



# EP Summary

## Integrated Gas

# ENTERPRISE 3D TRANSITION ZONE SEISMIC SURVEY Environment Plan Summary

### Review record

Rev	Date	Reason for issue	Author	Reviewer	Approver
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Review due: N/A

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### THE THREE WHATS

What can go wrong?  
What could cause it to go wrong?  
What can I do to prevent it?

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## Abbreviations and Acronyms

Abbreviation	Definition
3D	3-Dimensional
AFMA	Australian Fisheries Management Authority
AHS	Australian Hydrographic Service
AIS	Automatic Identification System
ALARP	As Low as Reasonably Practicable
AMSA	Australian Maritime Safety Authority
APPEA	Australian Petroleum Production & Exploration Association
ASX	Australian Stock Exchange
BIA	Biologically Important Area
BPC	Border Protection Command
CAMBA	China/Australia Migratory Birds Agreement
CFA	Commonwealth Fisheries Association
CMR	Commonwealth Marine Reserve
Cth	Commonwealth
DEDJTR	Department of Economic Development, Jobs, Transport and Resources (Vic)
DELWP	Department of Environment, Land, Water and Planning (Vic)
DoEE	Department of the Environment and Energy (Cth)
EP	Environment Plan
EPA	Environment Protection Authority (Vic)
EPBC	<i>Environment Protection Biodiversity Conservation Act 1999</i> (Cth)
ERC	Emergency Response Coordinator
ERP	Emergency Response Plan
FRDC	Fisheries Research Development Corporation
GHG	Greenhouse Gas
GMDSS	Global Maritime Distress Safety System
GPS	Global Positioning System
HSE	Health, Safety and Environment
IMO	International Maritime Organisation
IMS	Invasive Marine Species
IPIECA	International Petroleum Industry Environmental Conservation Association
JAMBA	Japan/Australia Migratory Birds Agreement
LPG	Liquefied Petroleum Gas
MARPOL	International Convention for the Prevention of Pollution from Ships
ML	Megalitre (1,000 litres)
MMO	Marine Mammal Observer
MNES	Matter of National Environmental Significance
MoU	Memorandum of Understanding
MSS	Marine Seismic Survey

## Enterprise 3DTZSS EP Summary

Abbreviation	Definilton
NCR	Non-Conformance Report
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NOPTA	National Offshore Petroleum Titles Administrator
NNTT	National Native Title Tribunal
OBN	Ocean Bottom Node
OCIS	Origin Collective Intelligence System
OPGGS Act	<i>Offshore Petroleum &amp; Greenhouse Gas Storage Act 2010 (Vic)</i>
OPGGS Regulations	Offshore Petroleum & Greenhouse Gas Storage Regulations 2011 (Vic)
OPEP	Oil Pollution Emergency Plan
PJ	Petajoule
PMS	Planned Maintenance System
PMST	Protected Matters Search Tool
QHSE	Quality, Health, Safety and Environment
SDS	Safety Data Sheet
SEL	Sound Exposure Level
SOPEP	Shipboard Oil Pollution Emergency Plan
SPL	Sound Pressure Level
TCF	Trillion Cubic Feet
TJ	Terajoule
UHF	Ultra High Frequency
VHF	Very High Frequency

## 1. Introduction

This Summary Environment Plan (EP) is prepared in accordance with Regulation 13(8) of the Offshore Petroleum and Greenhouse Gas Storage Regulations 2011 (OPGGs Regulations). The EP was accepted by the Department of Economic Development, Jobs, Transport and Resources (DEDJTR) (Earth Resources Branch) on the 23<sup>rd</sup> of December 2016.

On 27 March 2017 Origin made a variation to the EP to propose extended node and rope retrieval operations until 30 April 2017. Data acquisition using the seismic source vessel will not occur past 31 March 2017. DEDJTR accepted the variation to the EP on 31 March 2017.

### 1.1 Project summary

Origin Energy Resources Limited (Origin) is proposing to undertake the Enterprise three-dimensional (3D) Transition Zone Seismic Survey (Enterprise 3DTZSS, herein referred to as the 'survey') in the Otway Basin off southwest Victoria in exploration permit VIC/P42(V) (Figure 1.1). The survey will predominantly be undertaken within VIC/P42 but will enter waters outside the permit to the east in order to produce seamless data coverage with existing seismic surveys. Access to this area will be undertaken in accordance with a Petroleum Access Authority granted under Section 241 of the OPGGS Act.

The full fold coverage area for the survey (the 'acquisition area') will cover up to approximately 74 square kilometres (km<sup>2</sup>) in water depths ranging from approximately 2 metres (m) to 50 m. The survey will be undertaken entirely in Victorian state waters.

The survey is expected to take place over approximately four to six weeks between January and March 2017. Exact timing is contingent on fair sea state conditions suitable for marine seismic acquisition.

As a transition zone survey, part of the survey will extend onshore in to Petroleum Exploration Permit (PEP) 168, PEP169 and Petroleum Production Licence (PPL) 8. This part of the survey is addressed in an onshore Environmental Management Plan (EMP) submitted to, and accepted by the Earth Resources Regulation branch of the DEDJTR.

### 1.2 Proponent

Origin Energy (ASX: ORG) is the leading Australian integrated energy company, with market leading positions in energy retailing (approximately 4.2 million customers), power generation (approximately 6,000MW of capacity owned and contracted) and natural gas production (1,093 PJ of 2P reserves and annual production of 82 PJe).

Through Australia Pacific LNG (APLNG), its incorporated joint venture with ConocoPhillips and Sinopec, Origin has developed and is now operating one of Australia's largest Coal Seam Gas (CSG) to Liquefied Natural Gas (LNG) projects based on Australia's largest 2P CSG reserves base.

In the Otway Basin, Origin operates the:

- Otway Gas Plant, which processes and distributes gas from Origin's Geographe and Thylacine fields. The infrastructure consists of the Thylacine remotely-operated (unmanned) wellhead platform and a 70 km gas pipeline to the shore, together with onshore pipeline. The Geographe field ties into the Thylacine pipeline. The plant produces an average of 60 petajoules (PJ) per annum, 800,000 barrels (bbl) of condensate and 100,000 tonnes of Liquefied Petroleum Gas (LPG). Origin has a 67.23% stake in the development, which commenced production in mid-2007.
- Mortlake Power Station, a 550 MW gas-fired open cycle power station (the largest in Victoria), connected to the Otway Gas Plant by an 83 km gas pipeline. First generation of power commenced in early 2012.

Origin recently developed the Halladale and Speculant gas fields, located in Victorian state waters (Vic/L1(V)) west of Port Campbell. The Halladale and Speculant wells were drilled using extended reach drilling from a location south of Nirranda. Pipeline construction was completed in mid-2016. The pipeline connects the wells to the Otway Gas Plant.

Origin's gas exploration and production portfolio includes acreage in the Otway, Bass, Surat, Denison, Cooper/Eromanga, Beetaloo, Perth and Bonaparte Basins in Australia, and the Taranaki, Northland and Canterbury Basins of New Zealand.

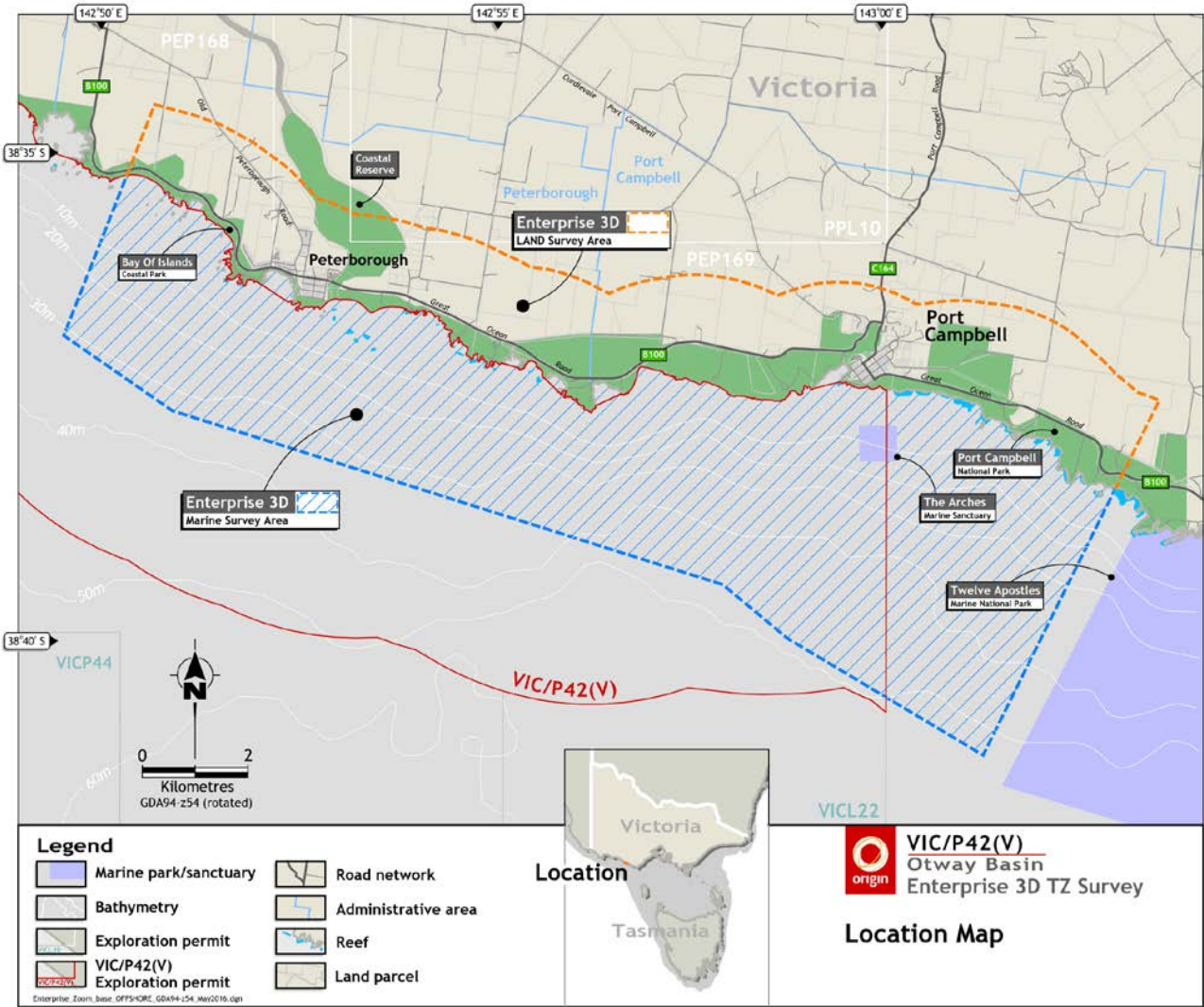


Figure 1.1. Enterprise 3DTZSS location

Origin's office is located in Brisbane at:

John Oxley Centre,  
339 Coronation Drive  
Milton, Qld, 4064  
ABN 66 007 845 338

The nominated liaison person for the activity is:

Scott Dale  
Environmental Approvals Manager  
Level 3, North Tower, 339 Coronation Drive,  
Milton, QLD, 4064  
Phone: 07-3867 0024  
Email: envapprovals@originenergy.com.au

The DEDJTR (Energy & Earth Resources) will be notified of any change in Titleholder of the activity or a change in the contact details of the Operator within seven days after such a change occurs.

### 1.3 Scope

The survey will be conducted in accordance with all applicable legislation and regulations, and specifically to meet the requirements of the OPGGS Act and associated OPGGS Regulations.

For this survey, the petroleum activity is defined as:

*'the time that the survey vessels first deploy seismic source and receiver equipment within the acquisition area until the time the vessels retrieve the equipment and depart the acquisition area for the last time.'*



## 2. Activity Description

### 2.1 Location

The area defined as the marine 'acquisition area' is located entirely within Victorian state waters of the Otway Basin (Figure 2.1), covering a maximum area of 73.9 km<sup>2</sup>. Coordinates of the acquisition area (including the terrestrial component) are provided in Table 2.1. The coastline forms the northern boundary of the acquisition area.

**Table 2.1. Survey acquisition area coordinates**

Latitude	Longitude	Location note
38° 34' 30.6" S	142° 50' 31.6" E	Western corner (shoreline)
38° 35' 18.4" S	142° 50' 06.5" E	South-west corner of survey
38° 36' 50.9" S	142° 49' 19.2" E	
38° 37' 37.5" S	142° 50' 44.9" E	
38° 39' 23.3" S	142° 57' 57.1" E	
38° 39' 55.0" S	142° 58' 46.2" E	
38° 41' 06.5" S	143° 01' 22.1" E	South-east corner of survey
38° 38' 24.6" S	143° 03' 02.6" E	South-east corner (shoreline)

The proximity of the closest source line to key features in the region is listed in Table 2.2.

The area defined as the 'acquisition area' is the physical area used to conduct the survey. Because of the small size of the vessels, and the short trailing equipment proposed for use in the transition zone survey, an 'operational area' (an area for conducting operations ancillary to acquisition such as vessel approach, vessel turns, testing of the seismic source and miscellaneous maintenance operations) is not required for this survey.

The survey vessels may sail beyond the acquisition area boundaries during times of unfavourable environmental conditions (seeking refuge) or due to operational constraints (equipment maintenance/repair, obstructions, port calls, etc.). However, the source will not be activated outside the acquisition area.

The water depth of the acquisition area varies between 2 to 50 m.

**Table 2.2. Distance to key features in the region from the closest source lines**

Locality	Distance from closest source line
Nearest landfall	200 m (0.1 nm) north – immediately west of Peterborough
Coastal towns	
Port Campbell	900 m (0.48 nm) north
Peterborough	850 m (0.45 nm) north
Warrnambool	37 km (20nm) northwest
Victorian Marine Reserves	
The Arches Marine Sanctuary	310 m (0.15 nm) (no acquisition within sanctuary)
Twelve Apostles Marine National Park (contains the Twelve Apostles, Loch Ard Gorge)	600 m (0.3 nm) east
Marengo Reefs Marine Sanctuary	57 km (30.7 nm) east-southeast
Coastal Reserves	
Port Campbell National Park	Immediately adjacent
Bay of Islands Coastal Park	Immediately adjacent
Commonwealth Marine Reserves	
Apollo	49 km (26.4 nm) southeast
Nelson	123 km (66 nm) south
Other environmental features	
Bay of Islands	Immediately adjacent
The Arch	Immediately adjacent

Locality	Distance from closest source line
London Bridge	Immediately adjacent
The Grotto	Immediately adjacent
'Big Reef'	57 km (30.7 nm) southeast
Lady Julia Percy Island	75 km (40.5 nm) northwest
Oil and gas infrastructure	
Otway gas pipeline	Overlapped
Casino gas pipeline	Overlapped
Minerva gas pipeline	Overlapped

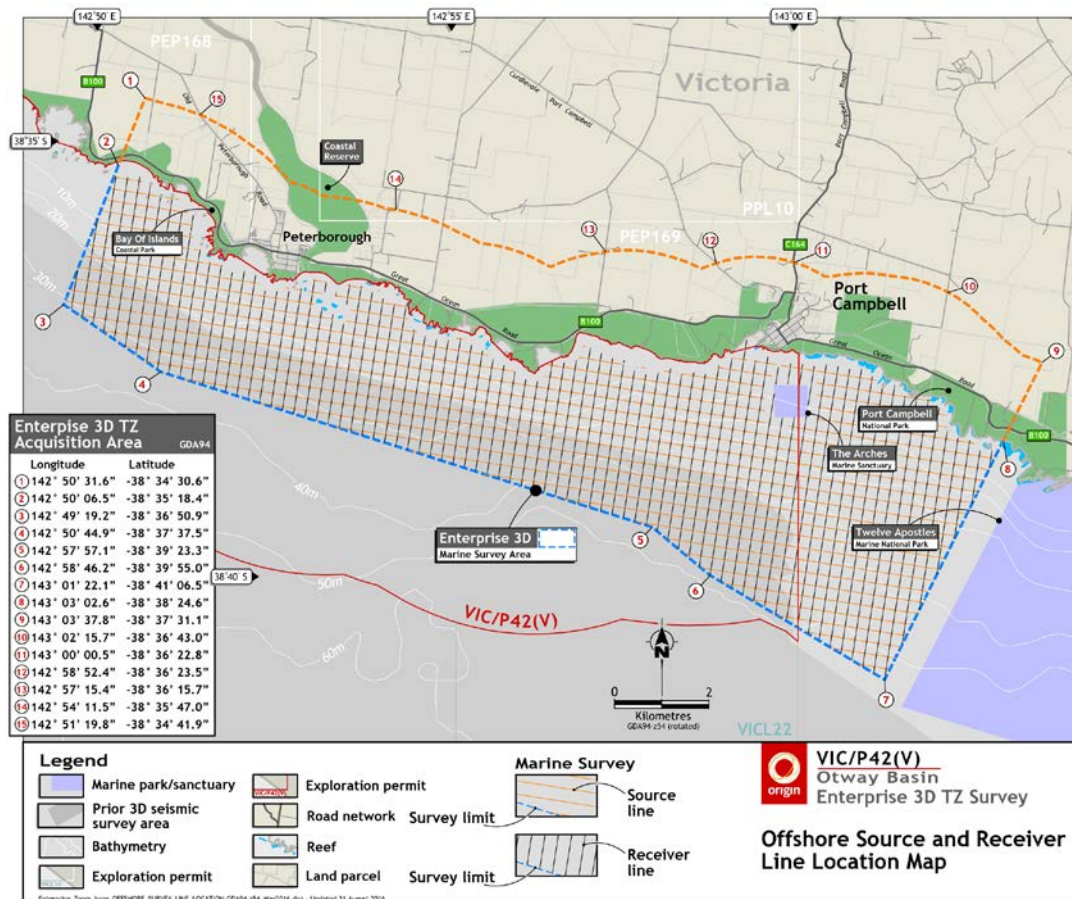


Figure 2.1. Detailed outline of the survey lines

## 2.2 Timing

The survey is expected to take place over approximately four to six weeks between January and March 2017. Exact timing is contingent on fair sea state conditions suitable for marine seismic acquisition.

