operational area overlaps with a small portion of the foraging BIA for whale sharks (**Figure 3-8**). As their occurrence within the operational area is likely to be rare and infrequent, and given the slow operating speed of the survey and support/chase vessels (unless in an emergency) and mitigation measures, the potential environmental risk of a vessel strike impact significantly a whale shark in the operational area is assessed to be Low.

Survey Timing

As far as practicable, Spectrum will undertake the survey within the operational area to avoid sensitive marine fauna periods such as pygmy blue whale migration. However, it may not always be possible given the potential duration of surveys, timing of migration and foraging periods, avoidance of turtle nesting around the established CMRs, vessel availability and weather constraints. Costs associated with placing a vessel that was part way through a survey on 'stand-by' until migration period is completed (1-3 months, depending on fauna) could equate to $400,000/day, and this cost is grossly disproportionate to any environmental benefit gained.

Vessel-marine fauna interaction procedures (**Figure 6-1**) will be implemented to ensure that any interactions between the seismic and support/chase vessels and cetaceans, whale sharks and turtles are managed in accordance with Part 8 of the EPBC Regulations 2000, and with guidelines from the Commonwealth Government (DEH 2005). These procedures, in the form of an action flowchart, will be distributed to the support/chase vessel masters, and the crew will be made aware of these requirements at induction prior to commencement of the survey.

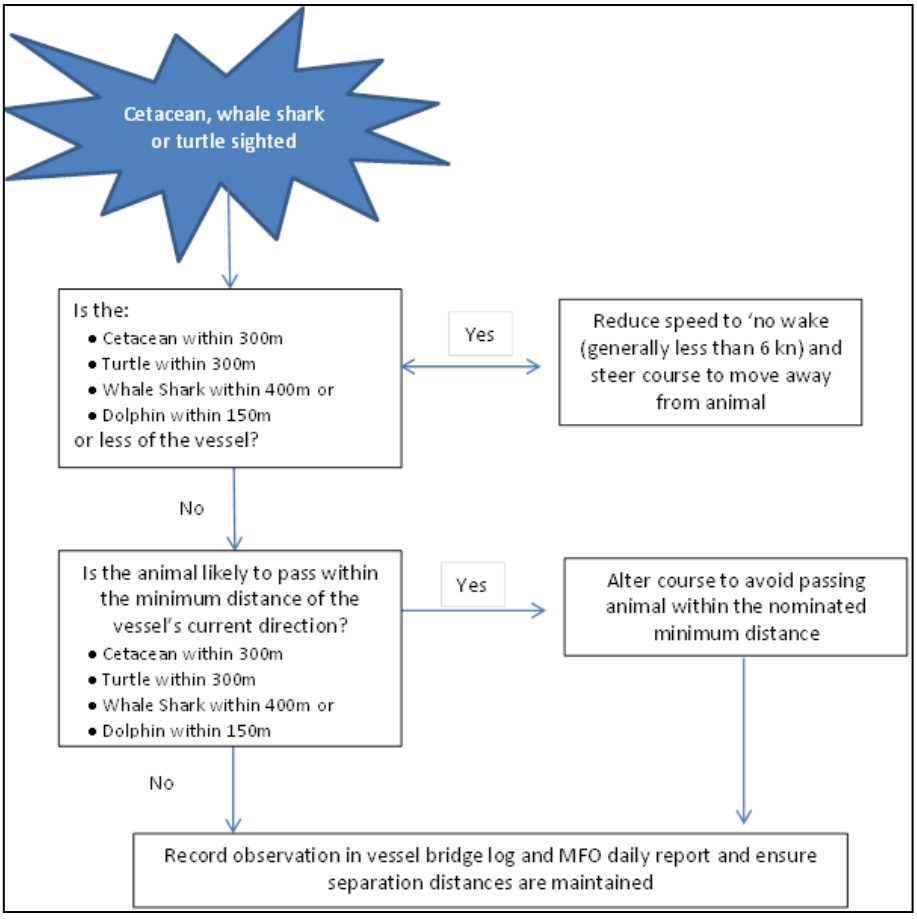


Figure 6-1: Vessel marine fauna interaction procedures

6.2 Vessel grounding

6.2.1 Description of Risk

Vessel impact and grounding has the potential to cause physical damage to benthic habitats and biological communities described in **Section 3.4** or adversely affect aquatic marine life due to loss of hydrocarbon containment.

6.2.2 Potential Environmental Impacts

While the vessel(s) will not approach within 29 km of the boundary of Cartier Island CMR where shallow reefs are present, other shallow features are present within the operational area as described in **section 3.3.4**. However, the potential for the survey and support vessel(s) to become grounded while working within the operational area is limited as the seismic source will not be fired in water depths less than 50 m. Vessel impact and grounding has the potential of damage and mortality to flora and fauna, cause fracturing, reef rock displacement, smothering and disturbance of benthic habitat and sediment mobilisation and turbidity (see **Section 5.3** for further benthic impact description). These may be caused by vessel contact with the ocean bottom, by prop wash and cable dragging during attempts by operators and/or salvagers to refloat the vessels, and by subsequent movement of destabilised substrates (Gittings *et al*., 1993).

Vessel grounding also has the potential to result in the loss of containment of hydrocarbons such as fuels and oils from vessels that may also adversely affect aquatic marine life (see **Section 6.5** for further hydrocarbon impact description).

6.3 Equipment Dragging or Loss

6.3.1 Description of risk

The accidental dragging or loss of seismic streamer equipment has the potential to cause minor physical damage to benthic habitats and biological communities described in **Section 3.4**.

Dragging of streamers along the seabed may result in localised physical disturbance of substrates, benthic habitats and communities. However, the likelihood and risk of significant damage or impact is considered low. In addition, equipment or objects may be lost overboard if not adequately sea fastened or during lifting.

6.3.2 Potential Environmental Impacts

In the unlikely event of damage to or loss of a seismic streamer, potential environmental effects will be limited to physical impacts on benthic communities arising from the cable and associated equipment sinking to the seabed. Dropped objects may be buoyant or sink to the seabed. Benthic habitats have the potential to be impacted with heavy loads resulting in potential loss of soft sediment communities within the impact zone. Buoyant items may present an entanglement risk to marine fauna, or a navigation hazard to other marine users.

Dragging of the streamer along the seabed may result in localized physical disturbance of substrates, benthic habitats and communities. However, given that the water depth range across the operational area (< 430 m), and the buffer around the known shallow area of Heywood shoal the risk of significant impacts resulting from equipment dragging or loss is considered to be low. Furthermore, the survey vessel will not transit marine parks or reserves where water depths are shallower.

6.4 Accidental Release of Hazardous or Non-hazardous Materials

6.4.1 Description of risk

Hazardous liquids including miscellaneous chemicals and waste streams (cleaning and cooling agents, stored or spent chemicals and leftover paint materials) are used or stored on board the vessel during the activity. The main engines and equipment such as pumps, cranes, winches, power packs and generators require MGO for fuel and a variety of hydraulic fluids and lubricating oils for efficient operation and maintenance of moving parts. These products are present within the equipment and also held in storage containers and tanks on the vessels, small hydrocarbon leaks could occur and are discussed in **Section 6.5**, chemical leaks are discussed further here.

Seal oil could potentially leak from the vessel thruster/propeller stern tube directly to sea as a result of leaking seals or mechanical damage. The header tank for stern tube oil is approximately 1 m^3 and is equipped with limit switches in the event of a leak, thus preventing complete loss.

Outside the vessel, the largest credible spill would be release of <1 m^3 of stern tube oil (non-hydrocarbon based lube oil) from the vessel thruster/propeller stern tube.

The maximum volume of hazardous chemical that could be released during routine operations is likely to be small and realistically limited to the volume of individual containers (e.g. drums etc.) stored on-deck. The most credible worst-case spill scenario onboard is considered to be loss of a <200 L release from an on-deck hydraulic hose, however the worst case is 1m^3 of stern oil. In the event that the spill is not contained on deck, there would be a release to the marine environment, which would be likely to rapidly disperse and evaporate.

Accidental loss of liquid wastes to the marine environment could occur via tank pipework failure or rupture, inadequate bunding and/or storage, insufficient fastening or inadequate handling may result in impacts to water quality and hence sensitive environmental receptors.

6.4.2 Potential environmental impacts

Environmentally hazardous chemicals and wastes lost to the marine environment may lead to contamination of the water column in the vicinity of the vessel. The potential impacts would most likely be highly localised and restricted to the immediate area surrounding the spill, with rapid dispersal to concentrations below impact thresholds likely to occur in the open area of ocean. The changes to water quality that may result could potentially lead to short-term impacts on marine fauna (e.g. pelagic/benthic fish, epifauna, cetaceans, marine reptiles and seabirds), with chronic impacts not expected owing to the short exposure times likely.

The area that may be affected by this risk for the majority of spilt material would most likely be restricted to a small area within the operational area.

Discharge of hazardous chemicals from spills is unlikely to have widespread ecological effects given the nature of the chemicals onboard, the small volumes that could be released, the depth and exposure of the location, and the appropriate SOPEP and clean-up procedures in place (**Section 8.1**). The risk is therefore considered to be Low.

6.5 Hydrocarbon Release Caused by Topsides (Vessel) Loss of Containment

6.5.1 Description of risk

The survey and support/chase vessels store and use small quantities of lubricating oils and hydraulic fluid, which have the potential to spill if not appropriately managed. Hydraulic fluid may also potentially be spilled from a leak in hoses or lines on hydraulic equipment such as cranes or winches.

6.5.2 Potential environmental impacts

Hydrocarbons may be stored on deck (or within below deck storage) on the survey and support/chase vessels and include lubricating oils or hydraulic fluids. The size of potential spills to deck of these substances are likely to be between 50 and 200 L (0.05 m^3 and 0.2 m^3, respectively), based on expected volumes of fluids available on deck typically stored in 50-200 L steel drums. Storage of these fluids on-board the vessels would be within a designated storage room or a contained (i.e. bunded) area on deck. Volumes of hydrocarbons >200 L (0.2 m^3) include main engine lubricating oils, waste engine oil and hydraulic fluid, and would normally be stored below deck in designated storage tanks. Thus, these hydrocarbons do not represent a direct hazard for deck spills, unless smaller volumes are being used on deck directly from a container.

Spills or leaks from hydraulic hoses on cranes, winches or other hydraulically operated equipment are possible, although typically involve only very small volumes of fluid loss (e.g. <1 L). These spills or leaks are typically contained within a bund or drip tray under the equipment mounted on deck. A burst hydraulic hose on an extended crane could potentially result in hydraulic fluid being sprayed in a fine jet out over the water. However, this would only result in a small volume (<1-25 L) before the problem was noticed, equipment shut-down and the leak stopped.

In the event a loss to sea does occur, impacts to the marine environment would be minimal due to the small potential volumes released, and that spilt hydrocarbons will rapidly evaporate, disperse and weather. The potential environmental impacts are outlined further in **Section 6.6**. Therefore, based on the small volumes and proper storage procedures, the risk of an accidental hydrocarbon release (topside) is considered to be low.

6.6 Hydrocarbon Release Caused by Vessel Collision Between Survey Vessel and Chase Vessel or Third-Party Vessel and refuelling

6.6.1 Description of Risk

The Cygnus SW MSS will be carried out using one survey vessel, and a chase vessel during activities in the Cygnus SW operational area. Vessels will store and use fuel (MGO), which has the potential to adversely impact the marine environment if accidentally released in significant quantities.

There is a possibility of a vessel collision occurring between the vessels (either project and support vessels, or 3rd party) within the operational area. The worst-case environmental incident resulting from a vessel collision is the rupturing of a vessel fuel tank resulting in the release of MGO to the environment. There is also potential of a diesel spill to the marine environment during refuelling due to fuel hose breaks, coupling failure or tank overfilling.

Vessel grounding due to shallow seabed is discussed in **Section 6.2**. There are no additional collision hazards such as surface infrastructure within the operational area.

The potential minor hydrocarbon release during refuelling is not expected to significantly impact the receiving environment with management controls proposed to prevent releases. In addition, since refuelling will not occur within 26 km of the Cartier Island CMR, no impacts to shoreline habitats are expected. Since the volume of 37.5m^3 is far smaller than the potential 365m^3 resulting from a vessel collision it is considered that any impacts are assessed in the following section covering fuel spill from a vessel collision.

6.6.2 Potential Environmental Impacts

The accidental discharge of diesel has the potential to cause toxic effects on marine fauna and flora and a localised reduction in water quality. Potentially affected biota includes seabirds, cetaceans, turtles and fish (including whale sharks) that may come into contact with a surface hydrocarbon slicks. If surface slicks or entrained diesel were to contact shallow waters or emergent features adjacent to the operational areas, then a range of benthic habitats and communities could be at risk of impacts. Commercial fishing activities and shipping in the area could also be impacted in the event of a major diesel spill.

Survey-specific Hydrocarbon Spill Modelling

The nearest shorelines from the operational area are Cartier Island and Browse Island (34 km and 30 km from the operational area) and the nearest mainland shoreline is 134 km away. Shoreline contact would be expected in ~ 27 hours at Cartier Island and 24.5 hours at Browse Island while no mainland shoreline contact would occur. After 27 hours 95% of the fuel is predicted to evaporate

resulting in potentially ~ 18 m^3 that could contact the shorelines of Cartier Island or Browse Island. Given the distance to the CMR, it is possible that hydrocarbons could contact the CMR potentially affecting receptors in the outer edge of the CMR i.e. within the water column only. Hydrocarbon loss in the vicinity of Heywood Shoal would be unlikely to impact on the shoal itself given its shallowest water depth of 13m, it is unlikely that pelagic receptors associated with the shoal could be affected (e.g. fish) as the diesel will evaporate quickly and likely entrain within the upper 1 metre of the water column only.

Spectrum considers the risk of unplanned release to be ALARP with the application of other controls and standards.

Potential impacts to each sensitivity identified in **Section 3** are explained in greater detail in **Table 6-2** below.