Origin has selected a survey 'window of opportunity' that it believes balances operational requirements with environmental and socio-economic considerations, using recent past survey experience in the Otway Basin as a guide. This includes:

- Sea state conditions optimal for survey occur from October to April inclusive. Beyond this time, sea state conditions are generally too rough for seismic acquisition. DITR (2005) verifies this by stating that in the Otway Region, seismic surveys can only be conducted outside of the winter season (May to September, inclusive) in order to escape the sound interference created by strong winds and waves.
- The pygmy blue whale aggregates to feed in the eastern area of the Otway Basin from November to May with peak numbers likely during February and March (Gill *et al.*, 2011).

Origin has undertaken a number of recent surveys in the region without any identified harm to cetaceans:

- Enterprise 3D MSS – 4 days in early November 2014 (overlapped by this survey area).
  - Astrolabe 3D MSS – 5 days in early November 2013 (31 km south of this survey area).
  - Bellerive 3D MSS – 13 days during February 2011 (90km south of this survey area).
  - Speculant 3D TZ MSS - 50 days over November and December 2010 (6 km west of this survey area).
- Southern right whales may be present in the area between mid-May and mid-November with the peak mating and calving period occurring from mid-July to end August which is outside the proposed survey window.
  - The economically important nearshore rock lobster (operates between 15 November to 1 June) and abalone fishery (year-round season) means there is no period of time in which at least one fishery is not potentially affected by the survey operations.
  - Australian fur-seals haul-out and feed during the proposed survey window at colony locations Moonlight Head (22 km southeast) and Cape Volney (haul-out and breeding) (23.5 km southeast from the acquisition area).
  - New Zealand fur-seal haul-out and breeding colonies are not located within the area potentially affected by the survey, however the species may forage within the acquisition area during the survey period.
  - Little penguins are present in the region year-round. While breeding occurs over the summer months and therefore overlaps the proposed survey window, this species is not listed as threatened and their numbers in the southwest of Victoria remain strong.
  - The Bonney Coast upwelling, with associated surface aggregations of krill that form an important diet for pygmy blue whales migration through the region, occurs from December to April, which overlaps the preferred seismic survey weather window.

DITR (2005) notes that in the Otway Basin, there is no clear period when seismic can be undertaken that will not overlap with other commercial or conservation uses of the area. Origin believes that the factors outlined above combine to make November to March the most suitable time to conduct the Enterprise 3DTZSS.

On 27 March 2017 Origin made a variation to the EP to propose extended node and rope retrieval operations until 30 April 2017. Data acquisition using the seismic source vessel will not occur past 31 March 2017. DEDJTR accepted the variation to the EP on 31 March 2017.

## 2.3 Purpose

The purpose of this survey is to acquire data to map the subsurface geology to determine the potential petroleum resources of the area. The survey is intended to satisfy the following criteria:

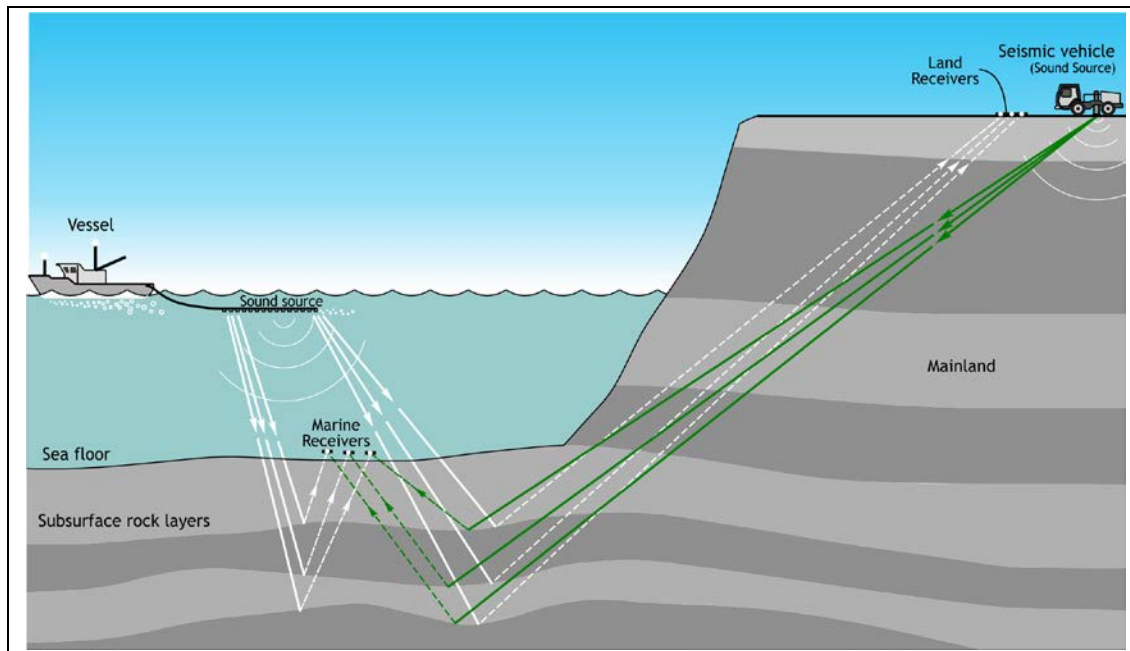
- Improve seismic imaging coverage between existing marine seismic survey data and the Victorian coastline to adequately assess leads in VIC/P42(V); and
- Acquire additional 3D seismic data coverage to meet the work program commitments.

The data acquired will be processed by Origin to aid in accurately defining prospectivity and possible drilling locations for future exploration activities associated with gas supply to the Otway Gas Plant.

## 2.4 Seismic Programme

Seismic surveying is a widely used exploration method used to define and analyse subsurface geological structures in the marine environment. Seismic surveying uses a technique that directs acoustic energy into these subsurface geological structures beneath the sea floor from equipment deployed by vessel.

This transition zone surveying will utilise ocean bottom nodes (OBN) laid on the seabed to collect receiver signals. The source vessel towing an acoustic source then traverses over the area where the seabed OBN have been laid. This is a variation on the towed streamers that are normally used in seismic surveying (Figure 2.2).



**Figure 2.2. Transition zone seismic survey acquisition diagrammatic representation**

The proposed survey is similar to the Speculant 3DTZSS undertaken in 2010 in terms of the technical methods and procedures.

Several vessels, including a source vessel and receiver deployment vessels are required for the survey (see Section 2.4.1). An acoustic source array is used with the source vessel transiting over the lines where the receivers have been installed on the seabed.

The seismic data gathered during the survey are then processed and analysed to produce images of the seabed subsurface geology in the survey area.

#### 2.4.1 Survey Contractor

Origin has contracted Geokinetics (Australasia) Pty Ltd (herein referred to as Geokinetics) as the seismic survey contractor. Geokinetics' scope includes both the onshore and offshore components of the survey. Geokinetics is one of the largest independent international land and shallow water geophysical service companies, with a presence in 29 countries and a capacity of over 30 acquisition crews. The company is headquartered in Houston, Texas, and has a regional office in Brisbane, Queensland.

Geokinetics undertook the Speculant TZSS for Origin in 2010, with the proposed survey crews having experience in international and Otway Basin TZSS. Geokinetics vessel crews are highly experienced in operating in sensitive environments.

#### 2.4.2 Vessels

Seismic operations and ancillary operations (e.g., undertaking marine observations, removal of entanglement hazards and scouting duties) will be restricted to daylight hours.

Geokinetics is proposing to use three shallow draft vessels for the survey; a seismic source vessel (the MV *Blackjack*) and two receiver deployment vessels (the MV *Prowler* and MV *Business Class*). A dive vessel the MV *Predator* and Remote Operated Vehicle (ROV) vessel *Pacific Crest* will also be used for retrieval activities. No support vessels are proposed.

The vessels will operate out of either the ports of Warrnambool, Port Fairy, Apollo Bay or Port Campbell, or a combination of these, and will be moored at one of these ports during night hours for the survey period. The survey not proceed when sea states exceed operational parameters (~4.5 m significant wave height).

Refuelling will only be undertaken at permanent refuelling facilities in port and wastes will not be discharged in state waters.

#### Maritime Safety

The vessels will operate in accordance with the Convention on the International Regulations for Preventing Collisions at Sea (COLREG, 1972) in accordance with the *Marine Safety Act 2010* (Vic).

The source and node deployment vessel operators will issue a vessel positioning notification to the Australian Hydrographic Service (AHS) who will in turn issue the survey location in the Notice to Mariners for Commonwealth waters (published fortnightly), and the Victorian Director - Maritime Safety who will issue a Notice to Mariners for Victorian waters.

A daily Auscoast warning of the survey vessel's location will also be issued to all vessels by Transport Safety Victoria through the Global Maritime Distress Safety System (GMDSS) communication network. The warning will provide details of the safe distance to be maintained around the seismic survey vessel and towed equipment.

The vessel masters are responsible for maintaining vessel control and for establishing and maintaining communication with other vessels and marine traffic during the survey. The vessels will use integrated navigation systems, including either Automatic Identification System (AIS) transponders or radio global positioning system (GPS) transponders. The addition of this equipment and the data it transmits provides accurate real-time updates of the position of all project vessels relative to the survey vessel and the towed seismic spread.

All vessels will be capable of communicating and operating both on dedicated ultra-high frequency (UHF) working channels and or Maritime very high frequency (VHF) working channels (typically monitoring Channel 16 and working on Channel 74).

### Lighting

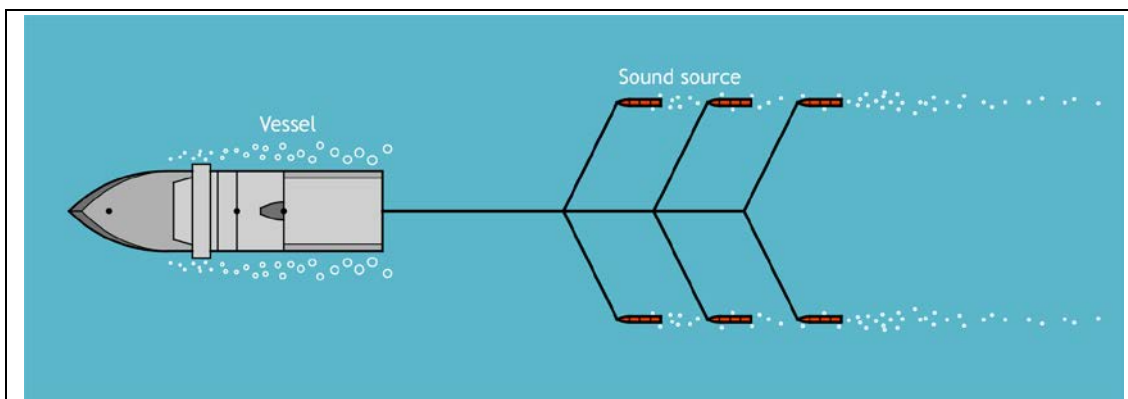
The lighting on the vessels during the survey will comply with COLREG. During survey deployment, recovery and acquisition, the source vessel will display navigation lights indicating the 'restricted ability to manoeuvre'. In addition to the mandatory navigation lighting, the working deck areas (albeit very small) will be lit as required to provide for safe work.

### Bad Weather Shelter

The worst-case sea state conditions in the area will be a south-westerly storm, which may result in a long period southwest swell up to 10 m. In the case where extreme weather makes it unsafe for the vessels to remain on location, they will either retrieve the in-water equipment and return to Warrnambool, alternative safe anchorages (such as Port Fairy and Apollo Bay) or turn into the weather and head into the seas. Port Campbell's orientation means it is not safe to use during south-westerly swells.

#### 2.4.3 Source Equipment

The marine seismic acoustic source will consist of an array of six sources of maximum volume of 150 cubic inches (cui), providing a total maximum array volume of 900 cui. The array will be towed with the centre approximately 9 m behind the source vessel at a depth range of  $2\text{ m} \pm 1\text{ m}$ . Figure 2.3 shows the array layout and towing arrangement.



**Figure 2.3. Towing diagram and gun array layout (plan view)**

While the total maximum volume of the source array is 900 cui, the effective source volume is only 270 cui. The sound pressure levels generated by the array are equivalent to a 270 cui array as the additional 630 cui will be used for bubble stabilisation, which reduces the signal-to-noise of the source. This volume is significantly smaller than typical deep-water seismic surveys which normally have a volumetric capacity in the range of 2,500 – 4,000 cui. The source array will have an operating pressure of 2,000 pounds per square inch (psi).

Source arrays are strategically arranged to direct most of the energy vertically downward rather than sideways. Marine acoustic lines will be spaced at approximately 250 m intervals across the survey area with acoustic pulses expected to be generated nominally every 25–50 m (or approximately

8-10 seconds). The distance and time between pulses may be adjusted if this will result in improved data. The acoustic source will normally traverse the survey area on a west-north-west to east-south-east bearing. Other azimuths may be sailed to obtain full-fold over the acquisition area.

The terrestrial seismic acoustic source will consist of a maximum array of three small vibroseis source vehicles (either an IVI Envirovibe or Inova Univibe) with a peak force of up to 26,000 lb and range frequency of 1- 475 Hz. Terrestrial seismic will be acquired over 22.4 km with acoustic pulses generated from the vehicles every 12.5 m.

#### 2.4.4 Receiver Equipment

Sound generated by the source array will be recorded by receivers laid on the seabed and onshore terrestrial receivers. Marine receivers will consist of OBN.

Marine nodal systems offer high quality four component data, with up to 30 days continuous recording, very good dynamic range and an exceptional coupling capacity. The receiver vessels are expected to be fitted with a customised semi-automated nodal handling and storage system with an estimated capacity of around 300 nodes, depending on the size of the vessel used.

The nodes will be connected together at set intervals with a strong polymer rope, plus a few meters of additional rope, which will allow for some undulation on the sea floor (Figure 2.4). The nodes will be laid onto the seabed at set intervals with acoustic transponders connected to the tether lines to confirm the position of equipment on the seabed, and allow for its location for retrieval in the unlikely event of equipment drift. The acoustic transponders will be connected to the tether line at the agreed intervals (likely to be 25–50 m). The acoustic positioning system will be used to confirm the position of the nodes on the seafloor. A surface buoy or acoustic release buoy (preferred) will be connected at the end of each receiver line where possible. Acoustic release buoys eliminate the need for any surface buoys that can drag the receiver lines in big swell, reduce the visual impact of the survey and minimise navigational hazards to third-party vessels.

Nodes will not be laid directly over sensitive seabed features such as shipwrecks. Spot checks of bathymetry will be performed on deployment using a standard on-board echo-sounder (essentially a 'fish finder') to validate the accuracy of the admiralty charts and ensure that such seabed features can be avoided. Based on previous seismic surveys undertaken in the region, Origin notes that the admiralty charts are known to be very accurate.

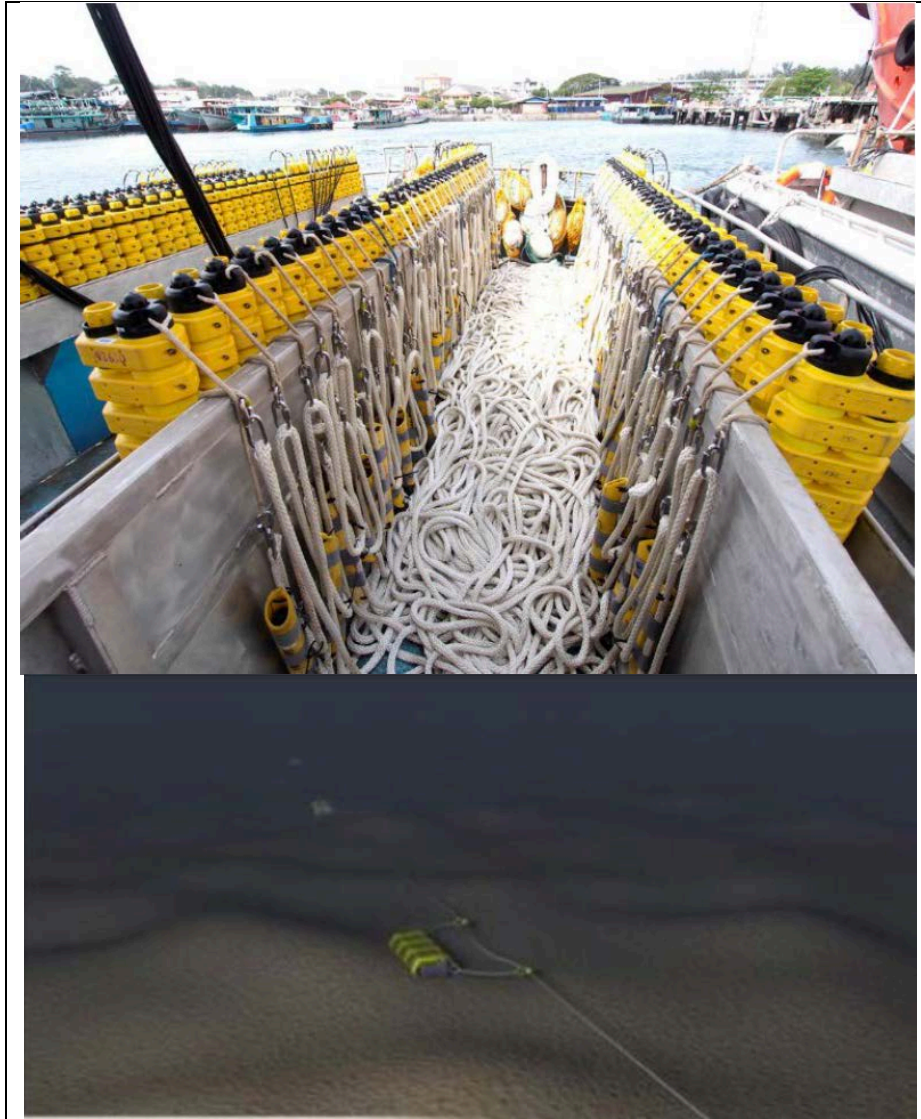
The receiver lines are expected to be spaced 250 m apart, with the nodes spaced at 25–50 m along the receiver lines. Marine receiver lines will be laid in sections (i.e., seismic data obtained across a small section of survey area at any one time) which is expected to consist of up to 4-5 receiver lines at any one time (Figure 2.5). This equates to a 1 km width between 5 lines. The length of the receiver lines ranges from 2 km at the narrowest point to 5.5 km at the widest part of the survey area.

Working a segment at a time, a deployment vessel will deploy marine receiver equipment which will be lowered from the stern of the vessel and sink and settle on the seabed. It is expected to take approximately 2 to 4 hours to deploy equipment per segment. A source vessel will then transit along the receiver lines to establish receiver positions and then along the seismic source lines creating the acoustic pulses that are recorded by the receivers on the seabed. Seismic acquisition across individual sections is expected to take 4 to 8 hours.

After all seismic data has been acquired and the recording vessel has confirmed the data acquisition, the receiver vessel will retrieve the receiver equipment in preparation for the next section's activities (i.e., move to the next section and repeat the process).

The survey has been designed to minimise the impact on the environment, commercial businesses and recreational activities. Design measures include eliminating seismic streamers to record data and making the majority of the marine survey area accessible to third parties to conduct their normal activities during the survey.

In addition to the OBN, sound from the marine source equipment will also be received by the onshore receiver nodes. The activity of deploying and retrieving the onshore receiver cables is assessed in an Environmental Management Plan (EMP) prepared by Origin under the *Petroleum Act 1998* (Vic), which has been accepted by the DEDJTR.



**Figure 2.4. Example of OBN ready for deployment (top) and deployed on the seabed (bottom)**

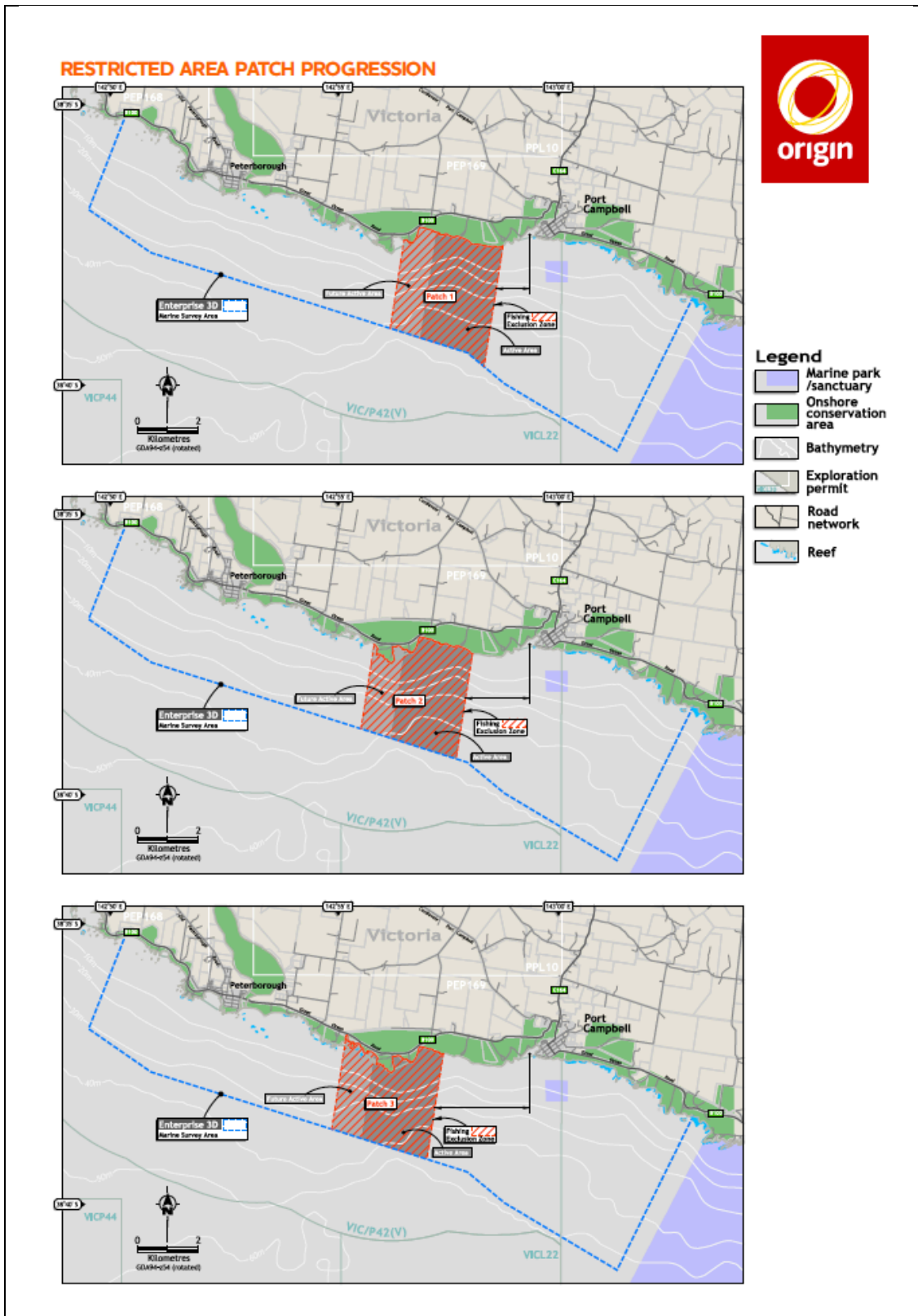


Figure 2.5. Example of daily source & receiver patch progression

2.4.5 Line Turns

Acquisition of marine seismic data will use the conventional method where data is acquired along straight lines, with the source array in use as the vessel turns and runs into the next acquisition line.



Given the short length of the trailing equipment behind the acquisition vessel (~ 12 m), the 'run-in' line distances are expected to be minimal.

Similar to the receiver lines, the sail (source) lines for the survey will be acquired in sections moving perpendicular across the receiver line section as shown by the red lines in Figure 2.6. The source lines will be between 2 km and 2.5 km long depending on whether 4 or 5 receiver lines have been laid in the section.



**Figure 2.6. Example of daily source and receiver patch**

#### 2.4.6 Data Recording

The data is measured by hydrophones in the nodal receivers. Once the nodes have been recovered from the seabed, they are placed in a data harvester where the data is reaped from each unit and the unit battery is charged for the next deployment. The data is then checked by the processing department for quality control and merged with navigation data to correctly position the data in time and space. The processing methods conducted on-board check that the data have been acquired to a satisfactory quality.

After the data has been successfully acquired, it will be further processed to obtain a 3D image of the sub-surface geology. The 3D image of the subsurface is then interpreted by Origin geoscientists to assess gas prospectivity.

## 2.5 Survey Summary

Table 2.5 summarises the proposed survey parameters.

**Table 2.5. Summary of acquisition parameters for the proposed survey**

Parameter	Detail
Earliest commencement date	1st November 2016 (or 2017)
Latest end date	31st March 2017 (or 2018)
Duration of survey	Approximately 4-6 weeks
Water depths	~2–50 m
Acquisition area	80 km <sup>2</sup>
Operating period	Daylight hours only
Survey exclusion period	April to October (inclusive)
Survey contractor	Geokinetics
<b>Seismic source</b>	
Total maximum volume of source array	270 cui
Source operating pressure	2,000 psi
Source line spacing	250 m

Parameter	Detail
Source point interval	25 m (distance between each shot taken on a line)
Source line orientation	East-west
Shot count	Approximate maximum of 10,000
Shot event count	Approximate maximum of 20,000
Patch definition	8-14 swath widths, 4-10 lines to roll
<b>Receivers</b>	
Receiver interval	25 m intervals
Receiver type	Geospace BOX autonomous marine node
Receiver sensor type	One cylindrical hydrophone + 3C fixed access geophones
Receiver line orientation	North-south
Receiver channels supplied	1,250
Receiver count	Approximate maximum of 10,000
Receiver patch definition	4-10 receiver lines x static line stations
Maximum receivers in patch	1,250

### 3. Stakeholder Consultation

Origin developed a Stakeholder Engagement Plan (SEP) for engaging stakeholders in the development of the EMP (onshore) and EP (offshore) for the Enterprise 3DTZSS. The SEP provides an operating framework and structured approach to Origin's interactions with external stakeholders.

#### 3.1 Stakeholder Identification

Stakeholders were initially identified using Origin's existing stakeholder database which has been built upon knowledge gained from its ongoing activities in the region/Otway Basin since 2000.

Further research was also undertaken to ascertain whether there were any other stakeholders (not previously identified) whom may be impacted by the proposed survey. For example, where potential impacts or activities are unique to this particular project or location, Origin undertook additional steps to identify and verify whether there were other stakeholders to be engaged. Professional diving, recreational and tourism activities in the survey area were also reviewed to identify relevant stakeholders. Table 3.1 lists and categorises the stakeholders consulted for the Enterprise 3DTZSS.

**Table 3.1 Enterprise 3DTZSS stakeholders**

Commonwealth Government	
Department of the Environment and Energy (DoEE)	Australian Maritime Safety Authority (AMSA)
Border Protection Control (BPC) Command	Australian Hydrographic Service (AHS)
Department of Defence (DoD)	
Victorian Government	
DEDJTR – Stakeholder Relations and Strategy	National Parks Advisory Council (NPAC)
Department of Environment, Land, Water and Planning (DELWP)	Office of the Minister for Energy, Environment and Climate Change
Parks Victoria	Transport Safety Victoria (Marine Safety)
Fisheries Victoria	
Local Government and other agencies	
Moyne Shire Council	Corangamite Shire Council
Wannon Water	Southern Rural Water
Community, tourism and recreational interests	
Parks Victoria (Port Campbell office)	Port Campbell Tourism and Information Centre
Twelve Apostles Tourism and Business Association (TATBA)	Port Campbell and Peterborough Country Fire Authority (CFA)
Port Campbell Progress Group	Port Campbell Board Riders Association
Peterborough Golf Club	Port Campbell Rifle Range
Great Ocean Road Touring	Port Campbell Boat Charters
Port Campbell State Emergency Service (SES)	Port Campbell Surf Life Saving Club (PCSLSC)
Port Campbell Police	Ocean Racing Club of Victoria
Victorian Recreational Fishers Association	Scuba Divers Federation of Victoria
Warrnambool Dive Club	Dive Industry Association of Victoria
Conservation interests	
Blue Whale Study Inc.	International Fund for Animal Welfare (IFAW)
Victorian National Parks Association (VNPA)	Deakin University (School of Life and Environmental Sciences)
Eastern Marr Aboriginal Corporation (EMAC)	
Petroleum industry	

Commonwealth Government	
BHP Billiton Petroleum	Lochard Energy
Santos Ltd	Australian Petroleum Production and Exploration Association (APPEA)
CO2CRC	
Commercial Fishers	
Seafood Industry Victoria (SIV)	Apollo Bay Fishermans' Cooperative
Victorian Rock Lobster Association (VRLA)	Portland Professional Fishermans' Association
Warrnambool Professional Fishermans' Association	Port Campbell Professional Fishermans' Association (PCPFA)
Victorian Abalone Divers Association (VADA)	
Oil spill preparedness and response agencies	
Australian Marine Oil Spill Centre (AMOSOC)	Adagold Aviation
Bristow	

## 3.2 Engagement Approach and Method

This section outlines the approach and methodology in which Origin has undertaken its stakeholder consultation.

### 3.2.1 Engagement Approach

Consultation for the Enterprise 3DTZSS has been broadly undertaken in line with the International Association for Public Participation (IAP2) spectrum, which is considered best practice for stakeholder engagement. In order of increasing level of public impact, the elements of the spectrum and their goals are:

1. Inform – to provide the public with balanced and objective information to assist them in understanding the problems, alternatives and/or solutions.
2. Consult – to obtain public feedback on analysis, alternatives and/or decisions.
3. Involve – to work directly with stakeholders throughout the process to ensure that public concerns and aspirations are consistently understood and considered.
4. Collaborate – to partner with the public in each aspect of the decisions, including the development of alternatives and the identification of the preferred solution.
5. Empower – to place final decision-making in the hands of the stakeholders.

Elements 1, 2 and 3 are those of relevance to this survey and have been adopted. Elements 4 and 5 are not of relevance given the short-term nature of the project and given that the environmental and socio-economic impacts and risks are being managed through the implementation of appropriate controls. The manner in which Origin has informed, consulted and involved stakeholders with the project are outlined through this section.

### 3.2.2 Engagement Methodology

Stakeholders were issued a project information flyer in June 2016 by email before being offered face-to-face meetings with Origin's representatives to formally seek feedback, discuss any issues and concerns and provide an opportunity to ask questions. Meetings also enabled Origin to confirm stakeholders' functions, activities and interests in relation to the proposed survey and to identify further opportunities for engagement.

Many of the stakeholders have had prior contact with Origin regarding previous projects in the region over several years and have been comfortable approaching Origin for information. However, in response to information sent by Origin for the survey, no meetings were requested by stakeholders. Notwithstanding the lack of response, Origin proactively sought out meetings with relevant commercial fishing stakeholders and other community groups.

### 3.2.3 Distribution of Survey Information via Fishing Associations

Origin has maintained and updated its own database of commercial fishers in the Otway Basin through the support of a local Fisheries Liaison consultant, and engages directly with local commercial fishers. However, to ensure broad communications that may be relevant to new commercial fishers moving into the Western Zone, Origin has again sought the support of SIV and VRLA to distribute Origin's

information flyer to relevant commercial fishing licence holders in the Western Zone. SIV distributed Origin’s information to all (148) rock lobster licence holders and operators (eastern and western zone operators) and 182 ocean catch licence holders and operators (who may traverse survey area).

The PCPFA met with Origin and will continue to distribute Origin’s information and attend further meetings. The VADA have met with Origin and emailed Origin’s information sheet, including diving information, to their members.

**3.2.4 Project Hotline and Dedicated Project Email**

Prominently located on all collateral to encourage questions and feedback are the project contact phone number (1800 797 011) and email address (community.team@originenergy.com.au). These inquiries are managed by the Community Relations Specialist and all contact is recorded in the stakeholder register. These contact details remain the same and in place for all Origin’s marine seismic survey projects and will also be included in local area public signage during the survey.