Table 6-2: Impacts of surface slicks and entrained oil to sensitive receptors within and adjacent to the Cygnus SW operational areas

Receptor	Proximity to potential spill source	Potential impact		
		Surface Marine Diesel	Entrained Marine Diesel	Beached Diesel
Marine fauna				
Cetaceans	Overlap	Marine mammals are generally able to metabolise and excrete limited amounts of hydrocarbons, but acute or chronic exposure poses greater toxicological risks (Grant and Ross, 2002). Such impacts may include changes in behaviour and reduced activity, including inflammation of the mucous membranes, lung congestion, pneumonia, liver disorders, and neurological damage (Geraci, 1990) 27 species of cetacean were identified by the EPBC Protected Matters search as potentially being present within the operational area or EMBA (Table 3-5). Of these, 4 are listed as threatened and potentially being present in the area. *Blue whales* The EMBA overlaps a BIA for blue whale migration in the North West and the species is known to known to occur between Scott Reef and Browse Island. However as the major migration route is between the 500 m – 1000 m isobath (outside of the operational area), significant numbers are not expected within the area that may be affected by a spill.		
		Surfacing within a hydrocarbon slick may lead to a toxic level of exposure. However, cetaceans have a thickened epidermis that greatly reduces the likelihood of hydrocarbon toxicity from skin contact with oiled waters (Geraci, 1990; O'Shea and Aguilar, 2001). For surface oil, inhalation of vapours at the waters surface and ingestion of hydrocarbons during feeding (in particular, surface skimming baleen whales) are more likely pathways of exposure (National Marine Fisheries Service, 2008). *Blue whale* Foraging blue whales are may encounter a diesel spill given the BIA overlap with the EMBA. However, the likelihood of significant numbers of foraging blue whales encountering a surface spill is considered low. It is possible that transient individuals may be traversing an area potentially affected by a spill during migration en route to known feeding grounds.	As described for surface oil, acute or chronic exposure, through skin contact, inhalation or ingestion can result in toxicological risks. However, the concentration of entrained hydrocarbons will be less in comparison to surface slicks, due to the effects of dilution with sea water and inability for some hydrocarbon residues to entrain. This behaviour of entrained diesel combined with a thick epidermis layer means cetaceans are unlikely to be affected greatly from skin contact with entrained hydrocarbons. Further, inhalation will not be a significant exposure pathway for entrained oil. However, entrained oil can be ingested during feeding, in particular by gulp feeding whales. *Blue whale* Due to the potential vicinity of foraging blue whales to the operational area, it is possible that feeding blue whales could encounter entrained oil. However, concentrations of entrained diesel are expected to be	N/A

Receptor	Proximity to potential spill source	Potential impact		
		Surface Marine Diesel	Entrained Marine Diesel	Beached Diesel
			low. Individuals may transit an area of higher concentration, i.e. closer to the spill source, although significant numbers are not expected.	
		Given the low numbers of threatened species (as outlined above), and other migratory species (**Section 3.4.1**), that are expected to encounter surface and entrained diesel, and the minor potential consequences of contact (as assessed above), significant numbers are not expected to be impacted and so the impacts of surface and entrained hydrocarbons on marine mammals is considered low.		
Marine reptiles	Overlap	The EPBC Protected Matters database search identified seven species of threatened marine reptile species (**Section 3.4.1**). There are known feeding, nesting and breeding areas for turtles within the operational area and wider environment. Therefore hatchlings are expected to be present in the area during seasonal periods (**Section 3.4.1**). Seasnakes are also found in the shallow water areas around Cartier Island. The effects of hydrocarbons on marine turtles and seasnakes include toxicity leading to significant changes in blood chemistry, irritation of eyes and mouth and potential digestive related illness.		
		The main pathways for hydrocarbon surface slick exposure include ingestion and inhalation of vapours. Turtles are particularly prone to ingestion of surface oil, especially where it forms solid masses such as tar balls. Hydrocarbons ingested by a turtle do not pass rapidly through its digestive tract, it may be retained for several days, increasing internal contact and the likelihood that toxic compounds will be absorbed. The risk of gut impaction also increases for turtles that have ingested oil. Sea turtles' diving behaviour also puts them at risk. They rapidly inhale a large volume of air before diving and continually resurface over time, therefore turtles in an oil spill would experience both extended physical exposure to the oil and prolonged exposure to hydrocarbon vapours. Given seasnakes behaviour is similar to turtles (returning to surface to air), they have the potential to be impacted in a similar way.	Entrained oil presents fewer impacts to turtles and seasnakes. While skin contact with entrained oil may occur, the entrained hydrocarbons will be at lower concentrations, due to dilution with water in the water column, and thus reducing the toxicity. Smaller quantities of hydrocarbons may be ingested, but concentrations, and resulting toxicity, will be less than surface oil. Further, the impacts of inhaling hydrocarbon vapours are not applicable to entrained oil.	Shoreline contact and beached diesel may result in toxic impacts to turtle nesting habitat potentially impacting adults, eggs and hatchlings. Small volumes (<18m^3) could be expected at shorelines along Cartier Island.

Receptor	Proximity to potential spill source	Potential impact		
		Surface Marine Diesel	Entrained Marine Diesel	Beached Diesel
		The consequences of marine turtles encountering a surface slick can be severe, and with nesting and foraging BIAs within the EMBA, impacts to local populations may occur in the event of an unplanned release. Seasnakes are identified as critically endangered and therefore are low in numbers, impacts to individuals could be expected. However, given that the spill will be gone within 28 hours, the frequency and chance of surface interactions are expected to be low. As such, the potential impacts of surface oil on turtle populations are considered low.	The effects of entrained oil on marine turtles and seansakes are less severe than surface slicks, however with nesting and foraging BIAs within the EMBA for turtles, and the establishment of the CMR to protect marine reptiles, impacts to local populations may occur in the event of an unplanned release. As such, the potential impacts of entrained oil on turtles and seasnakes are considered moderate.	While the impacts to turtle nesting beaches may be severe, the lack of mainland shoreline contact and the timing and location of the survey vessel(s) not undertake acquisition of the four northernmost 2D sail lines closest to the Cartier Island CMR during 1st November to 28th February, and not refuel within 26 km of the Cartier Island CMR means that the risk is considered low and reduces the likelihood of impacts to nesting turtles occurring from an unplanned release.
Seabirds	Overlap	Five threatened species were identified by the EPBC Protected Matters database search (Table 3-5), no BIAs for threated species have been designated in the vicinity of the operational area and EMBA (**Figure 3-9**). One threatened species, the Australian lesser noddy is known to breed in the area, although no biologically important areas are designated. The operational area and EMBA do however overlap BIAs for breeding and foraging of other listed species (**Table 3-5**). The migratory species highlighted in the protected matters search cover great distances when migrating, and so have the potential to transit over the operational area.		

Receptor	Proximity to potential spill source	Potential impact		
		Surface Marine Diesel	Entrained Marine Diesel	Beached Diesel
		Seabirds are particularly vulnerable to surface hydrocarbons. As most fish survive beneath floating slicks, they will continue to attract foraging seabirds, which typically do not exhibit avoidance behaviour. Direct contact with surface hydrocarbons can lead to irritation of skin and eyes. Smothering can lead to reduced water proofing of feathers leading to hypothermia. Smothering of feathers can also lead to excessive preening, diverting time away from other behaviours leading to starvation and dehydration. Preening of oiled feathers will also result in to ingestion of hydrocarbons and the associated impacts of toxicity and potential illness.	Entrained oil does not pose the same high risk of smothering as surface slicks as the effects of smothering on feathers are lower, reducing the amount of hydrocarbons ingested through preening. Seabirds may still encounter entrained hydrocarbons leading to irritation of skin and eyes, and also lower levels via ingestion and the associated toxicity effects.	Beached diesel poses a risk to species that utilize the shoreline for foraging. Ground nesting species may also be impacted. Direct contact with surface hydrocarbons can lead to irritation of skin and eyes. Smothering can lead to reduced water proofing of feathers leading to hypothermia. Smothering of feathers can also lead to excessive preening, diverting time away from other behaviours leading to starvation and dehydration. Preening of oiled feathers will also result in to ingestion of hydrocarbons and the associated impacts of toxicity and potential illness.
		The impacts of surface oil on seabirds can be severe. BIAs for foraging for a number of migratory listed species occur within the area that may be impacted by an unplanned release. As such seabirds may be expected to encounter a surface spill if it were to occur. However any spill would be contained within a 26 km radius and be gone within 28 hours limiting the potential for impact. As such, the potential impacts of surface oil on seabird populations are considered low.	The effects of entrained oil on seabirds are less severe than a surface slick, however as BIAs for foraging for a number of migratory listed species occur within the area that may be impacted by an unplanned release seabirds may be expected to encounter entrained diesel in low numbers. As such, the potential impacts of entrained oil on seabird populations are considered low.	Beached diesel will evaporate quickly in the temperatures experienced in potential shoreline contact areas. However, reduced prey may be available to foraging shorebirds due to mortality or avoidance, and nesting individuals may be disrupted. While the impacts to seabirds nesting and foraging on beaches and shorelines may be severe, the lack of mainland shoreline contact and low volume of oil potentially beaching on Cartier Island means that the risk is considered low.
Fish (including sharks)	Overlap	The North West Shelf supports a diverse assemblage of fish which may be spawning during survey activity, as outlined in 3.4.1 . Nine species where identified by the protected matters search, of which three are classified as vulnerable including the whale shark. A BIA for whale shark foraging overlaps the operational area.		

Receptor	Proximity to potential spill source	Potential impact		
		Surface Marine Diesel	Entrained Marine Diesel	Beached Diesel
		While fish and sharks do not generally break the sea surface, individuals may feed at the surface. However, since the diesel is expected to have fully dispersed and evaporated within 28 hours, and the low frequency of breaches at the surface, the probability of prolonged exposure to a surface slick by fish and shark species is low.	Hydrocarbon droplets can physically affect fish and sharks exposed for an extended duration (weeks to months). Smothering through coating of gills can lead to the lethal and sub-lethal effects of reduced oxygen exchange, and coating of body surfaces may lead to increased incidence of irritation and infection. Fish may also ingest hydrocarbon droplets or contaminated food leading to reduced growth. There is potential for localised mortality of fish eggs and larva due to reduced water quality and toxicity. Effects will be greatest in the upper 1 m of the water column and areas close to the spill source where hydrocarbon concentrations are likely to be highest and therefore demersal fish communities are not expected to be impacted.	N/A
		Due to the low probability of contact with surface oil, the impact of surface oil on fish and sharks is expected to be low.	Although entrained hydrocarbons can have negative impacts on fish and fish eggs/larvae, considering the volume of entrained hydrocarbons potentially encountered, the low persistence of diesel and the large extent of suitable marine habitat, impacts at the population level is considered low.	N/A
Marine habitats				
Sandy beaches	Overlap	Sandy beaches have a relatively low biodiversity although they do provide important habitats for nesting turtles, breeding and foraging seabirds, and shorebirds. They also provide habitat for polychaetes, molluscs, marine crustaceans, semi-terrestrial crustaceans and insects.		
		Surface hydrocarbons may accumulate on sandy beaches, impacting the area by physically smothering the habitat. Stranded oil may have toxic effects on invertebrates with knock on impacts on the shorebirds that forage upon them.	Entrained hydrocarbons will not become stranded on the shoreline and therefore will have no impact on sandy beaches.	Beached marine diesel may accumulate on sandy beaches, impacting the area by physically smothering the habitat. Stranded oil may have toxic effects on invertebrates with knock on impacts on the shorebirds that forage upon them.

Receptor	Proximity to potential spill source	Potential impact		
		Surface Marine Diesel	Entrained Marine Diesel	Beached Diesel
		Sandy beaches occur within the EMBA and therefore impacts to this sensitivity are possible if an unplanned release were to occur. However, the lack of mainland shoreline contact and the avoidance of 2D sail line acquisition along the 4 northernmost lines closest to the CMR during 1st November to 28th Feb, and no refuelling within 26 km of the Cartier Island CMR means that the risk is considered low and reduces the impact to recognised important habitats for threatened turtle species.		
Intertidal reefs	Overlap	Intertidal reefs occur within shallow near shore waters within the EMBA in the vicinity of Cartier Island.		
		Surface hydrocarbons may make contact with intertidal reefs should reef features become emergent, for example during low tide. Impacts of contact with surface oil can include impaired feeding, fertilisation, larval settlement and metamorphosis, larval and tissue death and decreased growth rates (Villanueva *et al*., 2008). Surface oil also has the potential to impact reef fauna (marine reptiles, fish, marine mammals) as outlined in the rows above.	Physical effects from entrained oil have the potential to coat contacted coral reefs. The phenomena of smothering of exposed coral surfaces or polyps by oil spills has only been reported where very large oil spill quantities, or very sticky oil slicks, have been encountered. Response to hydrocarbon exposure can include impaired feeding, fertilisation, larval settlement and metamorphosis, larval and tissue death and decreased growth rates (Villanueva *et al*., 2008). Entrained oil also has the potential to impact reef fauna (fish, marine reptiles, and marine mammals) as outlined in rows above.	See ‘Surface Marine Diesel’.
		Intertidal reefs occur within the area potentially impacted by a spill and therefore impacts to this sensitivity may occur due to an unplanned release of diesel.		
Submerged reefs	Overlap	Submerged reefs and shallow shoals are found within the operational area and EMBA (3.3.2)		

Receptor	Proximity to potential spill source	Potential impact		
		Surface Marine Diesel	Entrained Marine Diesel	Beached Diesel
		The likelihood of surface hydrocarbons contacting submerged reefs and shoals is moderate, largely due to the distance between the sea surface and the submerged habitat.	Physical effects from entrained oil have the potential to coat contacted coral reefs. The phenomena of smothering of exposed coral surfaces or polyps by oil spills has only been reported where very large oil spill quantities, or very sticky oil slicks, have been encountered. Response to hydrocarbon exposure can include impaired feeding, fertilisation, larval settlement and metamorphosis, including larval and tissue death and decreased growth rates (Villanueva *et al*., 2008). Filter feeders such as molluscs are especially liable to ingest oil with lethal and various sub-lethal effects. This includes alteration in respiration rates, decreases in filter feeding activity, reduced growth rates, biochemical effects, increased predation, reproductive failure and mechanical destruction by waves due to inability to maintain hold on substrate (Ballou *et al*. 1989; Connell and Miller 1981). Entrained oil also has the potential to impact marine fauna (fish, turtles, marine mammals) as outlined in rows above.	N/A
		Submerged reefs and shoals occur within the area potentially impacted by a spill and therefore impacts to this sensitivity may occur due to an unplanned release.		
Socioeconomic				
Fisheries	Overlap	A number of fisheries outlined in **Section 3.5** may be impacted in the unlikely event of a spill occurring.		
		Surface hydrocarbons will have negligible impacts on fish (see ‘Fish’ above) but exclusion zones surrounding a spill (if implemented by the control agency) can directly impact fisheries by restricting access for fishermen leading to financial losses.	Entrained hydrocarbons can have toxic effects on fish and fish spawning (as outlined in ‘Fish’ above) reducing catch rates and rendering fish unsafe for consumption leading to financial losses.	N/A

Receptor	Proximity to potential spill source	Potential impact		
		Surface Marine Diesel	Entrained Marine Diesel	Beached Diesel
		The impact of restricted access is considered low as the diesel will only persist at most for 28 hours.	Although entrained oil may reduce catch rates the effect is not expected to be long term and given the length of the fishing seasons for the fisheries potentially effected, the impacts are considered low.	N/A
Tourism	Overlap	The level of tourist activities such as diving, snorkelling and recreational fishing is low in the area due to the offshore waters of the operational area.		
		Exclusion zones (if implemented by the control agency) surrounding spills will reduce access for recreational fishing and snorkelling/diving on emergent and intertidal reefs.	Effects of entrained oil on fish may reduce recreational fishing in the area (due to effects described in 'Fisheries' and 'Fish' above). The impacts of entrained oil on intertidal and submerged reefs (as also described above) will impact snorkelling and diving activities.	Stranding of marine diesel on sandy beaches may impact some tourism activities.
		Due to the low levels of tourism expected in the area the impacts of a hydrocarbon spill on tourism is expected to be low.		
Shipping	Overlap	Commercial shipping activity in the North West Shelf has national and international significance, Vessel traffic is greatest in the north and west of the operational area, with some levels shipping occurring throughout the operational area and wider environment.		
		Exclusion zones (if implemented by the control agency) surrounding a spill will reduce access for local vessels. Local fishing vessels would have to take large detours leading to potential delays.	Entrained oil with have no impacts on shipping.	N/A
		Although there are shipping routes overlapping the operational area, diesel is not predicted to persist for more than 28 hours or spread more than 26 km, therefore potential impacts to commercial shipping and local vessels are considered low.	The impacts of entrained oil on shipping are likely to be negligible.	N/A
Defence	Overlap (Airspace)	Defence activities are not expected in the area that may be affected by a spill (see **section 3.1**).		
		Exclusion zones (if implemented by the control agency) surrounding a spill may lead to reduced access for marine based defence activities.	Entrained oil with have no impacts on defence activities.	Beached marine diesel will have no impacts on defence activities.