**3.2.5 Origin Website**

The survey information flyer has been made available on the Origin website (<https://www.originenergy.com.au/about/who-we-are/what-we-do/exploration-production.html>) for all interested members of the public to access. Flyers prepared for future project milestones will also be made available on the website.

**3.3 Stakeholder Engagement Register**

All stakeholder engagement activities, including actions arising and commitments made are recorded and tracked via the stakeholder engagement register that is accessible to the project team.

**3.4 Summary of Stakeholder Consultation**

Stakeholder consultation for the Enterprise 3DTZSS has involved extensive consultation with a broad range of stakeholders, as listed in Table 3.1. The key theme emerging from this consultation for the offshore component of the survey was that of potential issues to southern rock lobsters from the seismic source and the flow on impacts to rock lobster fishers. Table 3.2 outlines the key themes and outcomes from this consultation.

**Table 3.2. Key themes and outcomes from stakeholder consultation**

Theme	Stakeholders involved	Outcomes
Risks of damage to southern rock lobsters and consequent potential loss in rock lobster catches and therefore potential financial losses to rock lobster fishers.	SIV VRLA PCPFA	<p>The results of the Fisheries Research and Development Corporation (FRDC) research results regarding the impacts of seismic surveys on southern rock lobsters were released in mid-October 2016. The fisheries representatives were generally keen to understand the implications of this research for their fishery.</p> <p>Origin’s engagement with SIV and the VRLA has led to the agreement to develop a voluntary Memorandum of Understanding (MoU), including research, compensation and engagement principles.</p> <p>Ultimately, discussions with the SIV, VRLA and the PCPFA have led to several elements of the offshore survey being redesigned, including:</p> <ul style="list-style-type: none"> <li>• The potential for a reduced minimum survey area of 50 km<sup>2</sup>;</li> <li>• Removing the need for fishing exclusion zones, whereby fishing vessels can work within the survey area and lobster pots can be laid within the survey area; and</li> <li>• Moving in a west to east direction for predictability of survey movements.</li> </ul> <p>Establishment of a fisheries compensation framework has been formulated.</p> <p>Origin also commissioned underwater cumulative sound exposure level (CSEL) modelling to assist in determining the <i>affected area</i> for the survey. The result of this modelling are</p>

Theme	Stakeholders involved	Outcomes
		that, except in the shallowest part of the survey area, the CSEL drops below the 183 dB re 1 $\mu\text{Pa}^2 \cdot \text{s}$ (being the CSEL that the FRDC report estimates is the level below which sound is unlikely to impact lobsters) within 110 m of the shot point. In the shallowest part of the survey area (5 m), the cumulative SEL is reached within 160 m of the shot point in the in-line direction and within 260 m in the cross-line direction. The report notes that these ranges are likely to be an over-estimate (e.g., conservative).
Displacement from key fishing grounds, given that smaller vessels are only suitable for nearshore fishing in calm seas (the same conditions as those required for the survey).	SIV VRLA PCPFA	Stakeholders expressed concern about catchability impacts given the survey will be conducted during the fishing season. These discussions have led to several elements of the offshore survey being redesigned, as previously listed.

A complete copy of original communications to and from all stakeholders was provided in the full EP submission to the DEDJTR.

### 3.5 Ongoing Consultation

In accordance with the SEP, Origin will continue engaging with stakeholders after EP approval, in the lead up to, during and at the conclusion of the survey.

#### 3.5.1 Pre-survey Consultation

Consultation post-EP submission and prior to the commencement of the survey includes (but is not limited to):

- Notices in local newspapers about the upcoming survey ('The Warrnambool Standard', 'Cobden Timboon Coast Times' and community newsletter 'The Beacon').
- Signage will be erected at popular shore entry points and popular visitor areas through the project area to keep stakeholders such as fishers, surfers and divers aware of the project (example shown in Photo 3.1). These signs will be small and temporary, similar to other signage along the coast. The signage will include a project map, details regarding timing and duration of the survey and contact details. These temporary signs will be placed in consultation with Parks Victoria Port Campbell office. As such, exact locations for signage are not yet finalised.
- Discussion of fisheries compensation framework and processing of compensation claims with impacted rock lobster fishers;
- A letter drop to residents who live along the roads where seismic activities will occur;
- A public forum session for interested members of the public (one half day session in both Peterborough and Port Campbell, with details of location, date and time to be advised);
- Provision of a project update to key stakeholders regarding acceptance of the EP (including notification that the EP summary is available on the DEDJTR website at <http://earthresources.vic.gov.au/earth-resources-regulation/licensing-and-approvals/petroleum/environment-plan-summaries>); and
- Provision of another project update to key stakeholders two weeks prior to the commencement of the survey to advise them of the planned start date. For some stakeholders, these two communications may be combined, depending on timing of the acceptance of the EP and taking into consideration the Christmas and New Year holidays.



**Photo 3.1.** Example of project signage used at the Port Campbell foreshore during the 2014 Origin Enterprise seismic survey

### 3.5.2 Consultation during Operations

In accordance with the SEP, Origin will continue engaging with stakeholders during survey operations. This will be achieved in the following manner:

- Signage will remain in place for the duration of the survey.
- Origin personnel will be present in the survey area at the peak of the survey. These personnel will be stationed at the key boat ramps throughout the duration of the survey at at key beach locations when the survey is being undertaken nearby.
- Project information flyers will be provided to the Port Campbell Visitor Information Centre, Port Campbell Post Office, Peterborough shops and tourism operators so that interested people can peruse information about the project at their leisure.
- There will also be daily SMS updates (on an 'opt-in' basis) for fishers and other stakeholders who are interested in regular updates on the location and progress of the survey:
  - For fishers, marine activity updates every 2-3 days depending on weather and survey progress (given there will be no displacement of fishing activity, a daily service is considered unnecessary).
  - For tourism operators, local businesses or community members, onshore activity updates when the survey moves to a new patch, or at least every 4-5 days.
- Stakeholders have been informed of the variation to the EP to allow for rope and node retrieval.

### 3.5.3 Post-survey Consultation

Consultation at the completion of the survey includes:

- Notifying all stakeholders of survey completion within 3 days of survey completion.
- Discussions with rock lobster fishers to elicit their views on the success or otherwise of the survey in terms of vessel interactions and impacts to their fishery.

In all circumstances, methods of engagement will include a mix of methods outlined in Section 3.2 depending on the stated method preferred by the stakeholder (e.g., mail or email, phone calls or face-to-face meetings). Origin's Community Relations Specialist remains a presence in the region at all times and is available at short notice to meet with stakeholders face-to-face as required.

The stakeholder engagement register will be continually updated as a 'live' document.

### 3.5.4 Summary of Ongoing Consultation

A summary of the ongoing consultation with key stakeholders relevant to the offshore survey that aligns with the first three elements of the IAP2 spectrum is provided in Table 3.4.

**Table 3.4. Summary of ongoing stakeholder consultation with key stakeholders**

IAP2 element	Who	Details	Timing	Methodology
Inform	All stakeholders	As outlined throughout Section 3.2.	As required.	As required.
Consult	As concerned stakeholders emerge.	As outlined throughout Section 3.2.	As required.	As required.
Involve	Fisheries Victoria	Agree a defined set of 'investigation triggers' regarding changes to abundance of rock lobsters in the Victorian Fishery. Monitoring of stock/abundance levels. Engagement should the investigation triggers be activated.	Ongoing in the lead up to the survey. Annually (at least) to participate in the assessment of the abundance of the rock lobster fishery.	Face-to-face meetings Phone calls Formal letters Emails
	SIV	Development of a MoU that could cover: <ul style="list-style-type: none"> <li>Engagement processes;</li> <li>Approach to tabling, reviewing and interpreting research;</li> <li>Compensation framework (now and future claims);</li> <li>Ongoing monitoring of the rock lobster fishery in Origin seismic survey areas and trigger points for investigation; and</li> <li>Assessment of future research needs.</li> </ul>	Immediately in order to establish the MoU. At least annually thereafter.	Face-to-face meetings Phone calls Formal letters Emails
	VRLA	Involvement with the development of a MoU regarding monitoring of the rock lobster fishery and the process for claims for compensation as per SIV. Discussions regarding ongoing impacts that individual fishers may experience.	Immediately in order to establish the MoU. As required thereafter, in response to contact from the stakeholder, but at least annually.	Face-to-face meetings Phone calls Formal letters Emails

## 3.6 Fisheries Compensation Framework

The primary commercial fishery in the Enterprise 3DTZSS area is southern rock lobster. Origin understands the importance of the fishery to the industry and has engaged with SIV, VRLA, PCPFA



and individual fishers to work with the fishers and to avoid or minimise any disruption and economic impact.

Having initially discussed compensation frameworks with VRLA in May 2015, Origin recommenced consultation in July 2016 with VRLA and PCPFA. Origin's fundamental compensation principle is that commercial fishers should not suffer a detrimental economic loss as a result of its activities. Origin has developed a compensation framework that is responsive to specific feedback from VRLA in October 2016, including a requirement for a fisher claiming compensation for disruption to 'down tools', retire quota and not fish elsewhere during the survey, thereby not displacing other fishers.

To minimise impacts to commercial rock lobster fishers, Origin will work around fishers and there will be no displacement of fishing activity for the Enterprise 3DTZSS. If necessary to avoid any entanglement, Origin may be required to move lobster pot floats when placing equipment, or briefly lift a pot in the event of an entanglement, but Origin will not remove lobster pots.

Notwithstanding there will be no displacement of commercial rock lobster fishing, given the recent release of the research report *Assessing the impact of marine seismic surveys on southeast Australian scallop and lobster fisheries* (FRDC report 2012-008), there remains considerable uncertainty of the impacts of seismic surveys on local rock lobster populations and determining this would require many years of study. Commercial rock lobster fishers have expressed concerns regarding potential impacts on rock lobster population and catchability. Origin recognises these concerns and follows an overriding principle to ensure no commercial rock lobster fishers suffer economic loss due to Origin's activities.

Given the uncertainty, Origin has taken a precautionary approach and has committed to compensate fishers for any immediate or future economic impacts. In addition, to support sustainability, fishers who have a history of fishing in the sound-affected area will have the ability to retire their remaining 2016/2017 season quota that would have been caught in the sound-affected area during the survey and receive compensation for that quota.

In the medium- to long-term, if it is demonstrated that the survey caused or contributed to any actual impact on rock lobster abundance, recruitment or catchability in the sound-affected area, Origin will compensate fishers for any resulting economic loss. Origin has developed a compensation framework for engaging Fisheries Victoria to investigate impacts and Origin will continue to consult with SIV and VRLA, along with individual fishers.

Origin has also proposed development of an MoU with SIV and VRLA to establish an operational framework, as each industry operates in overlapping areas as they access Crown resources. SIV and VRLA have indicated that they agree in principle with that approach.

## 4. Receiving Environment

The acquisition area is located in the Otway marine bioregion (NOO, 2002) as classified by the Interim Marine and Coastal Regionalisation for Australia (IMCRA). This bioregion extends from Cape Otway (Vic) to Cape Jaffa (South Australia) and includes the western islands of Bass Strait such as King Island.

### 4.1 Physical Environment

The physical marine environment of the Otway region is characterised by very steep to moderate offshore gradients, high wave energy and temperate waters subject to upwelling events.

#### 4.1.1 Geomorphology, geology, bathymetry and surficial sediments

The south-eastern section of Australia's continental margin comprises the Otway Shelf and the Bonney Coast, Bass Strait, and the western shelf of Tasmania. The acquisition area is within the 400 km-long Otway Shelf, which lies between 37° and 43.5°S and 139.5°E (Cape Jaffa) and 143.5°E (Cape Otway). The narrowest point is off Portland, where the shelf is less than 20 km wide. It broadens progressively westward, to 60 km off Robe, SA, and eastward to 80 km off Warrnambool (James *et al.*, 2010). The Otway shelf is comprised of Miocene limestone below a thin veneer of younger sediments.

The seabed of the survey acquisition area on a macro-scale to the 25 m isobath is predominantly rocky (limestone) reef interspersed with reef/sediment areas (DPTLI, 2014). Fishing operators within the previous Speculant MSS area, 6 km to the northwest of the acquisition area, advised the seabed to comprise of predominantly rocky substrates with patches of highly mobile sand. The rocky seabed varies substantially in relief with some areas of relatively flat limestone and other areas of crevices, gutters, pillars and overhanging shelves. The Arches Marine Sanctuary, south of Port Campbell, displays vertical relief in seabed features.

Multibeam and Laser Airborne Depth Sounder (LADS) surveys have been conducted previously in the area. Analysis of this data for the Speculant survey shows that from the low tide mark to 5 m depth, the seabed is mainly comprised of rocky reef. In water depths from approximately 10 to 22 m water, the seabed comprises of sand on a sloping gradient and at 24 m the seabed is irregular reef (Origin, 2009).

The coastal geology immediately landward of the acquisition area comprises precipitous or undercut cliffs up to 60 m high of Port Campbell Limestone overlaying the Gellibrand Marl. Strong wave action is very effective in eroding these relatively soft, horizontally bedded rocks, causing development of a deeply indented coastline with narrow, elongated bays and headlands. Shore platforms are poorly developed and beaches are generally narrow. The limestone sea stacks of the Twelve Apostles occur to the east of the acquisition area.

#### 4.1.2 Metocean Conditions

##### Climate

The area is typical of a cool temperate region with cold, wet winters and warm dry summers. The day-to-day variation in weather conditions is caused by the continual movement of the highs from west to east across the Australian continent roughly once every 10 days.

##### Winds

Bass Strait is located on the northern edge of the westerly wind belt known as the Roaring Forties. In winter, when the subtropical ridge moves northwards over the Australian continent, cold fronts generally create sustained west to south-westerly winds and frequent rainfall in the region. In summer, frontal systems are often more shallow and occur between two ridges of high pressure, bringing more variable winds and rainfall.

During the proposed survey period, the average speed is 14 knots and maximum wind speed is 39.7 knots (recorded in December). Wind directions vary from the west-southwest or east-southeast during November and December to a more predominant southeast direction during January and February.

##### Tides

Tides are semi-diurnal with some diurnal inequalities, generating tidal currents along a north-east/south-west axis, with speeds generally ranging from 0.1 to 2.5 m/s. The maximum range of spring tides in western Bass Strait is approximately 1.2 m.

##### Currents

Factors influencing the current flow in the region are tidal forcing, waves, wind and large scale ocean circulation.

Winds tend to be the primary factor driving currents in western Bass Strait, predominantly from west to east. Bottom currents can exceed 0.5 m/s in nearshore areas during storms. Current velocities through Bass Strait are highly correlated with local wind stress. In the Port Campbell area, the predominant south-westerly swell direction means that there are minimal longshore currents as most waves reach the shore parallel to the coast. Therefore, in waters less than 10 m deep, water movements are influenced mainly by orbital motion waves and localised wave-generated currents.

In winter and spring, waters within the strait are well mixed with no obvious stratification, while during summer the central regions of the strait become stratified (RPS APASA, 2015).

### Waves

There are two principal sources of wave energy in the Otway Basin:

- From the westerly swell from the Great Australian Bight and Southern Ocean; and
- From locally generated winds, generally from the west and east.

In-situ wave measurements collected at the Minerva gas field site (as part of the BHP Minerva Project) located 6 km south of the acquisition area, revealed that 2 to 3.5 m waves occur for 50% of the time and waves over 7.6 m in height occur during winter. Close to shore, waves are estimated to break at the 7 m depth contour about 50% of the time.

Analysis of 11 years of wave data (supplied by Geoscience Australia) from near the Speculant survey area (5.5 km to the west of the Enterprise 3DTZSS) has enabled some predictions on expected weather and possible operations windows. Using hindcast wave data, November has the lowest average significant wave height. The average period of consecutive days with wave heights less than 2 m is three days in November; in other months, on average, it is less than two days.

### Sea Temperature

The temperature of surface waters in western Bass Strait ranges from approximately 10 to 18°C over the year. A seasonal thermocline is evident at approximately 30 m water depth in early December. This thermocline migrates deeper to reach approximately 100 m depth in May, when it dissipates through mixing. When the thermocline is established, temperatures in surface waters can be up to 4°C higher than waters below the thermocline.

### Ambient sound levels

Both physical and biological processes contribute to natural background sound. Natural sea sound sources are dominated by wind noise, but also include rain noise, biological noise and the sporadic noise of earthquakes. Man-made underwater sound sources in the region comprise shipping and small vessel traffic, petroleum-production and exploration-drilling activities and sporadic petroleum seismic surveys.

## 4.2 Coastal Environments

The description of the coastline is discussed moving from west to east, from the western edge of the Bay of Islands Coastal Park (approximately 30 km northwest of the acquisition area) to Glenaire (approximately 40 km southeast of the acquisition area).

The Bay of Islands Coastal Park and Port Campbell National Park coastline is dominated by inter-tidal shore platforms backed by rocky cliffs and sub-tidal reefs, interspersed with small sections of sandy beach. Sections of this shoreline contain hooded plover habitat and little penguin colonies.

The Port Campbell National Park (PCNP) coastline includes the townships (and ports) of Peterborough and Port Campbell. Peterborough lies on Curdies Inlet (intermittently open) which is an important shorebird habitat (including Australasian and Little Bitterns) and estuarine fish habitat. Shoreline limestone rock formations, such as the Grotto, London Bridge and the Twelve Apostles (located in the Twelve Apostles Marine National Park) are popular tourist attractions with nearby cliff top viewing platforms. Shearwater colonies are also present along this section of coastline. The Gellibrand River estuary (intermittently open) provides an important shorebird habitat and estuarine fish habitat. The immediate area offshore consists predominantly of reef and mixed reef/sediment.

The Great Otway National Park coastline to Glenaire consists predominantly of rocky intertidal platforms, particularly around Moonlight Head and Cape Volney which accommodates Australian fur seal colonies. East of this point the coastline is dominated by long stretches of sandy beach interspersed with intertidal rocky shores and sub-tidal rocky reefs.

### 4.3 Conservation Values and Sensitivities

The conservation values and sensitivities in and around the acquisition area are briefly described in this section.

#### 4.3.1 Victorian Protected Areas (Marine)

Victoria has a representative system of 13 Marine National Parks and 11 Marine Sanctuaries established under the *National Parks Act 1975* (Vic). Conservation values located in the vicinity of the acquisition area (Figure 4.1) include:

- Twelve Apostles Marine National Park - located 600 m east of the acquisition area;
- Port Campbell National Park - located on the coast immediately adjacent to the marine survey area;
- The Arches Marine Sanctuary - located immediately adjacent to the survey acquisition area;
- Bay of Islands Coastal Park - located on the coast immediately adjacent to the marine survey area;
- Merri Marine Sanctuary - located 37 km northwest of the acquisition area; and
- Great Otway National Park – located 11 km southeast of the acquisition area. Park boundaries include lands from the low water mark inland.

##### **Twelve Apostles Marine National Park**

The Twelve Apostles Marine National Park (75 km<sup>2</sup>) is located 7 km east of Port Campbell and covers 16 km of coastline from east of Broken Head to Pebble Point to an offshore limit of 5.5 km. The area is representative of the Otway Bioregion and is characterised by a submarine network of towering canyons, caves, arches and walls with a large variety of seaweed and sponge gardens plus resident schools of reef fish.

The park includes large sandy sub-tidal areas consisting of predominantly fine sand with some medium to coarse sand and shell fragments. These sandy expanses record high number of smaller animals such as worms, small molluscs and crustaceans; larger animals are less common.

##### **The Arches Marine Sanctuary**

The Arches Marine Sanctuary protects 45 ha of ocean directly south of Port Campbell. Located 5 to 25 m below the water surface is a labyrinth of limestone canyons, caves, arches and walls characterised by high-energy waves.

The complex limestone structures provide a foundation for seaweeds and sponges to grow on. A diverse array of life including sponges, bryozoans and sea stars exist in the sanctuary, with the upper side of the structures covered in the thick, brown kelp (*Ecklonia radiata*) with an understory of delicate red algae. The sanctuary has a very low abundance of sessile invertebrates. Sea stars are the dominant mobile invertebrates in the sanctuary and include *Nectria macrobrachia*, *Nepanthiaroughtoni* and *Tosia magnifica*. These habitats support schools of reef fish, seals and a range of invertebrates such as lobster, abalone and sea urchins.

##### **Merri Marine Sanctuary**

Merri Reefs Marine Sanctuary (25 ha) is located at the mouth of the Merri River, west of Warrnambool Harbour. Merri Marine Sanctuary contains a mixture of habitats, including intertidal reef, sand, shallow reef and rocky overhang. These areas provide a nursery for many fish species and a habitat for many algae species, hardy invertebrates and shorebirds. Bottlenose dolphins and fur seals are regular visitors to the shore.

#### 4.3.2 Victorian Protected Areas (Terrestrial)

##### **Port Campbell National Park**

The PCNP covers approximately 27 km of coastline stretching from the eastern side of Curdies Inlet (at Peterborough) to Princetown, covering 1,830 ha. Port Campbell National Park is world famous for its extraordinary collection of wave-sculpted rock formations and the Twelve Apostles that can be seen from the park.

Loch Ard Gorge, site of the 19th century shipwreck *Loch Ard*, as well as the Island Archway and London Bridge (which collapsed in 2009) are other features of the park. This park protects the terrestrial environment above the low water mark of this coastline.

##### **Bay of Islands Coastal Park**

This coastal park has outstanding ocean views and geological features and covers an extensive area of the coastline (~32 km in length and 950 ha), stretching from east from Warrnambool to Peterborough. Sheer cliffs and rock stacks dominate the bays, and heathlands contain wildflowers. This park protects the terrestrial environment above the low water mark of this coastline.

**Great Otway National Park**

The Great Otway National Park (103,185 ha) is located near Cape Otway and stretches from the low water mark inland on an intermittent basis from Princetown to Apollo Bay (approximately 100 km).

Landscapes within the park are characterised by tall forests and hilly terrain extending to the sea with cliffs, steep and rocky coasts, coastal terraces, landslips, dunes and bluffs, beaches and river mouths. There is a concentration of archaeological sites along the coast, coastal rivers and reefs. The park contains many sites of international and national geological and geomorphological significance including Dinosaur Cove (internationally significant dinosaur fossil site), Lion Headland and Moonlight Head to Milanesia Beach (internationally significant coastal geology and fossils).

The park provides habitats for the conservation of the rufous bristlebird, hooded plover, white-bellied sea eagle, fairy tern, caspian tern and Lewin’s rail and native fish such as the Australian grayling.

The park contains shell middens along the coast and several shipwreck features. This park protects the terrestrial environment above the low water mark of this coastline.

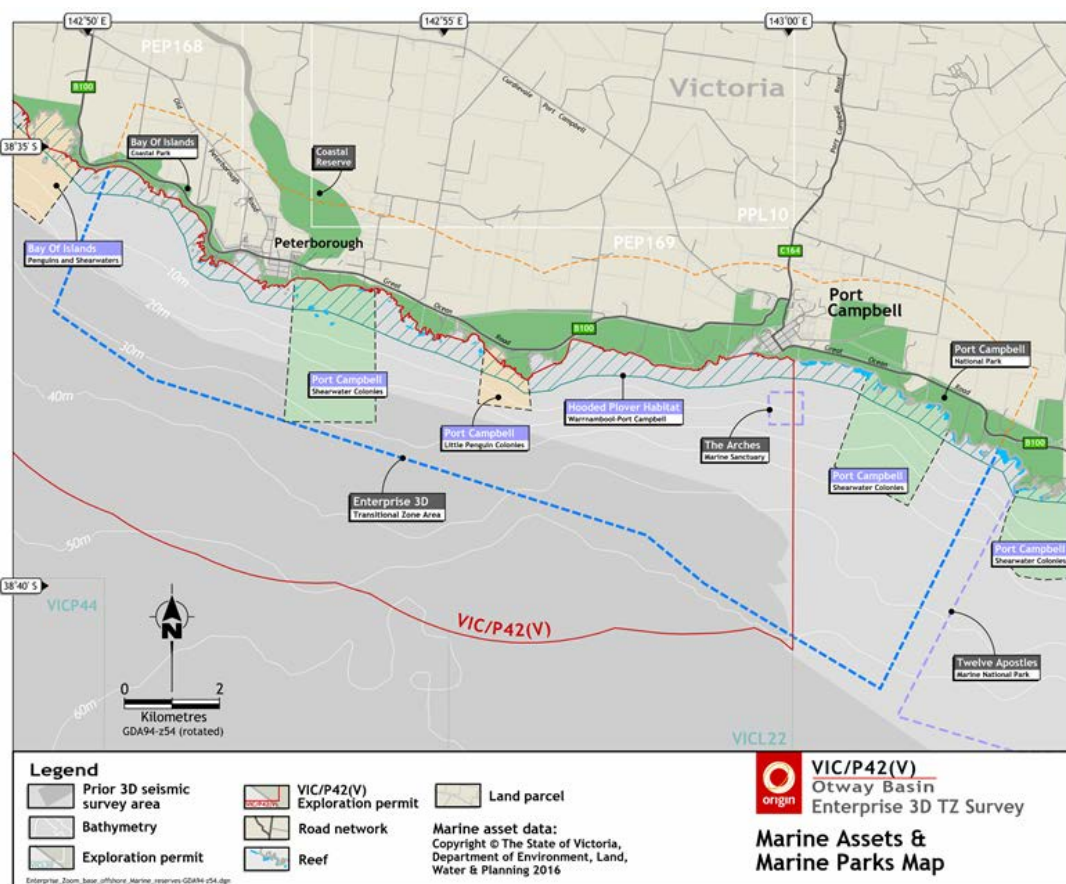


Figure 4.1. Conservation values in and around the survey area

4.3.3 Commonwealth Marine Reserves

The acquisition area is located within the South-east Commonwealth Marine Reserves Network, which was established to represent the various seafloor features of the region.

The nearest CMRs (as illustrated in Figure 4.2) are:

- Apollo CMR - approximately 49 km to the southeast; and
- Zeehan CMR - approximately 123 km to the south.

These CMRs will not be affected by the Enterprise 3DTZSS.

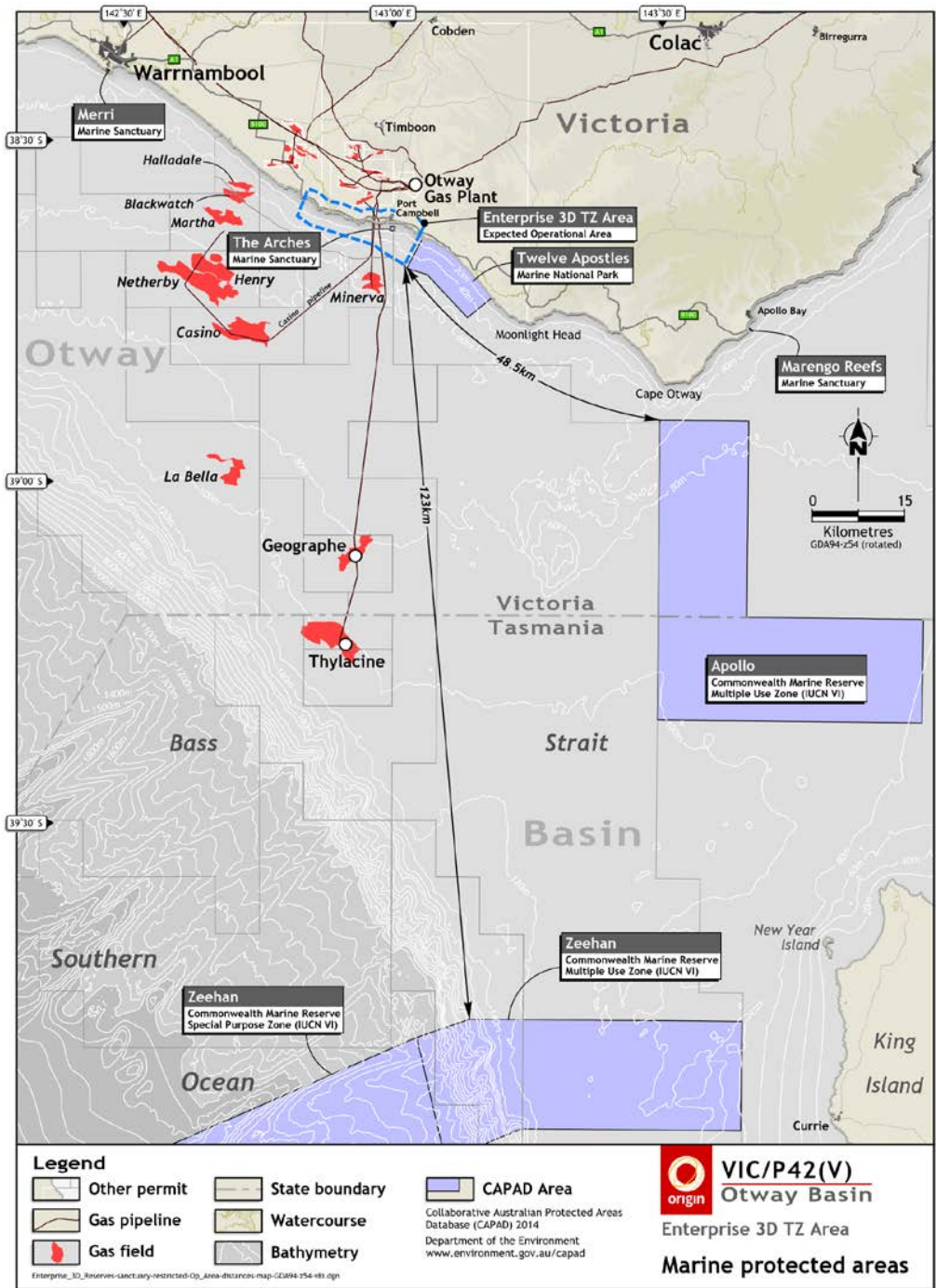


Figure 4.2. Marine protected areas in the vicinity of the acquisition area

4.3.4 Commonwealth Heritage List

There are no marine or coastal places on the Commonwealth Heritage list in the vicinity of the acquisition area.

4.3.5 World Heritage Properties

There are no World Heritage Properties in the vicinity of the acquisition area.

#### 4.3.6 National Heritage Places

The nearest places of National Heritage to the acquisition area are all located onshore and do not have marine or coastal components.

#### 4.3.7 Wetlands of International Importance

There are no marine or coastal Wetlands of International Importance (Ramsar-listed wetlands) in the vicinity of the acquisition area.

### 4.4 Key Ecological Features

The National Conservation Values Atlas maintained by the DoE provides details on the presence of Key Ecological Features (KEF) within or in proximity to the survey acquisition area. KEFs are elements of the Commonwealth marine environment that based on current scientific understanding, are considered to be of regional importance for either the region's biodiversity or ecosystem function and integrity.

The National Conservation Values Atlas indicates that the acquisition area does not intersect any KEF. The closest KEFs to the acquisition area are the Bonney Upwelling and the West Tasmanian Marine Canyons, approximately 65 km (35 nm) northwest and 72 km (39 nm) southwest from the closest point of the acquisition area respectively.

### 4.5 Biological Environment

Literature, online resources and databases have been reviewed to identify and assess flora and fauna species known to be present and potentially present within the survey area and surrounds. The following information sources were reviewed to collate this listing:

- The DELWP native Vegetation Information Management (NVIM) Tool and Biodiversity Interactive Map (DELWP website) for rare or threatened species habitats;
- The Victorian Biodiversity Atlas (DELWP website);
- The DoEE Protected Matters Search Tool (PMST) for matters of national environmental significance (MNES) protected under the *Environment Protection and Biodiversity Conservation Act 1999*;
- Relevant listings under the Victorian *FFG Act 1988*; and
- Relevant environmental guidelines and publically available scientific literature on individual species.

#### 4.5.1 Benthic habitats and species assemblages

The survey area lies in the 'shallow shelf' depth zone, which consists of exhumed limestone substrates that host encrusting mollusc, sponge, bryozoan and red algae assemblages.

The dominant benthic habitat throughout the acquisition area is rocky (limestone) reef interspersed with reef/sediment areas. Benthic communities associated with hard limestone substrates are comprised of sponges, encrusting and branching coralline algae, poysonellid algae, bryozoa, benthic forams, robust sarpullds, brachiopods, bivalves, gastropods, fleshy red algae and kelp.

Demersal fishes likely to be associated with carbonate sands on the inner shelf include eastern stargazer (*Kathetostoma laeve*), elephant shark (*Callorhynchus millii*), greenback flounder (*Rhombosolea taoarina*), gummy shark (*Mustelus antarcticus*), long-snouted flounder (*Ammotretis rostratus*), saw shark (*Pristiophorus nudipinnis*), southern sand flathead (*Platycephalus bassensis*) and southern school whiting (*Sillago bassensis*). The distribution of fish fauna is governed by biologically formed habitat structure as well as by food. Fish assemblages typically begin to change at depths greater than 20 m, with the loss of the kelp-associated wrasses and leatherjackets, and the appearance of deeper water fishes such as boarfishes (family Pentacerotidae), splendid perch (*Callanthias australis*) and banded seaperch (*Hypoplectrodes nigroruber*). Schools of barber perch (*Caesioperca razor*) are replaced by the related butterfly perch (*Caesioperca lepidoptera*). While fish present on shallow subtidal reefs include algavores, omnivores and carnivores, those on deep reefs are typically carnivorous as algae are typically not abundant at depth.