Receptor	Proximity to potential spill source	Potential impact		
		Surface Marine Diesel	Entrained Marine Diesel	Beached Diesel
		The level of defence activities carried out in the area is low, and with a maximum 28 hour persistence of the spill, the subsequent impacts are considered low.	The impacts of entrained oil on defence activities are negligible.	The impacts of beached marine diesel on defence activities are negligible.
Protected areas (see **Section 3.3.2**)		Potential impacts of surface and entrained oil on individual receptors listed in each protected area are described in the rows above.		
Key Ecological Features (see **Section 3.3.2**)		Potential impacts of surface and entrained oil on individual receptors listed in each KEF are described in the rows above. Given the depth of the 2 identified KEFs are below 100m, no impacts from hydrocarbon spills are expected.		

7 IMPLEMENTATION STRATEGY

The Cygnus SW MSS activity will be managed in compliance with all measures and controls detailed within the EP accepted by NOPSEMA under the OPGGS (E) Regulations, other environmental legislation and Spectrum's Management System (e.g. Environmental Management Policy).

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

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

As described in the EP, the implementation strategy includes the relevant details of the following:

- Environmental Management Framework;
- Roles and Responsibility;
- Training and competency;
- Monitoring and Record Keeping;
- Auditing and Inspection
- Management of non-conformance; and
- Emergency response

During the period that activities described in the EP are undertaken, Spectrum will ensure environmental performance is managed through an inspection and monitoring regime undertaken by Spectrum representatives or delegates based on the vessels.

Environmental compliance of an activity with the EP (and the EPO's) is measured using planned and systematic audits or inspections to identify weaknesses and non-conformances in the system and processes so that they can be identified. Improvement opportunities identified through monitoring, audits and incident investigations are implemented in a controlled manner and communicated to all relevant workforce, contractors and relevant third parties. Audits and inspections are in place to identify possible incidents and actions taken to prevent them from happening.

Non-conformances found are addressed and resolved by a systematic corrective action process and are reported to NOPSEMA where relevant.

Senior Spectrum and vessel contractor personnel will be accountable for ensuring conformance with environmental performance outcomes and standards. The EP identifies specific responsibilities for each role during the activity.

Incident notification and reporting to NOPSEMA and other regulators will be conducted as per the OPGGS(E)R, as detailed within the EP. Reported HSE incidents and hazards will be communicated to personnel during daily operational meetings.

8 EMERGENCY RESPONSE

8.1 Oil Pollution Emergency Plan

The Oil Pollution Emergency Plan (OPEP) for the proposed Cygnus SW MSS, taking into account the nature and scale of the activity and the potential spill risks involved (see above) comprises components of the survey vessel SOPEP that manage the environmental impacts of a spill, supported as required by applicable established, statutory OPEPs (e.g. NATPLAN, WestPlan MOP, WA DoT OSCP). In summary, the following plans are in place as a contingency in the unlikely event of an oil spill, which as a whole, represent the OPEP for this activity:

- Survey vessel SOPEP - deals with spills which are either contained on the vessel or which can be dealt with from / by the vessel. Support vessels (< 400 tonnes) which do not formally need a SOPEP, will possess an equivalent spill management plan which deals with spills which are either contained on the vessel or which can be dealt with from / responded by the vessel.
- National Plan for Maritime Emergencies (NATPLAN): Australian Maritime Safety Authority (AMSA) - is the Jurisdictional Authority (JA) and Control Agency (CA) for spills from vessel which affect Commonwealth waters, i.e. outside of 3 nm from the coast (AMSA 2014b).
- WA State Emergency Management Plan for Marine Oil Pollution (WestPlan-MOP) and Department of Transport (DoT) Oil Spill Contingency Plan (OSCP) - deals with spills from the vessels which affect WA State waters (AMSA 2011).

The OPEP will be regularly reviewed (as a minimum following each drill or actual incident) to ensure that it is appropriate to the nature and scale of the survey activities within its scope and to ensure maintenance of the response capability and the operator's preparedness. In compliance with Regulation 14(8AA), the OPEP will be continuously reviewed and kept up-to-date to ensure new information or improved technology can be incorporated as specifies in the SOPEP.

8.2 Vessel SOPEP

The survey vessel SOPEP, which is prepared in accordance with the IMO guidelines for the development of shipboard oil pollution emergency plans (resolution MEPC.54(32) as amended by resolution MEPC.86(44)), will include emergency response arrangements and provisions for testing the SOPEP (oil pollution emergency drills), as required under Regulations 14(8AA), 14(8A) and 14(8B) to 14(8E) of the OPGGS E Regulations. Vessels <400 tonnes that do not have a SOPEP will have an equivalent spill response plan that deals with spill response, pollution monitoring and provisions for testing the plan. These vessels / plans shall be included in the survey OPEP drills.

A drill of the oil spill emergency response arrangements will be conducted prior to commencement of the survey, during mobilisation. The SOPEP is subject to four scheduled drills per annum, therefore given the likely survey duration, at least one additional drill is likely to be conducted during the course of the Cygnus SW MSS.

A planned maintenance system (PMS) will be in place on the survey vessel and support vessels, to ensure that all equipment used during operations is in full working order, and does not represent a hydrocarbon spill risk. Stocks of absorbent materials aboard the survey vessel will be checked for their adequacy and replenished as necessary prior to the commencement of activities.

9 STAKEHOLDER IDENTIFICATION AND CONSULTATION

9.1 Stakeholder Consultation Summary for Cygnus SW MSS Environment Plan

The following stakeholder consultation outreach activities has been completed by Spectrum during pre-survey consultation and EP development:

- 5th January 2017: Issue via email and post to fishery licence holders of proposed survey details
- 15 February 2017: Issue via email and post to fishery licence holders of updated survey details
- 9 March 2017: issue via email to update survey details
- Follow up phone calls as required

9.2 Cygnus SW MSS Stakeholder Consultation Plan

Consultation with stakeholder groups, primarily within the commercial fishing industry, concerning the proposed Cygnus SW MSS operational area occurred prior to, and during the preparation of this EP. The stakeholder consultation will be undertaken in phases as described below:

- Phase 1 Preparatory Consultation - stakeholders notified of the proposed Cygnus SW MSS operational area
- Phase 2 Pre-survey Consultation - stakeholders notified of exact timing, duration and vessels
- Phase 3 On-going Consultation - includes complying with requests from stakeholders for additional information, survey updates, etc.
- Phase 4 Post-survey Notifications- includes complying with requests from stakeholders for notification of the completion of individual surveys.

9.2.1 Phase 1 - Preparatory Consultation

To prepare for stakeholder consultation, relevant persons were identified based on the following information:

- Commonwealth and WA State government agencies under relevant legislation
- Non-government organisations that have interest/activities in operational area
- GIS shapefiles of commercial fishery license areas
- current status reports of WA fisheries and aquatic resources (Fletcher & Santoro 2015)
- current status reports of Commonwealth fisheries and aquatic resources (ABARES 2015)
- current list of license holders extracts (provided by DoF)
- scientific literature
- information provided directly through previous stakeholder consultation.

The following stakeholders (including fisheries bodies and organisations, and State and Commonwealth government departments) were initially informed of the survey via letters or emails or post:

- Australian Antarctic Division (AAD)
- Australian Customs Services (Coastwatch)
- Australian Fisheries Management Authority (AFMA)
- Australian Hydrographic Service (AHS)
- Australian Marine Oil Spill Centre (AMOSC)

- Australian Maritime Safety Authority (AMSA)
- Austral fisheries
- Border Protection Command
- Centre for Whale Research (CWR)
- Coastwatch
- Conservation Council
- Director of National Parks (DNP)
- Commonwealth Fisheries Association (CFA)
- Department of Defence (DoD)
- Department of the Environment (DoE)
- Geoscience Australia
- International Fund for Animal Welfare (IFAW)
- Joint Airspace Control Cell
- MG Kailis Group
- Recfishwest
- WA Department of Fisheries (DoF)
- WA Department of Mines and Petroleum (DMP)
- WA Department of Transport (DoT)
- WA Department of Parks and Wildlife (DPaW)
- Western Australian Fishing Industry Council (WAFIC)
- WA Seafood Exporters
- WestMore Seafoods
- Wilderness Society
- Pearl Producers Association
- Department of foreign affairs and trade (DFAT)
- National Native Title Tribunal
- NT Parks and Wildlife Commission
- Pearl Producers Association
- World Wildlife Fund
- Shire of Wyndham East Kimberley
- Shire of Wyndham East Kimberley
- Shire of Derby West Kimberley
- Kimberley Land Council's (KLC)
- Shire of Broome

Commonwealth fisheries that overlap the Cygnus SW MSS operational area include:

- North-West Slope Trawl Fishery:
- Southern Bluefin Tuna Fishery
- Western Skipjack Fishery;
- Southern Tuna and Billfish Fishery; and
- Western Tuna and Billfish Fishery.

Additionally, Spectrum obtained extracts from the DoF Public Register for WA State-managed fisheries, and individuals currently holding licences for the following commercial fisheries were contacted and informed of the proposed operations:

- Abalone Managed Fishery (Zone 4);
- Joint Authority Northern Shark Fishery
- Mackerel Managed Fishery
- North Coast Demersal Fishery (Northern Demersal Scalefish Managed Fishery);
- Marine Aquarium Fish Managed Fishery
- Specimen Shell Managed Fishery
- West Coast Deep Crustacean Managed Fishery
- Broom Prawn Managed Fishery
- Kimberly Prawn Managed Fishery
- WA North Coast Shark Fishery
- Mud Crab Fishery
- Kimberly Gillnet and Barramundi Limited Entry Fishery
- Pearl Oyster Fishery
- South West Coast Salmon Fishery

All Commonwealth managed fisheries are administered through AFMA. As outlined on the AFMA website, the CFA and WAFIC are fishing associations that represent the North West Slope Trawl and Western Tuna Billfish Fishery (among other Commonwealth fisheries). The CFA is the peak body representing the collective rights, responsibilities and interests of their relevant fisheries, and WAFIC represent WA professional fishing, pearling and aquaculture enterprises. As such, they are the primary industry association contacts.

Spectrum sent the first contact letter to all stakeholders.

Following the initial letters sent via post, the operational area has been reduced significantly. Given the initial letters described a much larger area, and no concerns were raised by those contacted, follow-up letters with the updated survey area were not re-issued. This avoids stakeholder fatigue and as the worst case scenario has been consulted on, this is considered appropriate given the limited number of users in the area. To ensure all stakeholders are kept informed of the activity, pre-survey consultation is undertaken (Phase 2) to ensure all stakeholders are aware of the final survey area, details of relevant controls (as requested) and any changes to the initial notifications issued. Where stakeholder responses have not been received for this EP, phone calls were made (where numbers were available), stakeholders who did not answer the phone will be contacted again as part of Phase 2 consultation to avoid harassment and stakeholder fatigue.

9.2.1.1 Stakeholder Submissions

Details of the stakeholder responses as well as Spectrum's assessment of feedback and correspondence are included in **Table 9-1.**

Table 9-1: Details of Phase 1: Preparatory Consultation with stakeholder feedback and Spectrum's assessment

Ref No	Stakeholder	Date	Stakeholder Response	Spectrum Assessment on Feedback and response
1	Department of Defence (DOD)	5- Jan	Spectrum sent the first notification advising about the MSS	
		10-Jan	Noted, please keep us informed of activities to allow appropriate notice to mariner action to be published in a timely manner	No response required No further action required, keep informed of updates
		15-Feb	Spectrum sent update notification of the revised operational and survey areas	No response received. No further action required. Keep informed of updates
		9-Mar	Spectrum sent update notification of the revised operational and survey areas	No response received. No further action required keep informed of updates
2	Department of Parks and Wildlife (DPaW)	5- Jan	Spectrum sent the first notification advising about the MSS	
		6-Jan	Confirm the distances from the nearest data acquisition areas to Western Australian State waters and in particular to the Browse Island Nature Reserve and Scott Reef Nature Reserve.	Spectrum agreed to request for information.
		19-Jan	Spectrum responded on 19/01/17	Approximate distances to areas of interest provided and notification given that any changes to operational area in future will be communicated through stakeholder engagement. DPaW to be updated once final survey area is confirmed in pre-survey consultation.
		15-Feb	Spectrum sent update notification of the revised operational and survey areas	No response received. No further action required.
		9-Mar	Spectrum sent update notification of the revised operational and survey areas	No response received. No further action required keep informed of updates
3		5- Jan	Spectrum sent the first notification advising about the MSS	

Ref No	Stakeholder	Date	Stakeholder Response	Spectrum Assessment on Feedback and response
	Department of Mines and Petroleum (DMP)	6-Jan	• Acknowledgement of information • not require any further information at this stage • provide DMP with pre-start and cessation notifications prior to and at the completion of the activity	No response required. Notification commitments included in **Table 10-1**
		15-Feb	Spectrum sent update notification of the revised operational and survey areas	No response received. No further action required.
		9-Mar	Spectrum sent update notification of the revised operational and survey areas	DMP responded on 16 Mar
		16-Mar	DMP responded to Spectrum with the following points: • Not require any further information at this stage • Requested Spectrum review DMP's consultation guidance note for information pertaining to the reporting of incidents to DMP that could potentially impact on any land or water under State jurisdiction • Furthermore, should Spectrum identify the application of dispersant as a response strategy to an oil spill incident in Commonwealth waters, Spectrum should be mindful of DMP's approval requirements (Minister or appropriate Hazard Management Agency) prior to dispersant application under Regulation 35 of the Petroleum (Submerged Lands) (Environment) Regulations 2012 where dispersant may potentially impact upon State waters • provide DMP with pre-start and cessation notifications prior to and at the completion of the activity	No response to DMP required Reporting of incidents to DMP has been captured in the EP Given the use of MGO during the activity, dispersant application is not considered as an appropriate response and has therefore not been included within the EP and has not been risk assessed. Spectrum is aware of the DMP approval requirements and in the event that any aspect changes and dispersant application is recommended by the control agency, these requirements will be adhered to. As previously requested, commencement and cessation notifications will be provided as per **Table 10-1**
4	Australian Hydrographic Service (AHS)	5- Jan	Spectrum sent the first notification advising about the MSS	
		10-Jan	Noted, please keep us informed of activities to allow appropriate notice to mariner action to be published in a timely manner	No action required keep informed of updates

Ref No	Stakeholder	Date	Stakeholder Response	Spectrum Assessment on Feedback and response
		16-Jan	To advise that as of May 2016, email to AHS will be changed from 'ntm@defence.gov.au' to 'datacentre@hydro.gov.au'	No response required A consultation letter was sent to correct email initially as well as this address. Old email was deleted from file and all future consultation will refer to only new email address.
		15-Feb	Spectrum sent update notification of the revised operational and survey areas and included buffers	No response received. No further action required.
		16-Feb	Survey activities noted, please provide final details at least three weeks prior to commencement of survey so that a temp NTM may be issued.	Spectrum Responded confirming the final details will be sent to AHS 3 weeks prior survey commencement. AHS notification requirement was included in the EP
		9-Mar	Spectrum sent update notification of the revised operational and survey areas including distances of the revised operational and survey boundaries and sensitive areas or landmarks	AHS confirmed receipt of the update. No further action required.
5	Austral Fisheries	5-Jan	Spectrum sent the first notification advising about the MSS The intended recipient is on leave till Feb 17	No response required[3]
		15-Feb	Spectrum sent update notification of the revised operational and survey areas and included buffers	No response received. No further action required.
		9-Mar	Spectrum sent update notification of the revised operational and survey areas including distances of the revised operational and survey boundaries and sensitive areas or landmarks	No response received. No further action required.
6	Australian Fisheries Management	5-Jan	Spectrum sent the first notification advising about the MSS The intended recipient is on leave until Jan 16	No response required
		15-Feb	Spectrum sent update notification of the revised operational and survey areas and included buffers	No response received. No further action required.

Ref No	Stakeholder	Date	Stakeholder Response	Spectrum Assessment on Feedback and response
	Authority (AFMA)	9-Mar	Spectrum sent update notification of the revised operational and survey areas including distances of the revised operational and survey boundaries and sensitive areas or landmarks	No response received. No further action required.
		15-Mar	Stakeholder was followed up by phone after not responding to email correspondence. AFMA has not responded to engagement so far because they are not concerned about the survey. They are happy with consultation to date and will be included in future consultation notifications but have no concerns given the area of the survey.	No additional follow up required. Stakeholder email with revised survey area sent 9/3/2017
7	World Wildlife Fund (WWF)	5-Jan	Spectrum sent the first notification advising about the MSS The intended recipient is on leave until Jan 9	No response required
		15-Feb	Spectrum sent update notification of the revised operational and survey areas and included buffers	No response received. No further action required.
		9-Mar	Spectrum sent update notification of the revised operational and survey areas including distances of the revised operational and survey boundaries and sensitive areas or landmarks	No response received. No further action required.
		9-Mar	WWF responded that for any issues related to WWFs clean tech work program, provided new contact	New contact noted and updated in the recipient list. No further action required.
8	Recfishwest	5-Jan	Spectrum sent the first notification advising about the MSS The intended recipient is on leave 9 Jan 17	No response required
		15-Feb	Spectrum sent update notification of the revised operational and survey areas and included buffers	No response received. No further action required.
		9-Mar	Spectrum sent update notification of the revised operational and survey areas including distances of the revised operational and survey boundaries and sensitive areas or landmarks	No response received. No further action required.
9		5-Jan	Spectrum sent the first notification advising about the MSS	No response received.

Ref No	Stakeholder	Date	Stakeholder Response	Spectrum Assessment on Feedback and response
	National Native Title Tribunal	16-Feb	Survey and operational areas appear to lie outside the Kimberley Land Council's (KLC), Native Title Representative Body area. However, the larger survey area may encroach within the KLC's representative area. If you have not already consulted the KLC you may wish to do that.	Stakeholder letter (Feb version) was sent to KLC on 20 Feb 17 as advised
		22-Feb	Spectrum responded to NNTT advising that a consultation package was sent to KLC on 20 Feb as advised	No further action required
11	DOF	5 - Jan	Spectrum sent the first notification advising about the MSS	No response required
	DoF – Licensing Division	20/01/17	Please be aware that the future of the Northern Shark Fisheries (the WA North Coast Shark Fishery and the Joint Authority Northern Shark Fishery) is yet to be determined and is currently being considered as part of a review. In the case that the Northern Shark Fisheries are reactivated, other parties may be considered when granting access to the resource.	No response required.
	DOF	15-Feb	Spectrum sent update notification of the revised operational and survey areas and included buffers	
	DOF	16-Feb	DOF requested the following issues to be addressed in writing, including consultation, impact to fishermen, impacts to fishes and biosecurity	Spectrum responded to DOF on 9 Mar.

Ref No	Stakeholder	Date	Stakeholder Response	Spectrum Assessment on Feedback and response
	DOF	9-Mar	Spectrum sent DOF a written response that addressed all of DOF's concerns together with the revised operational and survey areas.	Summary of Spectrum's response to DOF includes: Spectrum has included DOF advice on fish spawning in the EP (Table 3-6) and assessed DOF concerns regarding cumulative impact (section 5.6.5). Spectrum notes DOF's objection to seismic activity in water depth below 50m. Less than 5% of Spectrum's survey area has a water depth of less than 50m (indicated in Figure 2 of the written response from Spectrum). Spectrum has assessed DOF's concern over biosecurity in section 5.5 of the EP. Spectrum has listed the controls committed to in the written response. Spectrum will be considering DOF recommendations for additional controls such as follow up inspection after 75 days since the vessel arrives and equipment treatment prior use in WA waters. Spectrum has identified and consulted all fisheries and licenced fishermen that are potentially impacted by the proposed Cygnus SW survey. All feedback is captured in a consultation log maintained by S2V Consulting. No response from DOF received after Spectrum sent its response to DOF's concerns.
		10-Apr	Spectrum followed up with DOF to provide updates on revised buffers and water depth around Heywood Shoal	Points of update include: Since further refinement of control measures for this activity, the implementation of a buffer around the 50m contour at Heywood shoal results in the seismic source not being fired at full power in water depths of <50m. Spectrum also enclosed a map of the Heywood shoal and associated buffer and bathymetry to support the refined control in relation to the 50m bathymetry contour around Heywood shoal.

Ref No	Stakeholder	Date	Stakeholder Response	Spectrum Assessment on Feedback and response
		11 Apr	DoF queried with regards to the comments “not being fired at full power in water depths of 50m” can you please clarify what source (cui) will be used in water depths less than 50m and the SPL.	Spectrum reviewed the survey area and identified some areas within the operational area where water depths are less than 50m. However, there is no requirement to undertake soft starts in this area. Therefore a commitment has been added to the EP stating the seismic source will not be fired in water depths of less than 50 m (EPS-43). This was communicated via email to DoF on the same day.
12	DMP	5-Jan	Spectrum sent the first notification advising about the MSS	No response received
		15-Feb	Spectrum sent update notification of the revised operational and survey areas and included buffers	
		16-Feb	DMP has reviewed the notification and does not require any further information at this stage. Please provide DMP with pre-start and a cessation notifications prior to and at the completion of the activity. Please submit future activity notifications to the Petroleum Environment Branch email address: petroleum.environment@dmp.wa.gov.au.	No response required
		9-Mar	Spectrum sent update notification of the revised operational and survey areas including distances of the revised operational and survey boundaries and sensitive areas or landmarks	No response required
		16-Mar	DMP has reviewed the notification and does not require any further information at this stage. Please provide DMP with pre-start and a cessation notifications prior to and at the completion of the activity.	DMP notification requirements are already included in the EP. No response required
13	WAFIC	5-Jan	Spectrum sent the first notification advising about the MSS	No response received
		15-Feb	Spectrum sent update notification of the revised operational and survey areas and included buffers	No response required

Ref No	Stakeholder	Date	Stakeholder Response	Spectrum Assessment on Feedback and response
			WAFIC provided new email address to be contacted for future consultation. WAFIC requested clarification if stakeholder notification dated 7 Jan was sent to WAFIC.	WAFIC is a valued stakeholder and Spectrum commits to ongoing consultation with WAFIC around all activities on the North West Shelf, and confirmed that all notifications had been sent to WAFIC
		16-Feb	WAFIC required details on controls to address impacts to fishermen and potential impacts on fish spawning, food chain and the overall environment. WAFIC questioned the time allowed for stakeholder to respond given that it was only 6 weeks between the first notification was sent and the EP was submitted. WAFIC referenced the APPEA's Draft Stakeholder Consultation and Engagement Principles and Methodology and requests that Spectrum to investigate multiple points of contact before a "no reply" (and therefore interpreting this as no interest) is registered, such as email and telephone and traditional mail. WAFIC identified the two fisheries that intersect with the Spectrum operational and survey area and provided fishing timing of these two fisheries and fish spawning timing. WAFIC therefore indicated that seismic should not occur in January, February, March and April and then October and December.	
13	WAFIC	22-Feb	WAFIC recognised two different emails that were used for consultation, one with s2vconsulting.com and the other amecfw.com	Spectrum responded in email to WAFIC on 9/03/2017
		2-Mar	Spectrum sent a follow up email to WAFIC acknowledging WAFIC's two emails dated 16 Feb and 22nd Feb and advising that Spectrum was collating a response.	

Ref No	Stakeholder	Date	Stakeholder Response	Spectrum Assessment on Feedback and response
		9-Mar	Spectrum responded to WAFIC addressing all of WAFIC's concerns with full details of all controls proposed. Spectrum also copied WAFIC in the issue of the third notification, which provided updates on the reduced operational and survey area. The notification issued on the same day.	Summary of Spectrum's response to WAFIC in this email include: Spectrum has assessed WAFIC's concerns regarding fish spawning (table 3-6 in the EP). Spectrum recognised the limited time allowed for stakeholders prior to the initial submission. Stakeholders have now had >8 weeks to review the initial notification sent to stakeholders, and since then the survey area has reduced, therefore a "worst case" larger area has been consulted on. Spectrum's review of existing literature does not indicate impacts to commercial fishery catches due to MSS, sections 5.4.3.1 and 5.6.3.4. In addition, the controls in place to manage impacts to turtles include no 2D acquisition along the four northernmost sail lines closest to the CMR during 1st November – 1st march. This overlaps the majority of the identified spawning season for "key indicator species" of Jan-April and October-December. Given the controls in place for 2D acquisition, it is actually unlikely the survey will be acquired during 1st November to 1st March, however this is not something that Spectrum can commit to as the survey may be acquired in phases. Spectrum offered a follow up phone call to discuss the letter and change in survey area. Spectrum will ensure that WAFIC are further consulted at least 4 weeks prior to survey commencement if no feedback is received prior to this date.
		10-Mar	WAFIC acknowledged the response from Spectrum and would reply in due course. WAFIC also advised to send all future correspondence to eora@wafic.org.au.	Spectrum to update distribution list
		11-Mar	Spectrum responded to WAFIC confirming the email address was noted and had removed the wrong addresses from the distribution list. Spectrum offered a phone call to discuss Spectrum's response	No further action required
		13-Mar	WAFIC and Spectrum agreed on the timing for the follow up phone call	The agreed timing was 15 Apr at 2pm
		15-Mar	Phone call with WAFIC	

Ref No	Stakeholder	Date	Stakeholder Response	Spectrum Assessment on Feedback and response
		16-Mar	Spectrum followed up with an email following the phone conversation on 15 April.	Key points in Spectrum's following up email include: Fisheries map and distances between operational area boundaries and key sensitive areas are enclosed Confirming all fisheries that may be impacted by the survey have been contacted Acknowledge the new WAFIC 'fee for service' to assist with stakeholder consultation Send the relevant controls that have been updated since last correspondence with WAFIC
		29-Mar	Spectrum followed up with WAFIC to see if WAFIC had a chance to review the information Spectrum sent following the phone catch up on 14/03/2017. WAFIC responded stating that she had not had time to review Spectrum's responses.	No further action required
		8-Apr	Spectrum updated WAFIC with the refined controls on 150 m buffer and water depth (no discharge of seismic source in water depths less than 50 m) around Heywood shoal and timing of the survey to avoid key identified spawning periods (no seismic activity from Jan- April).	No response received. No further action required.
14	DoT	5-Jan	Spectrum sent the first notification advising about the MSS	No response received
		15-Feb	Spectrum sent update notification of the revised operational and survey areas and included buffers	
		15-Feb	Please be advised that this information has been passed along to the relevant officer who will be in touch should they need any further information or have any comments.	No response required
		1-Mar	Please be advised that this information has been passed along to the relevant officer who will be in touch should they need any further information or have any comments.	No response required