#### 4.5.2 Plankton

The seasonal Bonney Coast upwelling contributes to locally productive pelagic habitats that exhibit a range of zooplankton such as copepods, decapods, krill and gelatinous zooplankton. Of particular importance in the region is the coastal krill, *Nyctiphanes australis*, which swarms throughout the water

column of continental shelf waters primarily in summer and autumn, feeding on microalgae and providing an important link in the blue whale food chain.

#### 4.5.3 Invertebrates

The marine invertebrates in the region include Porifera (e.g., sponges), cnidarians (e.g., jellyfish, corals, anemones, seapens), bryozoans (microscopic filter feeders), arthropods (e.g., sea spiders), crustaceans (e.g., rock lobster, krill), molluscs (e.g., bivalves, sea slugs, gastropods, abalone); echinoderms (e.g., urchins, sea cucumbers) and annelids (e.g., polychaete worms).

#### 4.5.4 Fish

Fish species present in the area are either pelagic, residing in the water column, or demersal (benthic) fish. Fish species inhabiting the region are largely cool temperate species, common within the South Eastern Marine Region.

Studies of the subtidal reefs of the Arches Marine Sanctuary have observed sea sweep (*Scorpius aequipinnis*), barber perch (*Caesioperca razor*), blue throat wrasse (*Notolabrus tetricus*), bastard trumpeter (*Latridopsis forsteri*), magpie perch (*Cheilodactylus nigripes*) and the dusky morwong (*Dactylophora nigricans*). Other common fish species that have been reported from this sanctuary include the zebra fish (*Girella zebra*), snapper (*Chrysophrys auratus*), marble fish (*Aplodactylus arctidens*), Australian salmon (*Arripis truttacea*), scaly fin (*Parma victoriae*) and Port Jackson shark (*Heterodontus portusjacksoni*).

Additional subtidal reef fish recorded in the Twelve Apostles Marine National Park include rosy wrasse (*Pseudolabrus psittaculus*), senator wrasse (*Pictilabrus laticlavus*), butterfly perch (*Cheilodactylus lepidoptera*), marble fish (*Aplodactylus arctidens*), bullseye (*Pempheris multiradiata*) and blue morwong (*Nemadactylus valenciennesi*).

Marine fish species that have a conservation listing and that may occur in around the survey area are listed in Table 4.1 and described further within this section. Important commercial fish species are described in Section 4.7.4.

**Table 4.1. FFG and EPBC Act-listed fish species that may occur in and around the survey area**

Common name	Species name	EPBC Act status			EPBC Type of presence	FFG Act	
		Listed threatened	Listed migratory	Listed marine		Listed	Conservation Status
Great white shark	<i>Carcharodon carcharias</i>	V	M	-	SHK	L	V
Porbeagle, mackerel shark	<i>Lamna nasus</i>	-	M	-	SHL	-	-
Australian grayling	<i>Prototroctes maraena</i>	V	-	-	SHL	L	V
Dwarf Galaxias	<i>Galaxiella pusilla</i>	V	-	-	SHL	L	V
Pipefish and seahorses	27 species	-	-	L	SHM	-	-

SHM: Species or species habitat may occur within area.

SHL: Species or species habitat likely to occur within area.

SHK: Species or species habitat known to occur within area

Definitions (these apply to each of the forthcoming tables)

Listed threatened species:	A native species listed (L) under the Victorian FFG Act (Section 10) or Commonwealth EPBC Act (Section 178). Extinct (Ex), regionally extinct (RE), extinct in the wild (EW), critically endangered (CE), endangered (E), vulnerable (V), conservation dependent (CD), near threatened (NT) or Data Deficient (DD).
Listed migratory species:	A migratory (M) species included in the appendices to the Bonn Convention and the annexes of JAMBA, CAMBA and ROKAMBA, as listed in Section 209 of the EPBC Act.
Listed marine species:	As listed in Section 248 of the EPBC Act.



### Great White Shark

The great white shark (*Carcharodon carcharias*) is widely distributed and located throughout temperate and sub-tropical waters with their known range in Australian waters including all coastal areas except the Northern Territory. Studies of great white sharks indicate that they are largely transient. However, individuals are known to return to feeding grounds on a seasonal basis. Observations of adult sharks are more frequent around fur seal and sea lion colonies, several hundred kilometres from the survey area, with the closest area being Portland (approximately 105 km west of the acquisition area).

### Porbeagle shark

The porbeagle shark (*Lamna nasus*) is widely distributed in the southern waters of Australia including Victorian and Tasmanian waters. The species preys on bony fishes and cephalopods, and is an opportunistic hunter that regularly moves up and down in the water column, catching prey in mid-water as well as at the seafloor. It also conducts long-distance seasonal migrations, generally shifting between shallower and deeper water.

### Australian grayling

The Australian grayling (*Prototroctes maraena*) is a dark brown to olive-green fish attaining 19 cm in length. The species typically inhabits the coastal streams of New South Wales, Victoria and Tasmania, migrating between streams and the ocean. Spawning occurs in freshwater from late summer to winter caused by an increase in river flows from seasonal rains. Most of its life is spent in fresh water, with parts of the larval or juvenile stages spent in coastal marine waters (approximately 6 months), though its precise marine habitat requirements remain unknown.

### Dwarf galaxias

Habitat suitable to the dwarf galaxias is slow flowing and still, shallow, permanent and temporary freshwater habitats such as swamps, drains and the backwaters of streams and creeks, often (but not always) containing dense aquatic macrophytes and emergent plants. Given the marine nature of this survey, this species will not be encountered.

### Sygnathids

Most of the marine ray-finned fish species identified in the EPBC Act PMST are sygnathiformes, which includes seahorses and their relatives (seadragon, pipehorse and pipefish). The majority of these fish species are associated with seagrass meadows, macroalgal seabed habitats, rocky reefs and sponge gardens located in shallow, inshore waters (e.g., protected coastal bays, harbours and jetties) less than 50 m deep. They are sometimes recorded in deeper offshore waters, where they depend on the protection of sponges and rafts of floating seaweed such as *Sargassum*.

The PMST species profile and threats profiles indicate that the sygnathiforme species listed for the acquisition area are widely distributed throughout southern, south-eastern and south-western Australian waters. The diverse range of ecological niches afforded by the patch reefs across the survey area would be expected to provide suitable habitat for these listed species, so these species may be present in the acquisition area.

#### 4.5.5 Cetaceans

Table 4.2 lists the species of cetaceans identified in Commonwealth and Victorian databases as having a possible presence within the acquisition area and surrounds. Details of these cetaceans are discussed further in this section.

**Table 4.2. FFG and EPBC Act-listed cetacean species that may occur in and around the survey area**

Common name	Species name	EPBC Act status			EPBC Type of presence	FFG Act Status	
		Listed threatened	Listed migratory	Listed marine		Listed	Conservation Status
<b>Whales</b>							
Dwarf minke whale	<i>Balaenoptera acutorostrata</i>	-	M	L	SHM	-	-
Antarctic minke whale	<i>B. bonaerensis</i>	-	M	L	-	-	-
Sei whale	<i>B. borealis</i>	V	M	L	-	-	DD

Common name	Species name	EPBC Act status			EPBC Type of presence	FFG Act Status	
		Listed threatened	Listed migratory	Listed marine		Listed	Conservation Status
Blue whale	<i>B. musculus</i>	E	M	L	FK	L	CE
Bryde's whale	<i>B. edeni</i>	-	M	L	SHM	-	DD
Fin whale	<i>B. physalus</i>	V	M	L	-	-	DD
Pygmy right whale	<i>Caperea marginata</i>	-	M	L	SHM	-	-
Southern right whale	<i>Eubalaena australis</i>	E	M	L	B	L	CE
Southern bottlenose whale	<i>Hyperoodon planifrons</i>	-	-	L	-	-	-
Humpback whale	<i>Megaptera novaeangliae</i>	V	M	L	SHL	L	V
Sperm Whale	<i>Physeter macrocephalus</i>	-	M	L	-	-	-
Shepherd's beaked whale	<i>Tasmacetus shepherdi</i>	-	-	L	-	-	-
<b>Dolphins</b>							
Common dolphin	<i>Delphinus delphis</i>	-	-	L	SHM	-	-
Risso's dolphin	<i>Grampus griseus</i>	-	-	L	SHM	-	-
Long-finned pilot	<i>Globicephala melas</i>	-	-	L	-	-	-
Dusky dolphin	<i>Lagenorhynchus obscurus</i>	-	M	L	SHM	-	-
Southern right whale dolphin	<i>Lissodelphis peronii</i>	-	-	L	-	-	-
Killer whale, orca	<i>Orcinus orca</i>	-	M	L	SHM	-	-
Indian Ocean bottlenose dolphin	<i>Tursiops aduncus</i>	-	-	L	SHL	-	-
Bottlenose dolphin	<i>Tursiops truncatus</i>	-	-	L	SHM	-	-

SHM: Species or species habitat may occur within area.

SHL: Species or species habitat likely to occur within area.

SHK: Species or species habitat known to occur within area.

FK: Foraging, feeding or related behaviour known to occur within area.

B: Breeding known to occur in area

The species listed as threatened in Table 4.2 are briefly described herein.

### Blue whale

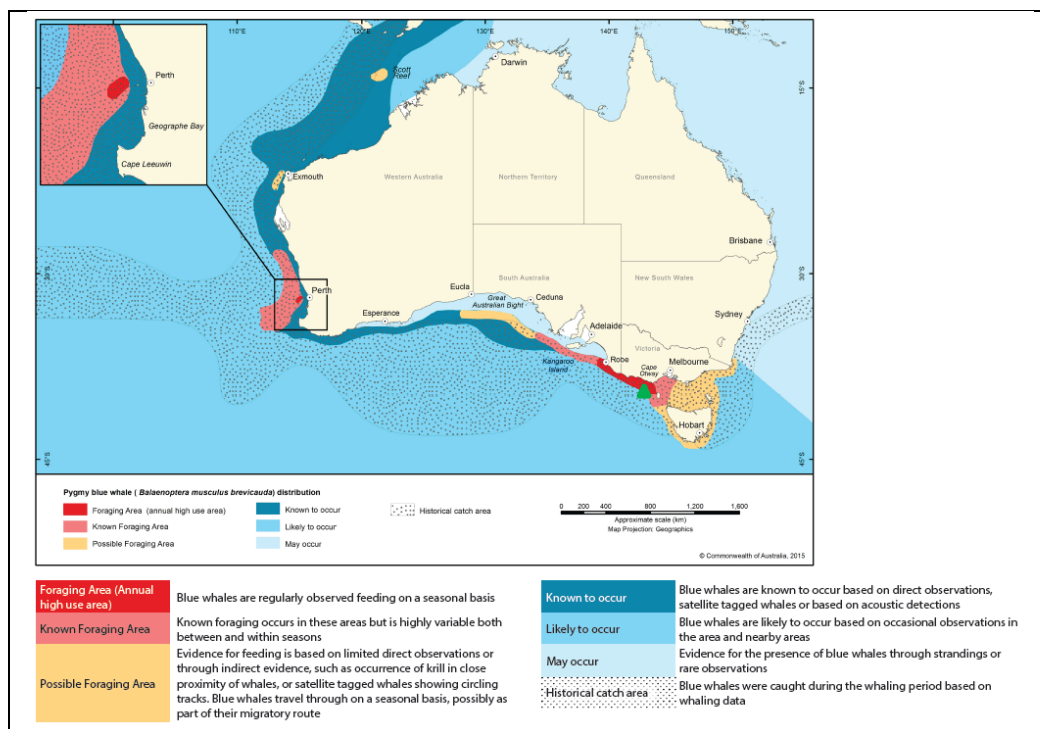
The blue whale is a cosmopolitan species, found in all oceans except the Arctic, but absent from some regional seas such as the Mediterranean, Okhotsk and Bering seas. There are two recognised subspecies of blue whale in Australian waters; the true blue whale (*Balaenoptera musculus intermedia*) and the pygmy blue whale (*B. musculus breviceauda*). The pygmy blue whale is mostly found north of 55°S, while true blue whales are mainly sighted south of 60°S.

Pygmy blue whales are most abundant in the southern Indian Ocean on the Madagascar plateau, and off South Australia and Western Australia, where they form part of a more or less continuous distribution from Tasmania to Indonesia (Figure 4.3). Acoustic monitoring has found the presence of true blue whales in the Otway region to be rare. Both sub-species of blue whale may, however, be found in Australian waters and reference to blue whale unless otherwise specified is synonymous to both species.

Bass Strait is considered to be a migratory corridor for blue whales, as confirmed by passive acoustic monitoring and aerial surveys conducted by Origin during its prior activities in the region. The migratory period for the blue whales into Bass Strait generally commences in November or December. There had been fewer than 50 sightings of blue whales in Bass Strait up to the year 1999, but since that time feeding blue whales have been more regularly observed in the Discovery Bay area (140 km west-northwest of the acquisition area) and more generally along the Bonney coast from Robe to Cape Otway.

The time and location of the appearance of blue whales in the east generally coincides with the upwelling of cold water in summer and autumn along this coast (the Bonney Upwelling) and the associated aggregations of krill that they feed on. The Bonney Upwelling generally starts in the eastern part of the Great Australian Bight in November or December and spreads eastwards to the Otway Basin around February as southward migration of the subtropical high pressure cell creates upwelling favourable winds.

Figure 4.4 illustrates the recorded pygmy blue whale distribution around Australia and identifies that the Otway region is a Biologically Important Area (BIA) for foraging according to the DoEE's National Conservation Values Atlas. The Enterprise 3DTZSS acquisition area lies within a 'Foraging Area (annual high use area)' which aligns with the important area for foraging in the National Conservation Values Atlas.

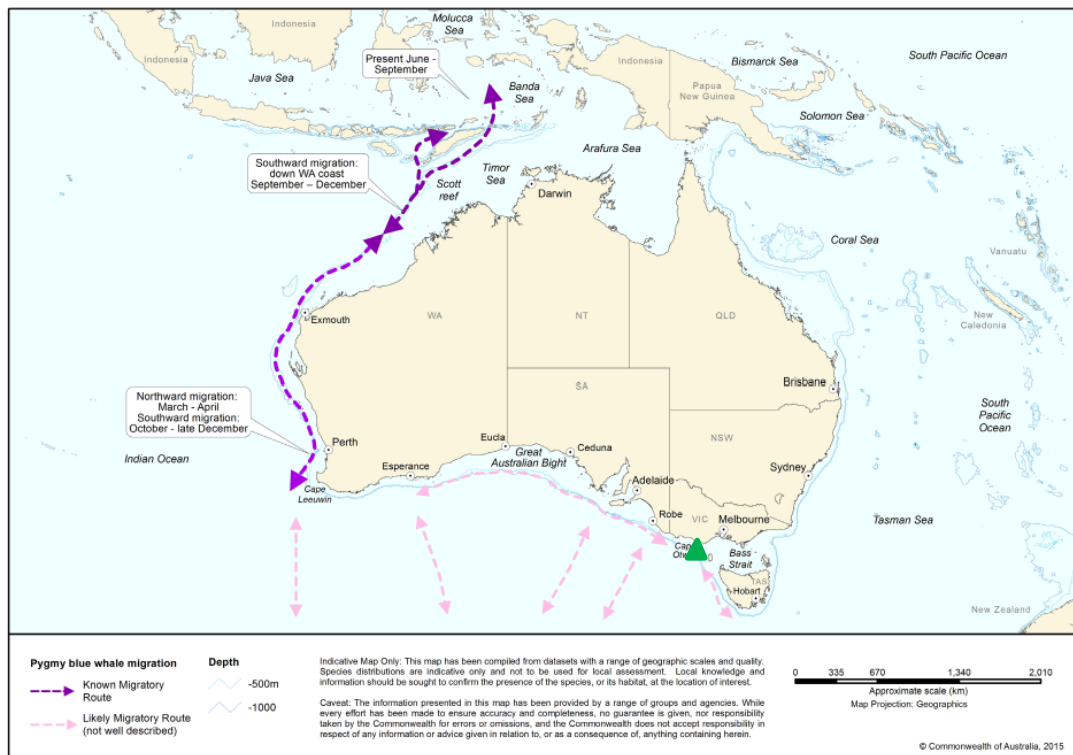


Source: DoE (2015). The green triangle represents the approximate survey area.

**Figure 4.3. Pygmy blue whale distribution around Australia**

Seasonal aerial surveys for blue whales undertaken between Cape Jaffa and Cape Otway over six seasons (2001-02 to 2006-07) found that the general pattern of seasonal movement of blue whales is from west to east, with whales foraging in between the Great Australian Bight and Cape Nelson in November and spreading further east in December.