Ref No	Stakeholder	Date	Stakeholder Response	Spectrum Assessment on Feedback and response
		9-Mar	Spectrum sent update notification of the revised operational and survey areas including distances of the revised operational and survey boundaries and sensitive areas or landmarks. DOT confirmed the receipt of the update.	No response required
15	A Raptis & Sons	5-Jan	Spectrum sent the first notification advising about the MSS	No response received
		15-Feb	Spectrum sent update notification of the revised operational and survey areas and included buffers	No response received
		9-Mar	Spectrum sent update notification of the revised operational and survey areas including distances of the revised operational and survey boundaries and sensitive areas or landmarks	No response received
		15-Mar	Reached admin and got mobile account for a stakeholder's representative. Called mobile and left a message.	Followed up with revised survey area 9/3/2017
16	Kailis Brothers	5-Jan	Spectrum sent the first notification advising about the MSS	No response received
		15-Feb	Spectrum sent update notification of the revised operational and survey areas and included buffers	No response received
		9-Mar	Spectrum sent update notification of the revised operational and survey areas including distances of the revised operational and survey boundaries and sensitive areas or landmarks	No response received
		15-Mar	Stakeholder was followed up by phone after not responding to email correspondence and stated "We in fact are currently non-operational investors in the fishery and lease our permits to catching operators. Kailis are not concerned about the Cygnus survey"	Spectrum contacted Kailis to follow up after not hearing from them. Stakeholder email with revised survey area sent 9/3/2017
17	Australian Maritime	5-Jan	Spectrum sent the first notification advising about the MSS	No response received
		15-Feb	Spectrum sent update notification of the revised operational and survey areas and included buffers	No response received

Ref No	Stakeholder	Date	Stakeholder Response	Spectrum Assessment on Feedback and response
	Safety Authority	9-Mar	Spectrum sent update notification of the revised operational and survey areas including distances of the revised operational and survey boundaries and sensitive areas or landmarks	No response received
		15-Mar	Stakeholder was followed up by phone after not responding to email correspondence	The email addresses on the distribution list were checked and an additional email added (amsaconnect@amsa.gov.au). Followed up with stakeholder email 9/3/2017 to original email and new email on distribution list.
18	Geoscience Australia	5-Jan	Spectrum sent the first notification advising about the MSS	No response received
		15-Feb	Spectrum sent update notification of the revised operational and survey areas and included buffers	No response received
		8/09/2017	Stakeholder was followed up by phone after not responding to email correspondence	Reached voicemail and left a message. Identified client services email and have added additional email address to the distribution list. Followed up with stakeholder email 9/3/2017 to original email and new email on distribution list.
		9-Mar	Spectrum sent update notification of the revised operational and survey areas including distances of the revised operational and survey boundaries and sensitive areas or landmarks	No response received
19	Director of National Parks	9-Mar	Spectrum sent update notification of the revised operational and survey areas including distances of the revised operational and survey boundaries and sensitive areas or landmarks	

Ref No	Stakeholder	Date	Stakeholder Response	Spectrum Assessment on Feedback and response
		27/03/17	We note that the revised operational area is smaller than previously proposed and is now, at its closest point, 12 km from the Cartier Island CMR and 60 km from the Ashmore Reef CMRs (both IUCN category Ia). Transitional management arrangements currently apply for both reserves. Under transitional management arrangements these reserves are to be managed consistent with their previous management plans. Both reserves are long standing reserves, are highly protected sanctuaries and are managed primarily to ensure habitats, ecosystems and native species are preserved in an undisturbed state and to facilitate research. Given the sensitivity of these reserves to impacts we recommend that in the preparation of the Environment Plan you give consideration to the potential impacts of the proposed activity on reserve values, and risk to those values, and consider ways to reduce impacts to as low as reasonably practicable. More information on the zone values can be found on our website under the 'Overview' tabs of the following hyperlinks: - Ashmore Reef CMR - Cartier Island CMR We look forward to continued consultation regarding the final approval of this environment plan and notification of any planned operations that may impact on reserve values. All ongoing correspondence can be directed to the Marine Protected Areas Branch at marinereserves@environment.gov.au	Thanked DNP for their comments. Under the current management plans, the CMR boundary is defined and the EP is consistent with the IUCN category 1a management principles. A concordance table with the IUCN principles was provided. In the event that the CMR boundaries change in the future (e.g. if new management plans come into effect), this assessment will need to be revisited to ensure the IUCN principles are still met (as per **Table 5-7**). Spectrum will ensure that any changes to the operational or survey area that may result in potential impacts to the CMRs will be communicated to the DNP to ensure consultation is completed.

Ref No	Stakeholder	Date	Stakeholder Response	Spectrum Assessment on Feedback and response
		8-Apr	Spectrum updated DNP with the following information: Confirming that the planned activities will not have an impact on the Cartier Island or Ashmore Reef CMRs and the activity is being conducted in compliance with IUCN principles The seismic vessel will not conduct activities described within this EP within 29 km of the CMR boundary therefore no planned or unplanned impacts could occur within the designated area Noise modelling does not predict that sound pressure levels will be above behavioural thresholds for turtles or cetaceans at the CMR boundary. Spectrum have a commitment in the EP to ensure that the status of relevant CMRs will be confirmed during pre-survey planning to ensure that activities are consistent with up-to-date IUCN principles and management plans in force	No response received. No further action required
20	Northern Wildcatch Seafood Australia (NWSA) on behalf of Northern	5-Jan	Spectrum sent the first notification advising about the MSS	No response received
		15-Feb	Spectrum sent update notification of the revised operational and survey areas and included buffers	No response received
		9-Mar	Spectrum sent update notification of the revised operational and survey areas including distances of the revised operational and survey boundaries and sensitive areas or landmarks	

Ref No	Stakeholder	Date	Stakeholder Response	Spectrum Assessment on Feedback and response
	Demersal Scalefish Managed Fishery	14-Mar	NWSA responded to Spectrum and raised their concerns, including: + to review the listed literature reviews for impacts on fish, especially fish stock from seismic survey + there is a threat of serious environmental damage to the stocks of goldband snapper in the NDSF through behavioural, and physiological, changes caused by seismic activity + the threat is cumulative given the extent of seismic activity by the oil and gas industry in the fishery + the threat ranges throughout the extent of the proposed survey area. It is not a case of a small localised impact + the risks of the activity are at an unacceptable level + that is especially so against the background of the stock assessment report. Further research may evidence the goldband spawning biomass being adequately managed through the conduct of industry but that is not to the point as that research is not yet complete. There is no research suggesting the behavioural changes caused by seismic do not have an impact on spawning aggregations of goldband + an alternative control measure, timing of the survey, can provide greater environmental benefit + the risk to the spawning biomass is not presently reduced to ALARP but can be reduced to ALARP by conducting surveys outside spawning windows. Surveys should not be conducted in January, February, March, April and October. The cost of doing so is not grossly disproportionate to the environmental benefit gained + we are not aware of the survey plan or EP taking any, or any sufficient, account of seasonality in terms of spawning seasons + we are not aware of any control measures being contemplated in this survey or EP to remove the threat to the spawning stock of goldband in the NDSF	Spectrum took NWSA's concerns on board and responded to NWSA on 31 Mar.

Ref No	Stakeholder	Date	Stakeholder Response	Spectrum Assessment on Feedback and response
		15-Mar	Spectrum confirmed receipt of NWSA's feedback	
		27-Mar	Spectrum offered a phone call with NWSA to discuss NWSA's concerns to ensure these are correctly captured in the Spectrum's written response.	
		29/03/17	Spectrum called NWSA and was advised (via voicemail) that the stakeholder is not ever available via phone and all correspondence should be using the same method as previously used	Note: no minutes taken given stakeholder was unavailable.

		31/03/17	Spectrum responded to NWSA via email addressing all of NWSA's concerns.	Summary is presented below + Spectrum will continue to include NDSF as a relevant stakeholder on this survey through email notifications. + Spectrum have committed to not undertaking the survey in Jan-April inclusive which will avoid those spawning periods NWSA discussed + Spectrum have reviewed the identified papers and conclude that the findings of the paper do not add any new insights to the other studies included or on the risk assessment currently included in the EP based on the multiple other relevant studies. + Spectrum have copied Dr Stephan Newman in our response as requested + Spectrum confirmed that the spawning periods of Goldband Snapper and Red Emperor have been included in the EP + Based on the extensive assessment of studies, consideration of the environment in which the activity will take place and in light of timing changes adopted in light of our correspondence with NDSF (see below), we conclude that the survey will not result in serious environmental damage given that survey area accounts for approximately 1-2 % of the designated fishery area. + Should another survey come to light which is conducted at the same time, a distance of 50km will be maintained between vessels. + Throughout the rest of the survey area, the water depths are >50m and unlikely to provide suitable spawning habitat for demersal fish species. + Spectrum commits to not acquiring the survey during January-April (inclusive), which will avoid spawning periods for indicator species + It is not clear from the publications when "peak" spawning of the red emperor occurs. If the survey has to stop in October, disproportionate costs and benefits will be caused. Spectrum however can amend the survey area to acquire data outside that

Ref No	Stakeholder	Date	Stakeholder Response	Spectrum Assessment on Feedback and response
				particular area if NWSA can advise on the potential area of spawning or preferred water depth for spawning of this species. + Spectrum attached the response with revised controls relevant to NWSA's concerns.
		05/04/17	Spectrum called NWSA and left voicemail stating a response had been sent directly to NWSA as advised.	No further action required.
21	Offshore petroleum/ DoE	5-Jan	Spectrum sent the first notification advising about the MSS The intended recipient is on leave 9 Jan 17	No response required
		15-Feb	Spectrum sent update notification of the revised operational and survey areas and included buffers	No response received. No further action required.
		9-Mar	Spectrum sent update notification of the revised operational and survey areas including distances of the revised operational and survey boundaries and sensitive areas or landmarks	No response received. No further action required.
		9/3/17	Thank you for contacting the Department of the Environment.	No response required

9.2.2 Phase 2 - Pre-Survey Consultation

Spectrum are mindful of identifying new stakeholders and of affording a notification period that is as long as possible. As such, Spectrum shall notify relevant stakeholders of the exact timing and final proposed area (which will be within the operational area already consulted on) that may affect their interests or activities. Unfortunately, due to the fluid nature of the seismic industry, not all information (e.g. vessels, timing, duration, exact location, etc.) may be finalised months in advance. However, as soon as final details are known, these shall be communicated with the relevant stakeholders.

It is anticipated that by approximately three weeks prior to commencing the survey or phase of the survey within the Cygnus SW MSS operational area, Spectrum will provide the following information to all relevant persons:

- the size, location and geographical coordinates for the survey
- the timing and duration
- parameters for the towed seismic array (e.g. acoustic source and streamer spread)
- details of the survey and support/chase vessels
- overview of potential risks and impacts
- proximity to any dive sites
- an offer of a 7-10 day forecast to all relevant stakeholders (if requested)
- contact details to submit a concern.

At any point during this notification process, stakeholders will have a further opportunity to raise with Spectrum any specific concerns or issues regarding the proposed survey. These will be assessed as outlined below. Stakeholders will be emailed and follow up phone calls undertaken to ensure they are aware of the survey and have adequate opportunity to respond.

Spectrum can provide a 7-10 day forecast prior to commencement of survey activities to commercial fisheries and aquaculture upon request.

Concurrent surveys require a minimum separation distance of 50 km between the two operating survey vessels to avoid noise interference with the received signals. If separation distances between the survey vessels are closer than 50 km, then the two proponents will determine procedures for simultaneous operations to eliminate or minimise the potential for noise interference and data corruption, for instance, a time-sharing arrangement over a 24-hour period during which time each vessel will acquire for a period of 12-hours whilst the acoustic sources of the other vessel are shutdown.

9.2.3 Phase 3 – Ongoing Consultation

Consultation with relevant stakeholders will be ongoing while the Cygnus SW MSS EP is valid. Spectrum will comply with requests by stakeholders for additional information and requests for updates during the Cygnus SW MSS. In addition, stakeholders will be notified of any changes to scope of the EP that may affect their interests or activities a minimum of three weeks in advance of a survey. Significant changes to the scope will trigger a review, and if necessary, a revision of the EP.

If the Cygnus SW MSS has not commenced within 6 months of the initial stakeholder consultation (i.e. by 30/06/17), Spectrum shall ensure that all stakeholders have been provided with an update of activities associated with the Cygnus SW MSS EP, including proposed timing, location and reasons for schedule.

9.2.4 Phase 4 – Post-survey Notification

On completion of each phase (if applicable) of the Cygnus MSS, a completion notification that summarises survey activities (e.g. survey dates, area surveyed, summary of environmental performance and compliance, etc.) will be sent to relevant stakeholders. If the activity is phased, the notification will also include information regarding potential future timing of the next phase. As detailed above, pre-survey notifications will be issued to relevant stakeholders prior to commencing each phase.

10 PERFORMANCE OUTCOMES, STANDARDS AND MEASUREMENT CRITERIA

Regulation 13(7) of the Environment Regulations requires that an EP include environmental performance outcomes (EPO), environmental performance standards (EPS) and measurement criteria (MC) that address legislative and other controls to manage the environmental impacts and risks of the activity.

EPO and EPS for the Cygnus SW MSS have been identified for the 14 environmental impacts and risks assessed via the detailed risk evaluation process. These EPS set the standards against which Spectrum will measure environmental performance and implementation of the control measures identified in this EP. For each EPS, appropriate MC for determining whether the EPO have been met have been identified. All of the EPO, EPS and MC to the Cygnus SW MSS are detailed in **Table 10-1**.

The EPO, EPS and MC specified are consistent with legislative requirements and Spectrum and Spectrum's policies, standards and procedures.

A breach of an EPO or EPS, as detailed in **Table 10-1**, constitutes a 'Recordable Incident' under the Environment Regulations.

Table 10-1: Cygnus SW MSS – Environmental Performance Outcomes, Standards and Measurement Criteria

Section	EPS #	Control Measures	Records of compliance
PLANNED (ROUTINE AND NON-ROUTINE) ACTIVITIES			
5.1	Noise emissions (non-seismic) from helicopter and vessel		
	1	Interaction between the survey and support/chase vessels (not including a vessel that is towing or retrieving/deploying a seismic array) and cetaceans within the operational area: + the vessel will not travel at speeds >6 knots within 300 m of a cetacean (i.e. precaution zone), and will not approach closer than 100 m from an animal (with the exception animals bow riding). + the vessel will not knowingly approach closer than 100 m from an animal (with the exception of animals bow riding). + the vessel will not knowingly approach closer than 300 m to a calf (whale or dolphin). + if a calf appears in the caution zone, then the vessel will withdraw from the caution zone at a constant speed of <6 knots.	Records of any support vessel or towed equipment interactions with marine fauna Records of any incidents involving breaches of the vessel-marine fauna interaction procedures Copy of support vessel-marine fauna interaction procedures available aboard support vessel
	2	Interaction between helicopters and cetaceans within the operational area will be consistent with EPBC Regulations 2000 - Part 8 Division 8.1 (Regulation 8.07) - Interacting with cetaceans, such that a person will not: + operate a helicopter at a height lower than 1,650 feet or within a horizontal radius of 500 m of a cetacean + approach a cetacean from head-on.	Records of any incidents involving breaches of the helicopter-marine fauna interaction procedures
	3	At least two experienced (>12 months in an MFO role in Australian waters) trained MFO will be on board the survey vessel at all times	MFO records/reports (daily, weekly) show that marine fauna interaction procedures are followed during survey including precaution zones, soft starts and recommencement procedures

Section	EPS #	Control Measures	Records of compliance
	4	Interaction between vessels (not including a vessel that is towing or retrieving/deploying a seismic array) and turtles and whale sharks within the operational area will be consistent with the vessel fauna interaction procedure that a vessel will not travel at speeds >6 knots within 300 m of a turtle or whale shark.	Records of any support vessel or towed equipment interactions with marine fauna Records of any incidents involving breaches of the vessel-marine fauna interaction procedures Copy of support/chase vessel-marine fauna interaction procedures available aboard support/chase vessel
5.2	**Light emissions**		
	5	Operations of the survey vessel must comply with: + International Regulations for Preventing Collisions at Sea 1972 (COLREG) (Marine Order 30) + Marine order 21 (Safety of navigation and emergency procedures).	Records indicating lighting requirements are acceptable for safety
	6	Seismic survey activities shall not be undertaken outside the operational area.	Vessel track log confirms that survey activities not outside operational area
	7	During the peak turtle nesting period of 1st November to last day of February no seismic acquisition along the four northernmost 2D sail lines closest to the Cartier Island CMR.	Vessel track log confirms compliance Records of any non-compliance
5.3	**Physical disturbance to benthic habitats due to deployment and retrieval of anchors**		
	8	No anchoring within operational area, except in emergency situations	Vessels logs showing no anchoring
5.4	**Interaction with Commercial fisheries, Tourism and Shipping**		
	9	Operations of the survey vessel must comply with: International Regulations for Preventing Collisions at Sea 1972 (COLREG); Standards of Training, Certification & Watchkeeping (STCW) Convention;	Records of any incidents involving fishing vessels or shipping

Section	EPS #	Control Measures	Records of compliance
		Navigation Act 2012: Marine Orders Part 21 (Safety of navigation and emergency procedures) 2012; Marine Orders Part 30 (Prevention of collisions) 2009; Marine Order 28 (Operations standards and procedures) 2012,specifically: + standard maritime safety procedures (including radar watch, radio contact, display of navigational beacons and lights) + standards for watchkeeping	
	10	Operations of the survey vessel will be in accordance with Marine Notice 21/2013: Sound navigational practices; and with Marine Notice 4/2012: Safety of Fishing Vessels.	Records of any incidents involving fishing vessels or shipping
	11	The Australian Maritime Safety Authority (AMSA) Rescue Coordination Centre (RCC) will be advised of the survey details (survey vessel, location, timing etc.) prior to mobilisation so that AMSA RCC ensures that NAVAREA X and AUSCOAST warnings can be issued and kept up to date. AMSA RCC and DMP will also be notified of survey completion.	Records of notification to AMSA RCC and DMP of survey details, and survey completion Issuance of NAVAREA X and AUSCOAST warnings
	12	The AHS will be advised of the survey details (survey vessel, location, timing etc.) not less than three weeks prior to mobilisation so that AHS can then issue a NTM.	Records of notification to AHS of survey details Issuance of NTM
	13	The survey vessel will have an AIS tracking device installed and operating to aid identification by other vessels	Records demonstrate that an AIS tracking device is installed
	14	Mariners will be alerted of survey vessels' presence and extent of towed array. This includes the display of navigational beacons and lights to indicate that the vessel has restricted manoeuvrability and the implementation of the survey vessel communications protocol.	Records demonstrate that any third-party vessels approaching the survey vessel and towed array were contacted and informed of navigational hazard

Section	EPS #	Control Measures	Records of compliance
	15	Notification of activity details to stakeholders three weeks prior to the survey commencing, including the offer of a 7-10 day forecast of operations (if requested) and the promulgation of a survey notification prior to the survey commencing and containing specific information of the survey vessels and contact information.	Records demonstrate that further notification of survey details was relayed to relevant commercial fisheries stakeholders
	16	Use of a dedicated support/chase vessel to manage interactions with stakeholders (including commercial fishing, charter and shipping vessels) during seismic acquisition operations including implementation of the SNA/ exclusion zone, which is likely to cover at least a 10-km radius from the survey vessel to account for the length of the towed streamer spread.	Records demonstrate that a dedicated chase vessel is employed for operations within the Cygnus SW operational area of the survey
	17	Tail buoys are visible to other mariners (e.g. reflective tape, strobes, radar reflector, etc.) so they are aware of the towed extent and vessels restricted manoeuvrability.	Records confirm that streamer tail buoy is visible to other mariners
	18	+ In-water equipment lost will be recovered (where possible) and detailed records maintained of any loss of in-water equipment lost. + If equipment lost is irretrievable, maintain records of the circumstances that prohibited the equipment from being recovered.	Records document location (last known) of immersible equipment lost to sea and attempts to recover it
	19	Recreational fishing from the survey vessel will be prohibited	Records demonstrate that all crew (marine and seismic) have been informed of this ban on recreational fishing
	20	MFO observation (as used for cetaceans, turtles and sharks) will include sightings of diving and charter vessels, particularly with the aim of determining if there are divers or small boats in the water.	MFO records detail all observations of diving and charter vessels (if any) during pre-start observations

Section	EPS #	Control Measures	Records of compliance
	21	If seismic operations overlap within 10 km of charter vessel dive/snorkelling tours or private vessels with divers (as advised by DNP), Spectrum will undertake a joint risk assessment and, if required, jointly develop and implement a SIMOPS plan in consultation with vessel operators. The SIMOPS plan will adopt the DMAC 12 guidance, including stopping seismic acquisition immediately before and when divers are in the water, if requested by the charter operator.	Records demonstrate that joint risk assessment occurred and SIMOPS developed jointly (if required)
	22	All relevant persons will be provided 3 week notification via DNP prior to activities commencing, and if requested, a daily forecast of operations to disseminate to charter boat operators (covering diving and fishing activities) and visitors to the operational area.	Records confirm that survey notification and if requested 7-10 day forecast sent to all relevant persons 3 week prior to survey commencement
	23	The survey vessel is not permitted to transit the CMRs	Records confirm that survey vessel did not transit the CMRs Records of any non-compliance
	107	The Cygnus SW MSS will not be conducted during 1st January to 30th April inclusive	Records confirm survey not conducted during these dates
	109	In the event that reliable information regarding the timing and area of red emperor spawning is identified, the survey acquisition plan will be reviewed in line with Section 7.7.4 of the EP	+ Consultation records + Survey acquisition records
5.5	**Ballast Water Discharge, and Biofouling of Vessel Hull, Other Niches and Immersible Equipment**		
	24	Ballast water discharges from the survey vessel must comply with the requirements of the Australian Ballast Water Management Requirements (as enforced under the *Quarantine Act 1908* [Section 27A]; and Quarantine Regulations 2000): + no discharge of high-risk ballast water within Australian territorial seas (within 12 nautical miles of WA coastline) including any ports	Records of any non-compliant ballast water discharges

Section	EPS #	Control Measures	Records of compliance
		+ completion of Department of Agriculture Ballast Water Management Summary (BWMS) forms for any ballast water discharge in Australian waters	
	25	Vessels must have a Ballast Water Management Plan that complies with Regulation B-1 of the International Convention for the Control and Management of Ship's Ballast Water and Sediments 2004. The Plan should have been prepared in accordance with the IMO Guidelines for Ballast Water Management and the Development of Ballast Water Management Plans (IMO Resolution MEPC.127(53).	Lloyd's Register Marine Design Appraisal Document for the Survey vessel Ballast Water Management Plan
	28	Application of DoA guideline that ballast exchanges be conducted as far as possible away from shore and in water at least 200 m deep	Records of any non-compliant ballast water discharges
	26	Whilst in Australian waters, the survey vessel must operate in accordance with the conditions detailed in the "Approval to Berth" issued by DoA when the vessel entered Australian waters in August 2014 and submitted a Quarantine Pre-arrival Report (QPAR)	Records of any non-compliance with DoA "Approval to Berth" for the Survey vessel
	27	The risks of introducing IMS via biofouling into WA waters and ports must be managed in accordance with marine pest management guidelines (as enforced under the WA *Fish Resources Management Act 1994*; and Fish Resources Management Regulations 1995): + immersible equipment and the survey vessel hull, sea chests and other niches must be 'clean' before the survey vessel enters WA waters and ports + the suspected or confirmed presence of any marine pests or disease must be reported within 24 hours by email (biosecurity@fish.gov.au) or telephone (FishWatch tel: 1800 815 507). This includes any organism listed on the WA	Records of any periodic inspection/cleaning of biofouling from immersible equipment, vessel hull and other niches conducted during the survey Records of any reporting of any suspected or confirmed presence of IMS to WA DoF

Section	EPS #	Control Measures	Records of compliance
		Prevention List of Introduced Marine Pests, and any other non-indigenous organism, that demonstrates invasive characteristics	
	29	Application of guidelines detailed in the *National Biofouling Management Guidance for the Petroleum Production and Exploration Industry, and the IMO Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species* implemented for the survey and support/chase vessels, including the use of a biofouling management plan and record book for the survey and support/chase vessels	Records of recent dry dock, IMS inspection and antifoulant application for survey vessel
	30	If the survey vessel has to leave Australian waters before completion of the survey, it will be required to undergo another vessel check (as per the DoF vessel check tool) to determine its low/Acceptable level of risk, prior to re-entering Australian waters to complete the survey.	Records of any additional vessel check with low/ acceptable risk
	31	The survey and chase/support vessels chosen for an individual survey will be assessed using the DoF Vessel Check tool and will have a "low/Acceptable" level of risk: https://vesselcheck.fish.wa.gov.au.	Vessel assessment records with 'low/Acceptable" level of risk
5.6	**Underwater Noise Emissions from Discharge of Airgun Array**		
	32	Operation of the seismic source within the Cygnus SW operational areas at all times during the survey must comply with all requirements of the EPBC Act Policy Statement 2.1 - Interactions between offshore seismic activities and whales Part A Standard Management Procedures, including: + Part A.1: Planning survey to avoid areas where whales are likely to be breeding, calving, resting or feeding (this EP); + Part A.2:Using trained crew to undertake fauna observations + During survey, undertaking: ► Part A.3.a:precaution zones (Observation zone: 3 km+; Low power zone: 2 km; and Shut-down zone: 500 m)	Records of any non-compliance with EPBC Act Policy Statement 2.1 Part A Standard Management Procedures

Section	EPS #	Control Measures	Records of compliance
		► Part A.3.1:pre start-up visual observation ► Part A.3.2:Soft start procedures ► Part A.3.3:Start-up delay procedure ► Part A.3.4:Operations procedure ► Part A.3.5:Stop work procedure ► Part A.3.6:Night time and low visibility procedures Part A.4:Submission of sighting reports to DoE within 2 months of survey completion.	
	33	Operation of the seismic source within the Cygnus SW operational areas at all times during the survey must comply with EPBC Policy Statement 2.1 (Part B.1) + Use of at least one dedicated MFO on board vessel + MFO(s) will have at least 12 months accumulated experience in a similar role in Australian waters	Records demonstrate that one dedicated MFO employed for the duration of the survey
	34	In addition to EPBC Policy Statement 2.1 A and B.1, The MFO's will also + maintain continuous visual observations for whale sharks and turtles within a 500 m horizontal radius of the survey vessel; + ensure that if whale sharks or turtles are sighted within 500 m horizontal radius of survey vessel, the acoustic source will be shut down; and + undertake visual observations for whale sharks and turtles for at least 10 minutes prior to the commencement of soft start, focusing on a 500 m horizontal radius of the survey vessel.	Records demonstrate MMO activities undertaken during survey
	35	Increased shut down/low visibility precautions: EPBC Policy Statement 2.1 Part B.6: if the acoustic source is required to power-down / shutdown three or more times during the preceding 24-hour period as a result of sighting	Records of any non-compliance with the specified Part B Additional Management Procedures during the peak period for migration of pygmy blue whales in the region (**1 July-31 August** and **15th Oct-15th December**)

Section	EPS #	Control Measures	Records of compliance
		pygmy blue whales, then the seismic operations must not be undertaken thereafter at night-time or during low visibility conditions. Seismic operations cannot resume at night-time or during low visibility conditions, until there has been a 24-hour period, which included seismic operations during good visibility conditions, during which no power-downs / shut-downs have occurred for pygmy blue whale sightings	
	36	Communications with other seismic survey vessels that may be operating in the vicinity ensures that a minimum distance of 50km is maintained between seismic survey vessels during seismic data acquisition: + Stakeholder notification prior to survey commencement + SIMOPS procedure developed and adhered to during survey as required + If other vessels operating within area and timeframe: + Ship to ship communications + Vessel radar and vessel ID	Stakeholder notification demonstrate correspondence between other operators in the vicinity of survey and developed SIMOPS if applicable
	37	Survey vessel personnel (seismic) provided with pre-survey briefing on EPBC Act Policy Statement 2.1 requirements	Records demonstrate that all seismic crew have attended pre-survey briefing on EPBC Act Policy Statement 2.1 requirements
	38	Tail buoys on the streamers will be fitted with turtle guards to minimise the risk of entanglement of marine fauna.	Equipment specifications demonstrate streamers fitted with turtle guards
	39	No discharge of the seismic source will occur outside of the Cygnus SW operational areas	Records of non-compliance – i.e. any discharges of the airgun array outside the operational areas during the survey Records of maps and coordinates communicated to contractors
	40	No discharge of seismic source within 200m of Heywood Shoal 50 m bathymetry contour at any time of year	
	41	No discharge of seismic source along the four northernmost 2D sail lines, closest to the Cartier Island CMR maintaining a minimum distance	