It is possible that blue whales may be present in the deeper waters of the acquisition area during survey activities. The likelihood and extent of the interaction is dependent on broad scale environmental factors affecting the abundance and distribution of blue whale feeding resources.



Source: DoE (2015). The green triangle represents the approximate survey area.

**Figure 4.4. Pygmy blue whale distribution around Australia**

### Southern right whale

Southern right whales (*Eubalaena australis*) are distributed in the southern hemisphere with a circumpolar distribution between latitudes of 16°S and at least 65°S. The species is pelagic in summer foraging in the open Southern Ocean between 40° and 65°S and migrates from the subantarctic to lower latitude coastal waters during winter to calve and mate. The distribution in winter, at least of the breeding component of the population, is concentrated near coastlines in the northern part of the range.

The estimated pre-whaling population of 55,000-70,000 and is estimated to have been depleted to a low of about 300 animals by the 1920s. The population is estimated to be higher now than it was three generations ago (87 years, assuming a generation time of 29 years).

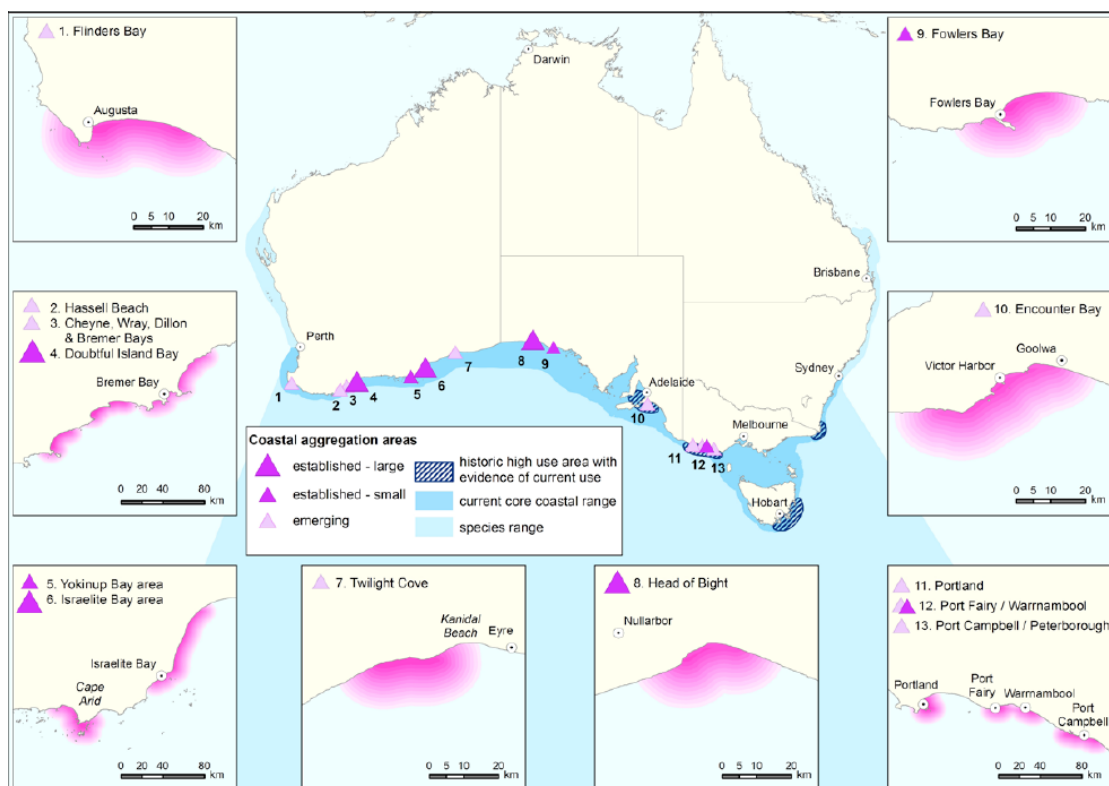
Major current breeding areas are nearshore off southern Australia, New Zealand, Atlantic coast of South America (Argentina and Brazil), and southern Africa (mainly South Africa). The species are regularly present on the Australian coast during winter and spring.

Peak periods for mating in Australian coastal waters are from mid-July through August. Pregnant females generally arrive during late May/early June and calving/nursery grounds are generally occupied until October (occasionally as early as April and as late as November), but not at other times. Calving takes place very close to the coast in Australia, usually in waters less than 10 metres deep.

Female southern right whales show calving site fidelity, generally returning to the same location to give birth and nurse offspring. Female-calf pairs generally stay within the calving ground for 2 to 3 months. Other population classes stay in coastal areas for shorter and more variable periods, and generally depart the coast earlier than female-calf pairs (most have left by September) (DSEWPC, 2012a).

Southern right whales generally occur within two kilometres of the shore and tend to be distinctly clumped in aggregation areas (DSEWPC, 2012a). An aggregation area occurs at Logan's Beach off Warrnambool (36 km northwest of the survey area). A number of additional areas for southern right

whales are emerging that might be of importance, particularly to the south-eastern population. In these areas, small but growing numbers of non-calving whales regularly aggregate for short periods of time. These areas include coastal waters off Peterborough, Port Campbell, Port Fairy and Portland in Victoria (Figure 4.5).



Source: DSEWPC (2012a).

**Figure 4.5. Aggregation areas for southern right whales**

Southern right whales in Australian waters were, until recently, considered to be one population. It is possible that south-east Australian right whales may be demographically separate from those in south-west Australia, although some genetic transfer is known to occur. The 'western' Australian sub-population occupies areas between Cape Leeuwin in Western Australia and Ceduna in South Australia, with an estimated population size of 2,500 individuals. The 'eastern' sub-population, consisting of fewer than 300 individuals, can be found along the south eastern coast, including Tasmania and rarely further north than Sydney. Despite the 'western' sub-population showing signs of recovery, the 'eastern' sub-population is not.

The closest known calving/nursery grounds to the acquisition area occur at Logan's Beach off the coast of Warrnambool in southwest Victoria (approximately 36 km northwest of the closest point of the acquisition area) and intermittently at Portland (106 km west-northwest of the acquisition area). The acquisition area lies within the potential emerging aggregation area at Port Campbell and, while the area is currently located outside the current biologically important area (BIA) for feeding, breeding or aggregation, it does lie in the BIA for migration (& resting on migration) present in all Victorian State waters identified in the National Conservation Values Atlas (Figure 4.6).

The foraging ecology of southern right whales is poorly understood and observations of feeding whales are rare. Coastal Australian waters are not generally used for feeding. Likely foraging grounds for southern right whales that breed and or calve in Australia and New Zealand have been identified as:

- The Naturaliste Plateau off south-west Western Australia, where southern right whales were historically whaled in the Austral summer (Townsend, 1935);
- The Subtropical Front (Childerhouse *et al.*, 2010; Bannister, 2001), an area of high of elevated primary production (Moore and Abbott, 2000) which typically occurs between latitudes 39°-42°S; and
- Antarctic waters.



Source: National Conservation Values Atlas. The magenta rectangle represents the survey area.

**Figure 4.6. BIA for the southern right whale**

As a highly mobile migratory species, southern right whales travel thousands of kilometres between habitats used for essential life functions. Movements along the Australian coast are reasonably well understood, but little is known of migration travel, non-coastal movements and offshore habitat use.

A defined near-shore coastal migration corridor is unlikely given the absence of any predictable directional movement of southern right whales such as that observed for humpback whales. A predominance of westward movements amongst long-range photo-identification re-sightings may indicate a seasonal westward movement in coastal habitat.

On the Australian coast, individual southern right whales use widely separated coastal areas (200 to 1,500 km apart) within a season, indicating substantial coast-wide movement. The longest movements are undertaken by non-calving whales, though calving whales have also been recorded at locations up to 700 km apart within a single season. Such movements indicate that connectivity of coastal habitat is important for southern right whales. Both non-calving and calving whales also move occasionally between Australia and sub-Antarctic New Zealand coastal habitat between years. The winter distribution of whales not appearing on the Australian coast is unknown. It is thought that fewer than 10% of females calving on the coast in any one year use the waters off Victoria, South Australia, NSW and Tasmania. Southern right whales are thought to be solitary during migration, or accompanied by a dependent calf or occasionally a yearling offspring.

The proposed timing of the Enterprise 3DTZSS significantly reduces the likelihood of encountering southern right whales by avoiding peak times for coastal migration and inshore nursing.

### Humpback whale

Humpback whales (*Megaptera novaeangliae*) are present around the Australian coast in winter and spring. Humpbacks undertake an annual migration between the summer feeding grounds in Antarctica to their winter breeding and calving grounds in northern tropical waters. Along the southeast coast of Australia, the northern migration starts in April and May while the southern migration peaks through the area around November and December (DEH, 2005b). A discrete population of humpback whales has been observed to migrate along the west coast of Tasmania and through Bass Strait. The exact timing of the migration period varies between years in accordance with variations in water temperature, extent of sea ice, abundance of prey, and location of feeding grounds. Feeding occurs where there is a high krill density, and during the migration this primarily occurs in Southern Ocean waters south of 55°S.

The waters of western Bass Strait are not known feeding, resting or calving grounds for humpback whales, although feeding may occur opportunistically where sufficient krill density is present. The nearest area to the survey representing important resting area for migrating humpback whales is Twofold Bay, a resting area off the NSW coast approximately 640 km to the northeast of the acquisition area.

The acquisition area is located close to shore and west of the humpbacks' normal summer migration route. During Origin's Enterprise 3DTZSS undertaken during early November 2014 (adjacent to this

proposed acquisition area), 16 humpback whales were sighted. As such, it is possible that low level encounter may occur if the survey is undertaken during November/December.

The recovery of humpback whale populations following whaling has been rapid. The Australian east coast humpback whale population, which was hunted to near-extinction in the 1950s and early 1960s, had increased to 7,090±660 (95% CI) whales by 2004 with an annual rate of increase of 10.6±0.5% (95% CI) between 1987–2004 (Noad *et al.*, 2011). The available estimates for the global population total more than 60,000 animals, and global population is categorised on the IUCN Red List as Least Concern.

#### **Sei whale**

The sei whale has been infrequently recorded between November and May (but not during April) during aerial surveys in the region. This species is listed as vulnerable and migratory under the EPBC Act. There are no known mating or calving areas in Australian waters. Sei whales are considered a cosmopolitan species, ranging from polar to tropical waters, but tend to be found more offshore than other species of large whales. They show well defined migratory movements between polar, temperate and tropical waters. Migratory movements are essentially north-south with little longitudinal dispersion.

Sei whales move between Australian waters and Antarctic feeding areas, sub-Antarctic feeding areas (e.g., Subtropical Front), and tropical and subtropical breeding areas. The proportion of the global population in Australian waters is unknown as there are no estimates for sei whales in Australian waters.

Sei whales feed intensively between the Antarctic and subtropical convergences and mature animals may also feed in higher latitudes. Sei whales feed on planktonic crustacea, in particular copepods and amphipods. Below the Antarctic convergence sei whales feed exclusively upon Antarctic krill (*Euphausia superba*).

Based upon the species preference for offshore waters, the nearshore location of the acquisition area and the absence of sei whales observed during the 2010 Speculant or the Enterprise (2014) surveys, it is considered unlikely that this species will be encountered during the Enterprise 3DTZSS.

#### **Fin whale**

The fin whale has been infrequently recorded between November and Feb during aerial surveys in the region. This species is listed as vulnerable and migratory under the EPBC Act.

Fin whales are considered a cosmopolitan species and occur from polar to tropical waters, and are rarely in inshore waters. They show well defined migratory movements between polar, temperate and tropical waters. Migratory movements are essentially north-south with little longitudinal dispersion. Fin whales regularly enter polar waters. Unlike blue whales and minke whales, fin whales are rarely seen close to ice, although recent sightings have occurred near the ice edge of Antarctica.

There are stranding records of this species from most Australian states, but they are considered rare in Australian waters. Based upon the species preference for offshore waters, the nearshore location of the acquisition area and the absence of fin whale species observed during the 2010 Speculant survey or the Enterprise MSS (2014), it is considered unlikely that this species will be encountered during the Enterprise 3DTZSS.

#### **Dolphins**

Encounter with bottlenose and common dolphins species is likely during the Enterprise 3DTZSS, and unlikely for the remaining species listed in Table 4.2.

## 4.5.6 Pinnipeds

Table 4.3 lists the two pinniped species that may occur within or around the acquisition area, and are briefly described herein.

**Table 4.3. EPBC Act-listed pinniped species that may occur in or around the survey area**

Common name	Species name	EPBC Act status			Likely presence	FFG Act Status	
		Listed threatened	Listed migratory	Listed marine		Listed	Conservation Status
New Zealand fur seal	<i>Arctocephalus forsteri</i>	-	-	L	SHM	-	V
Australian fur seal	<i>A. pusillus</i>	-	-	L	SHM	-	-

SHM: Species or species habitat may occur within area.

#### Australian fur seal

Australian fur seals (*A. pusillus*) breed on islands of the Bass Strait but range throughout waters off the coasts of South Australia, Tasmania, Victoria and New South Wales. Numbers of this species are believed to be increasing as the population recovers from historic hunting. The species is endemic to south-eastern Australian waters.

In Victorian waters they breed on offshore islands, including Lady Julia Percy Island, Seal Rocks in Westernport Bay, Kanowna and Rag Islands off the coast of Wilson's Promontory and The Skerries off Wingan Inlet in Gippsland. The most important breeding sites are Lady Julia Percy Island and Seal Rocks, with 25% of the population occurring at each of these islands. Their preferred breeding habitat is a rocky island with boulder or pebble beaches and gradually sloping rocky ledges.

Haul out sites with occasional pup births are located at Cape Bridgewater (113 km west of the survey area), at Moonlight Head (22 km east of the survey area), on various small islands off Wilsons Promontory and Marengo Reef near Apollo Bay. Australian fur seals are present in the region all year, with breeding taking place during November and December.

Research being undertaken at Lady Julia Percy Island (75 km northwest of the acquisition area) indicates that adult females feed extensively in the waters between Portland and Cape Otway, out to the 200 m bathymetric contour. Seal numbers on the island reach a maximum during the breeding season in late October to late December. By early December, large numbers of lactating females are leaving for short feeding trips at sea and in late December there is an exodus of adult males. Thereafter, lactating females continue to alternate between feeding trips at sea and periods ashore to suckle their pups. Even after pups begin to venture to sea, the island remains a focus, and at any time during the year groups may be seen ashore resting.

During the summer months, Australian fur seals travel between northern Bass Strait islands and southern Tasmania waters following the Tasmanian east coast, however, lactating female fur seals and some territorial males are restricted to foraging ranges within Bass Strait waters. Lactating female Australian fur seals forage primarily within the shallow continental shelf of Bass Strait on the benthos at depths of between 60 - 80 m and generally within 100 - 200 km of the breeding colony for up to five days at a time.

Male Australian fur seals are bound to colonies during the breeding season from late October to late December, and outside of this they time forage further afield (up to several hundred kilometres) and are away for long periods, even up to nine days. It is therefore possible that seals will move through the acquisition area.



### New Zealand fur seal

New Zealand fur seals (*Arctocephalus forsteri*) are found in the coastal waters and offshore islands of South and Western Australia, Victoria, New South Wales and New Zealand. The species breeds in southern Australia at the Pages Islands and Kangaroo Island, which produces about 75% of the total pups in Australia. Small populations are established in Victorian coastal waters including at Cape Bridgewater near Portland (113 km west of the acquisition area), Lady Julia Percy Island near Port Fairy (75 km northwest of the acquisition area), Kanowna Island (near Wilson's Promontory) and The Skerries in eastern Victoria.

New Zealand fur seals colonies are located outside the acquisition area, however it is possible New Zealand fur seals may be present within the acquisition area foraging for food during the survey period.

#### 4.5.7 Marine Reptiles

Three threatened marine reptile species (turtles) may be present in or around the acquisition area as outlined in Table 4.4 and described in this section. The EPBC Act PMST erroneously identifies that breeding is likely to occur in the area. There are no identified BIAs for these reptiles in western Bass Strait.

**Table 4.4. EPBC Act-listed turtle species that may occur in or around the acquisition area**

Common name	Species name	EPBC Act			Likely presence	FFG Act	
		Listed threatened	Listed migratory	Listed marine		Listed	Conservation Status
Loggerhead turtle	<i>Caretta caretta</i>	E	M	L	B	-	-
Green turtle	<i>Chelonia mydas</i>	V	M	L	B	-	-
Leatherback turtle	<i>Dermochelys coriacea</i>	E	M	L	B	L	CE

B: Species or species breeding likely to occur within area.