Section	EPS #	Control Measures	Records of compliance
		at which the seismic source is fired at full power of 45km from the CMR boundary during the period 1st November – 28th February	
	42	Spectrum to provide seismic vessels and subcontractors, maps and coordinates of the Acquisition Area, Operational Area (including the 2D lines) such that spatial and temporal exclusions are clearly defined	
	43	Seismic source will not be fired in less than 50 m water depth	
	108	Following complete acquisition (full coverage) of the two lines closest to Heywood shoal (one either side of the shoal), the source will only be fired within 1km of the 50m bathymetry around Heywood shoal: + at 50% of full power; and + at a minimum distance of 300m from the shoal; and + if less than 24 hours has passed since the vessel was last within 1km of the shoal	Records of survey acquisition
5.7	**Reduced air quality from Air emissions**		
	44	Adherence to MARPOL 73/78 Annex VI (as implemented in Commonwealth waters by the Commonwealth *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and Marine Orders - Part 97: Marine pollution prevention - air pollution). In particular: + optimisation of fuel use to increase efficiency and minimise emissions + use of low sulphur fuel when it is available to minimise emissions from combustible sources + emissions managed by the implementation of a planned maintenance system (PMS) + Quarterly reviews of Ship Energy Efficiency Management Plan (SEEMP) and energy performance (for vessels > 400 GT).	International Air Pollution Prevention Certificate (IAPP) for the survey vessel Maintenance records available for audit Fuel specification data for fuel loaded prior to and during survey SEA weekly inspection reviews SEEMP and PMS

Section	EPS #	Control Measures	Records of compliance
	45	Sulphur content of fuel oil will not exceed 3.5% m/m resulting in reduced sulphur emissions during the activity.	Records demonstrate that MGO with required sulphur content was used on survey vessels.
	46	Pursuant to MARPOL Annex VI, survey and support vessels will maintain a current International Air Pollution Prevention (IAPP) Certificate which certifies that measures to prevent ozone-depleting substance (ODS) emissions, and reduce NOx, SOx and incineration emissions during the activity are in place.	Current IAPP certificate
	47	ODS managed in accordance with MARPOL Annex VI to reduce the risk of an accidental release of ODS to air.	Completed ODS record book or recording system
	48	Implementation of a Ship Energy Efficiency Management Plan (SEEMP) for the survey vessel (MARPOL 73/78 Annex VI requirement from 1 January 2012).	International Air Pollution Prevention Certificate (IAPP) for the survey vessel Records of daily fuel consumption (calculated from vessel daily progress reports) and Sulphur content (% by mass) of diesel used for operations Emissions managed by the implementation of a planned maintenance system (PMS) Aggregate records of fuel consumption and associated GHG emissions for survey available following survey completion SEEMP records available for audit
	49	Vessel combustion equipment (including incinerator) compliant with MARPOL 73/78 Annex VI requirements.	International Air Pollution Prevention Certificate (IAPP) for the survey vessel.
5.8	**Discharge of Bilge Water, Sewage and Food Wastes**		
	50	Bilge water discharges (machinery space bilges) must comply with the requirements of: MARPOL Annex I - Oil Protection of the Sea (Prevention of Pollution from Ships) Act 1983 - Section 9.	Records confirm that the survey vessel has an IMO approved / MARPOL compliant oily water separator Records of any non-compliant bilge water discharges – e.g. oil content >15 ppm; discharge whilst vessel is stationary

Section	EPS #	Control Measures	Records of compliance
		Bilge water discharges can occur only if: + the vessel has a IMO approved/MARPOL compliant oily water separator (International Oil Pollution Prevention Certificate [IOPPC]) + the vessel is proceeding en-route (i.e. is not stationary) + oil content less than 15 parts per million (ppm) + oil discharge monitoring and control system and oil filtering equipment are operating. + If the above cannot be met, oil must be retained aboard for on-shore disposal. Bilge water contaminated with chemicals must be contained and disposed of onshore, except if the chemical is demonstrated to have a low toxicity (as determined by the relevant MSDS). Discharges of bilge water will be recorded in the survey and support/chase vessel engine room logs.	

Section	EPS #	Control Measures	Records of compliance
	51	Sewage discharges from vessels must comply with the requirements of: MARPOL Annex IV - Sewage Protection of the Sea (Prevention of Pollution from Ships) Act 1983 - Section 26D Marine Order 96 (Marine pollution prevention — sewage) 2013. Sewage systems must be an IMO approved/MARPOL compliant sewage treatment plant. Sewage and putrescible wastes must be passed through a grinder or comminuter and a disinfection system so that the final product is small enough to pass through a screen of less than 25 mm diameter prior to disposal to the sea. Comminuted and disinfected sewage can be discharged if: + the vessel is >3 nm from nearest land + sewage originating from holding tanks is discharged at a moderate rate (as defined in Marine Order 96) while the vessel is proceeding en-route at a speed not less than 4 knots.	Records confirm that the survey vessel has an IMO approved / MARPOL compliant sewage treatment plant Records of any non-compliant discharges of sewage – e.g. contravention of minimum distances from land for treated and untreated sewage discharge, discharge rate and vessel speed
	51 (cont)	Sewage that is not comminuted or disinfected can be discharged if: the vessel is >12 nm from nearest land, marine park or reserve sewage originating from holding tanks is discharged at a moderate rate (as defined in Marine Order 96) while the vessel is proceeding en-route at a speed not less than 4 knots.	Records confirm that the survey vessel has an IMO approved / MARPOL compliant sewage treatment plant Records of any non-compliant discharges of sewage – e.g. contravention of minimum distances from land for treated and untreated sewage discharge, discharge rate and vessel speed

Section	EPS #	Control Measures	Records of compliance
	52	Pursuant to MARPOL Annex VI, survey and support vessels have a current International Sewage Pollution Prevention (ISPP) Certificate which certifies that required measures to reduce impacts from sewage disposal are in place. Vessels to have MARPOL certification for applicable equipment including sewage system and garbage management. Preventive maintenance on sewage treatment equipment is completed as scheduled.	Records confirm that the survey vessel has an IMO approved / MARPOL compliant sewage treatment plant Records of any non-compliant discharges of sewage – e.g. contravention of minimum distances from land for treated and untreated sewage discharge, discharge rate and vessel speed
	53	Food waste discharges from vessels must comply with the requirements of: MARPOL Annex V - Garbage Protection of the Sea (Prevention of Pollution from Ships) Act 1983 - Section 26F Marine Order 95 (Marine pollution prevention - garbage) 2013. Food wastes can be discharged from the survey and support/chase vessel if: it is comminuted or ground to a particle size <25 mm the vessel is moving faster than 4 knots the discharge takes place as far as practicable from the nearest land, but in any case, ≥3 nm from the nearest land and not within CMR Food wastes that are not comminuted or ground can be discharged if: the vessel is en-route the discharge takes place as far as practicable from the nearest land, but in any case, ≥12 nm from the nearest land	Records confirm that the survey vessel is equipped with grinder/comminuter for maceration of food wastes Records of any non-compliant discharges of food wastes – e.g. contravention of minimum distances from land for treated and untreated food wastes
	54	Deck cleaning products released to sea are biodegradable, non-bio-accumulative and not hazardous	MSDS and product supplier supplementary data as required

Section	EPS #	Control Measures	Records of compliance
	55	Incinerators will be operated in accordance with established operating procedures that align with manufacturers' specifications. Incineration of any oil sludge on board, or disposal of any oil sludges/slops in port, must be recorded in the survey vessel Oil Record Book (a requirement under MARPOL 73/78).	SEA weekly inspection reviews oil record book and notes and non-compliant oily sludge disposal
	56	Operations of the vessels will be in accordance with Marine Notice 6/2012: Revised Garbage Discharge Regulations for Ships.	Records confirm that Survey Vessel Garbage Management Plan meets the requirements of Marine Notice 6/2012
UNPLANNED ACTIVITIES (ACCIDENTS/ INCIDENTS)			
6.1	**Collision between Survey Vessels / Towed Array and Marine Fauna**		
	1,3,4	Measures to minimise the likelihood of vessel collision with marine fauna (EPS1, EPS3 EPS4)	Records of any support vessel or towed equipment interactions with marine fauna Records of any incidents involving breaches of the vessel-marine fauna interaction procedures Copy of support vessel-marine fauna interaction procedures available aboard support vessel
	57	Any incidents of vessel or towed array collision with cetaceans, turtles or whale sharks must be reported as a reportable incident for the activity, in accordance with OPGGS (E) Regulations 2009 - Regulation 26.	Reportable incident reports are prepared and submitted for any incidents involving vessel or towed array collision with cetaceans, turtles or whale sharks
	58	Any incidents of vessel or towed array collision with whales must be reported to the Department of Environment (DoE) via the National Marine Mammal Data Portal, online national ship strike database and associated web-based questionnaire: https://data.marinemammals.gov.au/report/shipstrike.	Records confirm that any incidents of vessel collision with a cetacean are reported to the Commonwealth Department of Environment
	59	Operations of the survey and support/chase vessel will be in accordance with Marine Notice 15/2016: Minimising the risk of ships colliding with	Records confirm that any incidents of vessel collision with a cetacean are reported to the Commonwealth Department of Environment

Section	EPS #	Control Measures	Records of compliance
		cetaceans, specifically that any incident of collision shall be reported to DoE	
	60	Vessel to follow Australian National Guidelines for Whale and Dolphin Watching (DEH 2005, as amended) (for the avoidance of whales)	Vessel-whale interaction procedures for non-acoustic energy source operations implemented and available aboard support vessel. Records of interactions maintained by MFOs
	61	Streamer tail buoys will be fitted with appropriate turtle guards or be of an improved design such as PartnerPlast 900.	Records confirm that survey vessel streamer tail buoy is fitted with a turtle guard or be of PartnerPlast standard Records of any non-compliance
6.2	**Vessel grounding**		
	62	The survey vessel is not permitted to transit CMRs.	Records confirm that survey vessel did not transit the CMRs Records of any non-compliance
	63	Vessels will use approved navigation systems and depth sounders.	Records demonstrate that the vessel is equipped with approved navigational system and is functional
	64	Vessels >400 GRT must have an implemented and tested SOPEP in place that complies with the requirements of: + Regulation 37 of MARPOL Annex I + Marine Order 91 (Marine pollution prevention - oil) 2014 + OPGGS Environment Regulations 14(8B) and 14(8C).	Records demonstrate that the vessel has a valid/compliant SOPEP in place
	65	Vessels <400 GRT that do not have a SOPEP will have an approved spill management plan or equivalent.	Records demonstrate that the vessel has a spill management plan or equivalent in place
	43	Seismic source will not be fired in less than 50 m water depth	Records confirm that seismic source was not fired in less than 50 m water depth Records of any non-compliance
	40	No discharge of seismic source within 200m of Heywood Shoal 50 m bathymetry contour at any time of year	Records confirm that no operations occur within 200 m of the identified Heywood shoal

Section	EPS #	Control Measures	Records of compliance
			Records of any non-compliance
	41	No discharge of seismic source along the four northernmost 2D sail lines, closest to the Cartier Island CMR maintaining a minimum distance at which the seismic source is fired at full power of 45km from the CMR boundary during the period 1st November – 28th February	Records confirm that vessel did not fire the seismic source along 2D sail lines during the period 1st November – 28th February Records of any non-compliance
6.3	**Equipment Dragging or Loss**		
	23	The survey vessel is not permitted to transit CMRs.	Records confirm that survey vessel did not transit the CMRs Records of any non-compliance
	66	Vessels will use approved navigation systems and depth sounders.	Records demonstrate that the vessel is equipped with approved navigational system and is functional
	67	Streamer equipped with pressure-activated, self-inflating buoys designed to bring the equipment to the surface if lost accidentally	Records demonstrate that the streamer is equipped with pressure-activated, self-inflating buoys
	68	Streamers will be towed at a depth that will not allow them to be closer than 10 m from the seabed.	Records demonstrate that streamers are towed at a depth that will not allow them to be closer than 10 m from the seabed.
	69	Use of a solid streamer, rather than a fluid-filled streamer	Records demonstrate that a solid streamer is being utilised for the survey
	70	Streamers and associated equipment shall be checked/ inspected prior to use.	Check indicates that streamers are attached correctly
	71	Lost towed equipment will be relocated and recovered where safe and practicable to do so	Records document location (last known) of immersible equipment lost to sea and attempts to recover it
	72	Any incident of loss of streamer or associated equipment shall be reported to NOPSEMA.	Monthly reports and Annual reports to NOPSEMA detail incidents
	73	Procedures will be developed and implemented for lifting activities and streamer deployment/ retrieval.	Documents on vessels and available
	74	Equipment will be deployed during appropriate weather conditions only.	Records indicate weather conditions were within those outlined within contractor procedures as being favourable

Section	EPS #	Control Measures	Records of compliance
	75	Appropriate storage of equipment aboard.	Records to show that storage is adequately maintained and used
	76	All lifting undertaken on board the vessels to be load rated as appropriate for the working load.	Records of lift-plan
	43	Seismic source will not be discharged in less than 50 m water depth	Records confirm that seismic source was not fired in areas of less than 50 m water depth Records of any non-compliance
	40	Seismic source discharge will not occur within 200m of the identified Heywood Shoal 50m bathymetry contour	Records confirm that no seismic source discharged within 200 m of the identified Heywood shoal 50m bathymetry contour Records of any non-compliance
	41	No discharge of seismic source along the four northernmost 2D sail lines, closest to the Cartier Island CMR maintaining a minimum distance at which the seismic source is fired at full power of 45km from the CMR boundary during the period 1st November – 28th February	Records confirm that vessel did not fire the seismic source along 2D sail lines during the period 1st November – 28th February
6.4	**Accidental Release of Hazardous or Non-hazardous Materials**		
	77	Handling of hazardous and non-hazardous materials on-board the survey and support/chase vessels will comply with relevant legislation and ensure: + No discharge of plastics or plastic products of any kind. + No discharge of domestic wastes or maintenance wastes. + All waste receptacles covered with tightly fitting, secure lids to prevent any solid wastes from blowing overboard. + All solid, liquid and hazardous wastes (other than bilge water, sewage and food wastes) will be incinerated or compacted (if	Records confirm that handling of hazardous wastes is in compliance with these requirements Records of any accidental releases of hazardous materials aboard the survey and chase vessels

Section	EPS #	Control Measures	Records of compliance
		possible) and stored in designated areas and sent ashore for recycling, disposal or treatment. + Any hydrocarbon storage on deck must be designed and maintained to have at least one barrier (i.e. form of bunding) to contain and prevent deck spills entering the marine environment. This can include containment lips on deck (primary bunding) and/or secondary containment measures (e.g. bunding, containment pallet, transport packs, absorbent pad barriers) in place. + Correct segregation of solid and hazardous wastes.	
	64	Vessels >400 GRT must have an implemented and tested SOPEP in place that complies with the requirements of: + Regulation 37 of MARPOL Annex I + Marine Order 91 (Marine pollution prevention - oil) 2014 + OPGGS Environment Regulations 14(8B) and 14(8C).	Records demonstrate that the vessel has a valid/compliant SOPEP in place
	78	All hazardous substances (as defined in NOHSC: 1008 [2004] - Approved Criteria for Classifying Hazardous Substances) will have MSDS that are readily available on-board.	MSDS available and correct for hazardous substances
	79	All vessels will have spill response bins/kits in close proximity to hydrocarbon storage areas for prompt response in the event of a spill or leak. The kits will be checked for their adequacy and replenished as necessary prior to the commencement of activities and on a regular basis thereafter.	Spill kits will be checked prior to the commencement of activities. Spill response kits will be close to hydrocarbon storage areas and checked and replenished on a regular basis.
	65	Vessels <400 GRT that do not have a SOPEP will have an approved spill management plan or equivalent.	Records demonstrate that the vessel has a spill management plan or equivalent in place
6.5	**Hydrocarbon Release Caused by Topsides (Vessel) Loss of Containment**		
	80	In the event of any fuel or oil spills to sea, SOPEP/OPEP procedures will be followed for notification and consultation with AMSA and WADoT to	Appropriate forms and channel of communications followed

Section	EPS #	Control Measures	Records of compliance
		ensure prompt and appropriate mobilisation of NATPLAN or WestPlan-MOP/WA DoT OSCP as appropriate.	
	81	The survey vessel must have a valid IOPPC applicable to vessel class	Records confirm that the survey vessel has a valid IOPPC
	82	Equipment located on deck and utilising hydrocarbons (e.g. cranes, winches or other hydraulic equipment) will: + have as a minimum primary bunding (i.e. deck edge lips or up-stands) to prevent loss of hydrocarbons to the marine environment. + be maintained to reduce risk of loss of hydrocarbon containment to the marine environment.	SEA weekly inspection notes the vessel has a process in place to manage maintenance of deck equipment (e.g. survey vessel PMS)
	83	<u>Spill Response Readiness:</u> Vessel SOPEPs will be in the prescribed format described in Guidelines for the Development of SOPEPs, adopted by IMO as Resolution MEPC.54(32) An OPEP drill (Regulation 14(8C)), appropriate to the response arrangements and nature and scale of the activity, will be conducted in Australian waters prior to the commencement of the survey and tested as per the following: + when new response arrangements are introduced + if previous response arrangements are significantly amended + not later than 12 months after the most recent test + if a new location for the activity is added to the EP after the response arrangements have been tested and before the next test is conducted. SOPEP drills will be undertaken as per the seismic vessel standard operating procedure.	Records confirm that the SOPEP is in the prescribed format Records demonstrate that OPEP/SOPEP drills have taken place Records confirm that the SOPEP drills are reported and reviewed correctly Records demonstrate that spill response bins/kits have been inspected

Section	EPS #	Control Measures	Records of compliance
		Support/chase vessels will test response arrangements prior to the commencement of the survey. All drill tests will be reported as per MARPOL Annex I (Regulation 37) and OPGGS Environment Regulations 14(8B) and 14(8C) requirements and reviewed as part of the ongoing monitoring and improvement of emergency control measures.	
	84	Reporting: + When a fuel/oil spill to sea occurs, the survey vessel master will inform the RCC Australia using a POLREP form (AMSA 197 [MO 91/2] + Any diesel spills to sea >80 L will be reported to NOPSEMA as soon as practicable and with written notification within three days. + A written record of the notification to NOPSEMA must be given to NOPTA and the Department of the responsible State Minister (DoT, DMP, DPaW and/or DER) within seven days.	Records demonstrate that any fuel/oil spills to sea have been reported to RCC Australia using the correct POLREP form Records demonstrate that any diesel spills >80 L have been reported to NOPSEMA and written notice to relevant State department
6.6	**Hydrocarbon Release Caused by Vessel Collision Between Survey Vessel and Chase Vessel or Third-Party Vessel and refuelling**		
	9	Operations of the survey vessel must comply with the following: International Regulations for Preventing Collisions at Sea 1972 (COLREG) Standards of Training, Certification & Watchkeeping (STCW) Convention *Navigation Act 2012*: + Marine Order 21 (Safety of navigation and emergency procedures) 2012 + Marine Order 30 (Prevention of collisions) 2009 + Marine Order 59 (Offshore industry vessel operations) 2011 + Marine Order 28 (Operations standards and procedures) 2012, specifically:	Records of any incidents involving fishing vessels or shipping

Section	EPS #	Control Measures	Records of compliance
		► standard maritime safety procedures (including radar watch, radio contact, display of navigational beacons and lights) ► standards for watchkeeping.	
	10	Prevention of vessel collisions: Operations of the survey vessel will be in accordance with Marine Notice 21/2013: Sound navigational practices and with Marine Notice 4/2012: Safety of Fishing Vessels.	Records of any incidents involving non-compliance of the survey vessel operations with sound navigational practices Records of any incidents involving non-compliance of the survey vessel operations with safety of fishing vessels
	87	The AMSA Rescue Coordination Centre (RCC) will be advised of the survey details (e.g. survey vessel, location, timing, coordinates, etc.) within three weeks prior to commencement of an individual survey to ensure NAVAREA X and AUSCOAST warnings are issued and up-to-date. AMSA RCC will also be notified of survey completion and coordinates.	Records of notification to AMSA RCC of survey details and survey completion Issuance of NAVAREA X and AUSCOAST warnings
	12	The AHS will be advised of the survey details (e.g. survey vessel, location, timing, coordinates, etc.) a minimum of three weeks prior to mobilisation for the promulgation of a Notice to Mariners (NTM) broadcast.	Records of notification to AHS of survey details Issuance of NTM
	13	The survey vessel will have an AIS tracking device installed and operating to aid identification by other vessels.	Vessel inspection confirms that an AIS tracking device is installed
	15	Notification of activity details to stakeholders three weeks prior to the survey commencing, including, the offer of a 7-10 day forecast of operations (if requested) and the promulgation of a survey notification prior to the survey commencing and containing specific information of the survey vessels and contact information.	Records confirm that survey notification and if requested 7-10 day forecast sent to all relevant persons 3 week prior to survey commencement
	88	Refuelling at sea will be subject to vessel standard operating procedures, plus the following additional measures:	Equipment shall be checked as part of pre-mobilisation audit

Section	EPS #	Control Measures	Records of compliance
		+ AMSA will be notified prior to any refuelling taking place. + At-sea refuelling will not take place within 30 m or less depth + At sea refuelling will not take place during 2D sail line acquisition within 26 km of Cartier Island CMR Refuelling of vessels will be undertaken under favourable wind and sea conditions as determined by the vessel masters. + Refuelling will take place during daylight hours only. + Job Hazard Analysis (JHA) or equivalent in-place and reviewed before each fuel transfer. + All valves and flexible transfer hoses checked for integrity prior to use and certified. Dry break couplings (or similar) in place for all flexible hydrocarbon transfer hoses.	All steps in refuelling procedures shall be followed to ensure no spills during bunkering
	89	Only marine gas oil (MGO) will be used for survey activities within the operational area.	Records demonstrate that MGO was used on survey vessels.
	90	Lifting equipment is maintained and certified, and Lifting procedures are followed	Records of lift-plan Maintenance records
	91	Approval must be obtained from the Vessel Manager before any at sea refuelling can occur.	Records demonstrate that vessel manager's approval is obtained prior refuelling
	85	The survey vessel must have a Shipboard Oil Pollution Emergency Plan (SOPEP) in place that complies with the requirements of: + Regulation 37 of MARPOL Annex I + Marine Order 91 (Marine pollution prevention — oil) 2014	Records demonstrate that the survey vessel has a valid/compliant SOPEP in place
	86	Reporting of any spills of hydrocarbons to the sea from the survey vessel must comply with the requirements of:	Records demonstrate that the incident report complies with MO91

Section	EPS #	Control Measures	Records of compliance
		Marine Order 91 (Marine pollution prevention — oil) 2014	
	92	<u>Immediate actions:</u> + In the event of a vessel-to-vessel collision, implementation of measures described in the vessel's emergency contingency plans and measures described in the OPEP (**Section 8.1**). + In Commonwealth waters, notify AMSA immediately (1 800 641 792 or 6230 6811) + In WA State waters, contact DoT MEER immediately (9480 9924) + Commence spill monitoring and supply real-time information to control agency as soon as it is safe and practicable to do so	AMSA notified Response actions to monitor and evaluate
	93	<u>Spill Response Readiness</u>: Vessel SOPEPs will be in the prescribed format described in Guidelines for the Development of SOPEPs, adopted by IMO as Resolution MEPC.54(32) An OPEP drill (Regulation 14(8C)), appropriate to the response arrangements and nature and scale of the activity, will be conducted in Australian waters prior to the commencement of the survey and tested as per the following: + when new response arrangements are introduced + if previous response arrangements are significantly amended + not later than 12 months after the most recent test + if a new location for the activity is added to the EP after the response arrangements have been tested and before the next test is conducted. SOPEP drills will be undertaken as per the seismic vessel standard operating procedure.	+ Records confirm that the SOPEP is in the prescribed format + Records demonstrate that OPEP/ SOPEP drills have taken place at prescribed intervals + Records confirm that the SOPEP drills are reported and reviewed correctly

Section	EPS #	Control Measures	Records of compliance
		Support/chase vessels will test response arrangements prior to the commencement of the survey. All drill tests will be reported as per MARPOL Annex I (Regulation 37) and OPGGS E Regulations 14(8B) and 14(8C) requirements and reviewed as part of the ongoing monitoring and improvement of emergency control measures.	
	94	<u>Reporting:</u> + When a fuel/oil spill to sea occurs, the survey vessel master will inform the RCC Australia using a Marine Pollution Report (POLREP) form (AMSA 197 [MO 91/2] + Any diesel spills to sea >80 L will be reported to NOPSEMA as soon as practicable and with written notification within three days. + A written record of the notification to NOPSEMA must be given to NOPTA and the Department of the responsible State Minister (DoT, Department of Mines and Petroleum (DMP), DPaW and/or DER within seven days.	Records demonstrate that copies of the correct POLREP form (AMSA 197 [MO 91/2]) are available aboard the survey vessel
	95	<u>Response strategy:</u> The primary response strategy in the event of a diesel spill to sea from the survey vessel will be to: + Immediate notification to RCC Australia + Allow small diesel spills to disperse and evaporate naturally, and monitor position and trajectory of any surface slicks + Physical breakup by repeated transits through larger spills as directed by AMSA/DOT.	Reponses demonstrate that appropriate monitoring and evaluation implemented

Section	EPS #	Control Measures	Records of compliance
	96	Spill monitoring: + In the event of a major diesel spill from the survey vessel to the sea, Spectrum will implement relevant Type I "Operational Monitoring" implemented for spill surveillance and tracking. + If there is a likelihood of a diesel spill impacting any protected areas (e.g. Cartier Island CMR) Spectrum will: ► notify DPaW and/or DoE. ► implement the appropriate Type II "Scientific Monitoring" to understand the effects of the spill and any response activities on the marine environment.	Records demonstrate that: appropriate Type I operational monitoring has been implemented Appropriate stakeholders have been engaged/consulted in the development of an appropriate Type II scientific monitoring plan
	97	During the pre-survey planning phase and prior to the commencement of individual surveys located near a sensitive area (e.g. the Cartier Island or Ashmore Reef): + Prior to survey commencement, Spectrum will engage with a third-party response provider to evaluate scientific monitoring appropriate to the nature and scale of a potential, credible spill + If required and in collaboration with response provider, Type II Scientific Monitoring Plan will be developed and meet the monitoring guidelines and methodologies described in the AMSA Oil Spill Monitoring Handbook (AMSA 2003a) and Oil Spill Monitoring Background Paper (AMSA 2003b).	Records demonstrate that Spectrum has engaged with a third party response provider prior to survey commencement. Records demonstrates that Type II Scientific Monitoring Plan is developed as required.
	98	Stakeholder consultation: Pre-survey consultation with AMSA and DoT to ensure agreement in place for SOPEP interface with NATPLAN, WestPlan-MOP and WA DoT OSCP Consultation in the event of a major diesel spill - relevant stakeholders (apart from Combat Agencies) will be contacted in the event of a large	Records demonstrate that Spectrum has: consulted with AMSA and DoT regarding the activity and SOPEP interfaces with NATPLAN, WestPlan-MOP and WA DoT OSCP consulted with all relevant stakeholders in the event of a major diesel spill

Section	EPS #	Control Measures	Records of compliance
		diesel spill occurring during surveys within the Cygnus SW MSS operational area	
	99	Insurances Spectrum has public liability insurance that covers any pollution that could result in environmental damage, specifically pollution emanating from their vessels. As such, this insurance would cover the cost of environmental monitoring or clean-up post spill.	Records demonstrate that Spectrum has appropriate financial assurances
9	**Stakeholder Consultation**		
	100	Relevant persons identified and notified of the Activity by provision of a Stakeholder Consultation Package prior to submission of this EP.	Stakeholder consultation package (email/letters/phone call logs) detail all stakeholders contacted
	101	All correspondence with external stakeholders is recorded in the stakeholder consultation log.	Completed stakeholder consultation log is up to date
	102	Notification of activity details to stakeholders three weeks prior to the survey (or survey phase) commencing, including the offer of a 7-10 day forecast of operations prior to the survey commencing and containing specific information of the survey vessels and contact information, including: + the size, location and geographical coordinates for the survey + the timing and duration + parameters for the towed seismic array (e.g. acoustic source and streamer spread) + details of the survey and support/chase vessels + an offer of a 7-10 day forecast to all relevant stakeholders + contact details to submit a concern.	Activity notification with all relevant known details provided to all stakeholders; if requested, relevant stakeholders also provided with forecast
	103	If the Cygnus SW MSS has not commenced within 6 months of the initial stakeholder consultation (i.e. by 30/06/17), Spectrum shall ensure that	Completed consultation log and stakeholder correspondence indicating stakeholders contacted prior to 30/06/17 if survey has not commenced

Section	EPS #	Control Measures	Records of compliance
		all stakeholders have been provided with an update of activities associated with the Cygnus SW MSS EP, including proposed timing, location and reasons for schedule change	
	104	The maximum period of time that the Activity will take place for is 90 days. If the Activity is split over time e.g. acquired in phases, an EP review will be conducted in line with **Section 7** to ensure stakeholders are aware of the Activity and the EP is still fit for purpose.	Record of EP review conducted evidences relevant stakeholder review
	105	On completion of the Cygnus SW MSS, a completion notification that summarises survey activities (e.g. survey dates, area surveyed, summary of environmental performance and compliance, etc.) will be sent to relevant stakeholders	Stakeholder correspondence stating survey has been completed
	106	In the event of new, relevant information being identified (by stakeholders or Spectrum) which affects the management of the EP, a risk assessment will be conducted in line with **Section 4.**	Record of risk assessment and actions undertaken

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