#### Loggerhead turtle

The loggerhead turtle (*Caretta caretta*) is globally distributed in sub-tropical waters and is rarely seen off the Victorian coast. The loggerhead is a carnivorous turtle, feeding primarily on benthic invertebrates in habitat ranging from nearshore to 55 m depth.

The main Australian breeding areas for loggerhead turtles are generally confined to southern Queensland and Western Australia. Loggerhead turtles will migrate over distances in excess of 1,000 km, but show a strong fidelity to their feeding and breeding areas. No known loggerhead foraging areas have been identified in Victoria waters although foraging areas have been infrequently identified in waters off South Australia. This species is not expected to be encountered during the survey.

#### Leatherback turtle

The leatherback turtle (*Dermochelys coriacea*) is a pelagic feeder found in tropical, sub-tropical and temperate waters throughout the world. Unlike other marine turtles, the leatherback turtle utilises cold water foraging areas, with the species most commonly reported foraging in coastal waters between southern Queensland and central NSW, southeast Australia (Tasmania, Victoria and eastern SA), and southern WA. This species is an occasional visitor to the Otway shelf and has been sighted on a number of occasions during aerial surveys undertaken by the Blue Whale Study Group, particularly to the southwest of Cape Otway. It is mostly a pelagic species, and away from its feeding grounds is rarely found inshore.

No major nesting has been recorded in Australia, with isolated nesting recorded in Queensland and the Northern Territory. This species nests only in the tropics. The waters of the acquisition area do not represent critical habitat for the species and the species is not expected to be encountered during survey activities.

### Green turtle

Green turtles (*Chelonia mydas*) nest, forage and migrate across tropical northern Australia. They usually occur between the 20°C isotherms, although individuals can stray into temperate waters as vagrant visitors. Green turtles spend their first 5-10 years drifting on ocean currents. During this pelagic (ocean-going) phase, they are often found in association with drift lines and floating rafts of *Sargassum*. There are no known nesting or foraging grounds for green turtles offshore Victoria; they occur only as rare vagrants in these waters. This species is not expected to be encountered during the survey.

#### 4.5.8 Avifauna

A diverse array of seabirds and terrestrial birds utilise the Otway region and may potentially forage within or fly over the acquisition area, resting on islands during their migration.

Bird species listed by the EPBC Act PMST, the FFG Act and the DSE Advisory List of Threatened Vertebrate Fauna in Victoria (DES, 2013) as possibly occurring in or around the acquisition area or likely to overfly the acquisition area, or raised as items in consultation activities are outlined in Table 4.5 and described further in this section.

**Table 4.5. Listed avifauna species that may occur in or around the acquisition area**

Common name	Species name	EPBC Act status			Likely presence	FFG Act	
		Listed threatened	Listed migratory	Listed marine		Listed	Conservation Status
Fork-tailed swift	<i>Apus pacificus</i>	-	M	L	SHL	-	-
Australasian bittern	<i>Botaurus poiciloptilus</i>	E	-	-	SHK	L	E
Great skua	<i>Catharacta skua</i>	-	-	L	SHM	-	-
Southern royal albatross	<i>Diomedea epomophora epomophora</i>	V	M	L	FL	-	-
Northern royal albatross	<i>Diomedea epomophora sanfordi</i>	E	M	L	FL	-	-
Wandering albatross	<i>Diomedea exulans</i>	V	M	L	FL	L	V
Antipodean albatross	<i>Diomedea exulans antipodensis</i>	V	M	L	FL	-	-
Blue petrel	<i>Halobaena caerulea</i>	V	-	L	SHM	-	-
Southern giant-petrel	<i>Macronectes giganteus</i>	E	M	L	SHM	L	V
Northern giant-petrel	<i>Macronectes halli</i>	V	M	L	SHM	L	NT
Australasian gannet	<i>Morus serrator</i>	-	M	L	-	-	-
Orange-bellied parrot	<i>Neophema chrysogaster</i>	CE	-	L	ML	L	CR
Osprey	<i>Pandion haliaetus</i>	-	-	L	SHL	-	-
Sooty albatross	<i>Phoebastria fusca</i>	V	M	L	SHL	L	-
Gould's petrel	<i>Pterodroma leucoptera leucoptera</i>	E	-	-	SHM	-	-

Common name	Species name	EPBC Act status			Likely presence	FFG Act	
		Listed threatened	Listed migratory	Listed marine		Listed	Conservation Status
Soft-plumaged petrel	<i>Pterodroma mollis</i>	V	-	L	SHM	-	-
Flesh-footed shearwater	<i>Puffinus carneipes</i>	-	M	L	FL	-	-
Grey plover	<i>Pluvialis squatarola</i>	-	M	-	-	-	E
Australian fairy tern	<i>Sternula nereis nereis</i>	V	-	-	BL	L	E
Buller's albatross	<i>Thalassarche bulleri</i>	V	M	L	FL	-	-
Shy albatross	<i>Thalassarche cauta cauta</i>	V	M	L	FL	L	V
Grey-headed albatross	<i>Thalassarche chrysostoma</i>	E	M	L	SHM	L	V
Campbell albatross	<i>Thalassarche impavida</i>	V	M	L	FL	-	-
Black-browed albatross	<i>Thalassarche melanophris</i>	V	M	L	FL	-	-
Salvin's albatross	<i>Thalassarche salvini</i>	V	M	L	FL	-	-
White-capped albatross	<i>Thalassarche steadi</i>	V	M	L	FL	-	-
Bar-tailed godwit (baueri)	<i>Limosa lapponica</i>	V	-	-	SHM	-	-
Bar-tailed godwit (menzbeieri)	<i>Limosa lapponica menzbeieri</i>	CE	-	-	SHM	-	-
Fairy prion	<i>Pachyptila turtur subantactica</i>	V	-	L	SHK	-	V
Hooded plover	<i>Thinornis rubicollis rubicollis</i>	V			SHK	L	V
Short-tailed shearwater	<i>Puffinus tenuirostris</i>	-	M	L	BK	-	-
Little tern	<i>Stern albifrons</i>	-	M	L	SHM	L	V
Little penguin	<i>Eudyptula minor</i>	-	-	L	BK	-	-
White-bellied sea eagle	<i>Haliaeetus leucogaster</i>	-	-	L	SHK	L	V
Black-faced cormorant	<i>Phalacrocorax fuscescens</i>	-	-	L	BK	-	NT
Common greenshank	<i>Tringa nebularia</i>	-	-	L	SHL	-	V
Great knot	<i>Calidris tenuirostris</i>	-	-	-	-	L	E

Common name	Species name	EPBC Act status			Likely presence	FFG Act	
		Listed threatened	Listed migratory	Listed marine		Listed	Conservation Status
Little bittern	<i>Ixobrychus minutus dubius</i>	-	-	-	-	L	E
Eastern great egret	<i>Ardea modesta</i>	-	-	-	-	L	V
Grey-tailed tattler	<i>Tringa brevipes</i>	-	-	-	-	L	C
Gull-billed tern	<i>Glecochelidon nilotica macrotarsa</i>	-	-	-	-	L	E
Caspian tern	<i>Hydroprogne caspia</i>	-	-	-	-	L	NT

SHM: Species or species habitat may occur within area.

SHL: Species or species habitat likely to occur within area.

SHK: Species or species habitat known to occur within area.

FK: Foraging, feeding or related behaviour known to occur within area.

FL: Foraging, feeding or related behaviour likely to occur within area.

ML: Migratory route likely to occur in area.

BL: Breeding Likely to occur in area

BK: Breeding known to occur in area

**Albatrosses** and **giant-petrels** are among the most dispersive and oceanic of all birds, spending more than 95% of their time foraging at sea in search of prey and usually only returning to land (remote islands) to breed. Only five species of albatross and the southern and northern giant petrel are known to breed within Australia. Breeding within Australian territory occurs on the isolated islands of Antarctica and the Southern Ocean, as well as islands off the south coast of Tasmania and Albatross Island off the north-west coast of Tasmania in Bass Strait.

There are no islands with colonies of threatened marine seabirds within the vicinity of the acquisition area.

All Australian waters can be considered foraging habitat for albatross and petrels, with the most important habitat considered to be south of 25°S, which includes the acquisition area. Given these species' ability to cover vast ocean distances while foraging, it is possible these species may overfly and forage in the vicinity of the acquisition area.

The **orange-bellied parrot** (*Neophema chrysogaster*) (listed as critically endangered under the FFG Act and EPBC Act) breeds in Tasmania during summer, migrates north across Bass Strait in autumn and over winters on the mainland. Birds depart the mainland for Tasmania from September to November.

The parrot's breeding habitat is restricted to southwest Tasmania, where breeding occurs from November to mid-January mainly within 30 km of the coast. The species forage on the ground or in low vegetation. During winter, on mainland Australia, orange-bellied parrots are found mostly within 3 km of the coast. In Victoria, they mostly occur in sheltered coastal habitats, such as bays, lagoons and estuaries, or, rarely, saltworks. The orange bellied parrot may overfly the acquisition area however the species is not likely to be impacted as there are no suitable resting, nesting or feeding sites that can be affected by the survey.

The **short-tailed shearwater** (*Puffinus tenuirostris*) (not listed as threatened under any State or Commonwealth legislation, but classified under international convention as migratory) is known to occur and breed in western Bass Strait. It is Australia's most abundant seabird, with millions of birds converging on small offshore islands along the southern Australia's coast during their summer breeding season, with Bass Strait being their stronghold. It breeds in Australia and winter in the North Pacific, and returns to southern Australia in summer to breed. The species feeds on krill, small fish and other marine creatures, mostly feeding on the water surface.

A colony of approximately 12,000 short-tailed shearwaters nest on Mutton Bird Island (located 5 km southeast of the acquisition area) in Victorian waters from September through to April. The Bay of Islands Coastal Park (Schlomburg Beach adjacent to survey area) also contains shearwater habitat. This species may overfly and forage within the acquisition area during the survey period.

Several populations of the **little penguin** (*Eudyptula minor*) (not listed as threatened under any State or Commonwealth legislation) occur within Bass Strait, with nesting sites located on islands within Bass

Strait and at various mainland shorelines. The little penguin is an iconic species that usually mates between August to October, builds nests at the end of September, incubate the eggs in October and raise their nestlings through November and December. Nesting colonies occur in burrows on sandy or rock islands often at the base of cliffs or in sand dunes adjacent to marine areas. Penguin colonies are known to occur in the southwest region of Victoria.

Maximum foraging ranges for little penguins are generally between 15-50 km from their nesting locations, reduced to 10-15 km during the breeding season (Phillip Island Penguin Foundation, 2015; McCauley, 1994), with maximum diving depths of 10-30 m, feeding on fish such as pilchards, anchovies, red cod and squid (Phillip Island Penguin Foundation, 2015).

A number of species listed in Table 4.5 utilise coastal shoreline habitats. These species are commonly found on coastal shores including beaches and rocky shores and either feed at low tide on worms, crustaceans and molluscs or fish species or feed on aquatic biota.

#### 4.5.9 Threatened Communities

Threatened Ecological Communities (TECs) provide wildlife corridors and/or habitat refuges for many plant and animal species, and listing a TEC provides a form of landscape or systems-level conservation (including threatened species). The giant kelp marine forests of South East Australia is the only listed TEC around the survey area, and is protected under the EPBC Act.

Giant kelp (*Macrocystis pyrifera*) is a large brown algae that grows on rocky reefs from the seabed 8 m below sea level and deeper. Its fronds grow vertically toward the water surface, in cold temperate waters off south east Australia. It is the foundation species of this TEC in shallow coastal marine ecological communities. The kelp species itself is not protected, rather, it is communities of closed or semi-closed giant kelp canopy at or below the sea surface that are protected (DSEWPC 2012b).

Giant kelp is the largest and fastest growing marine plant. Their presence on a rocky reef adds vertical structure to the marine environment that creates significant habitat for marine fauna, increasing local marine biodiversity. Species known to shelter within the kelp forests include weedy sea dragons (*Phyllopteryx taeniolatus*), six-spined leather jacket (*Mesuchenia freycineti*), brittle star (*Ophiuroid sp*), urchins, sponges, blacklip abalone (*Tosia spp*) and southern rock lobster (*Jasus edwardsii*).

Giant kelp requires clear, shallow water no deeper than approximately 35 metres. The largest extent of the ecological community is in Tasmanian coastal waters. Some patches may also be found in Victoria and South Australia.

Extensive surveys of macroalgal communities were undertaken along the Otway Shelf from Warrnambool to Portland in 2013. Sites were adjacent to shore or on offshore rocky reefs covering a depth range of 0 to 36 meters water depth. These surveys did not locate giant kelp at any site but identified that other brown algae species are prolific to around 20 m water depth.

Surveys of The Arches Marine Sanctuary and Twelve Apostles Marine National Park have not located giant kelp. As water depths within the survey area lie between 5-60 m, it is possible giant kelp could occur within the survey area to approximately 20 m. However the presence of the TEC in the acquisition area is considered highly unlikely.

#### 4.5.10 Invasive Marine Species

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. More than 200 non-indigenous marine species including fish, molluscs, worms and a toxic alga have been detected in Australian coastal waters.

In the South-east Marine Region, 115 marine pest species have been introduced. Key known pest species in the South-East Marine Region include:

- Northern pacific sea star (*Asterias amurensis*);
- Fan worms (*Sabella spallanzanii* and *Euchone sp*);
- Bivalves (*Crassostrea gigas* (Pacific oyster) *Corbulagibba* and *Theorafragilis*);
- Crabs (*Carcinus maenas* (European shore crab) and *Pyromaiatuberculata*);
- Macroalgae (*Undaria pinnatifida* (Japanese giant kelp) and *Codium fragile ssp.tormentosoides*; and
- The introduced New Zealand screw shell (*Maoricolpus roseus*), known to form extensive and dense beds on the sandy sea-floor in eastern Bass Strait spreading to the 80 m depth contour off eastern Victoria and NSW.

The Marine Pests Interactive Map indicates that the ports likely to be used for the survey (Warrnambool, Apollo Bay or Port Fairy) do not currently harbour any marine pests.

## 4.6 Socio-economic Environment

This section describes the socio-economic environment in and around the acquisition area, including onshore aspects as relevant.

### 4.6.1 Coastal Settlements

The coastal communities of Apollo Bay, Princetown, Port Campbell, Peterborough, Warrnambool, Port Fairy and Portland all provide services to the commercial and recreational fishing industries in southwest Victoria. Portland is Victoria's western-most commercial port, and is a deep-water port with breakwaters sheltering a marina and boat ramp. The Port of Warrnambool has a breakwater and yacht club, and provides shelter for commercial fishing boats. Port Fairy has both harbour and fish processing facilities, but is not suitable for use by large vessels, nor is Port Campbell.

Port Campbell is the nearest town to the acquisition area. At the time of the 2011 census, the population of Port Campbell was 618. Dairy cattle farming is the town's largest employment type (19.3%), followed by tourist accommodation (10.6%), sheep, beef and grain farming (5%) and cafes, restaurants and food services accounting for 4.7%.

### 4.6.2 Shipping

The South-east Marine Region is one of the busiest shipping regions in Australia and Bass Strait is one of Australia's busiest shipping routes. Agricultural products and woodchips are transported from the Port of Portland to receiving ports in the Gulf of St Vincent, South Australia, and through Bass Strait to Melbourne and Sydney. The Port of Melbourne has over 3,300 vessels calling in to the port every year and is anticipating a doubling in container trade by 2022.

AMSA has advised Origin that given the inshore nature of this survey, only local vessels (primarily fishing vessels) utilise the survey area waters and vessel traffic is local and low intensity.

### 4.6.3 Petroleum Exploration and Production

Petroleum exploration has been undertaken within the Otway Basin since the early 1960s. Gas reserves of approximately 2 trillion cubic feet (tcf) have been discovered in the offshore Otway Basin since 1995, with production from five gas fields using 700 km of offshore and onshore pipeline. Up to 2015, the DEDJTR reports that 23 PJ of liquid hydrocarbons (primarily condensate) has been produced from its onshore and offshore basins, with 65 PJ remaining, while 85 PJ of gas has been produced (Victoria and South Australia), with 1,292 PJ remaining.

There are a number of production assets located in the Otway Basin (Figure 4.7) which include the following:

- The Otway Gas Field Development, operated by Origin, is located 70 km south of Port Campbell. The development consists of a remotely operated platform (at Thylacine), offshore and onshore pipelines and a gas processing plant located 6.4 km northeast of Port Campbell.
- The Casino Gas Project developed by Santos (now owned by Cooper Energy). It comprises subsea wellheads and pipeline to shore to the Iona gas plant for processing and distribution (5.8 km northeast of Port Campbell, and adjoining the Otway Gas Plant).
- The Minerva Gas Development is operated by BHP Billiton and commenced production in April 2005. This involved the drilling and installation of two subsea wells in shallow waters, which were tied back to an onshore gas plant via a single pipeline.

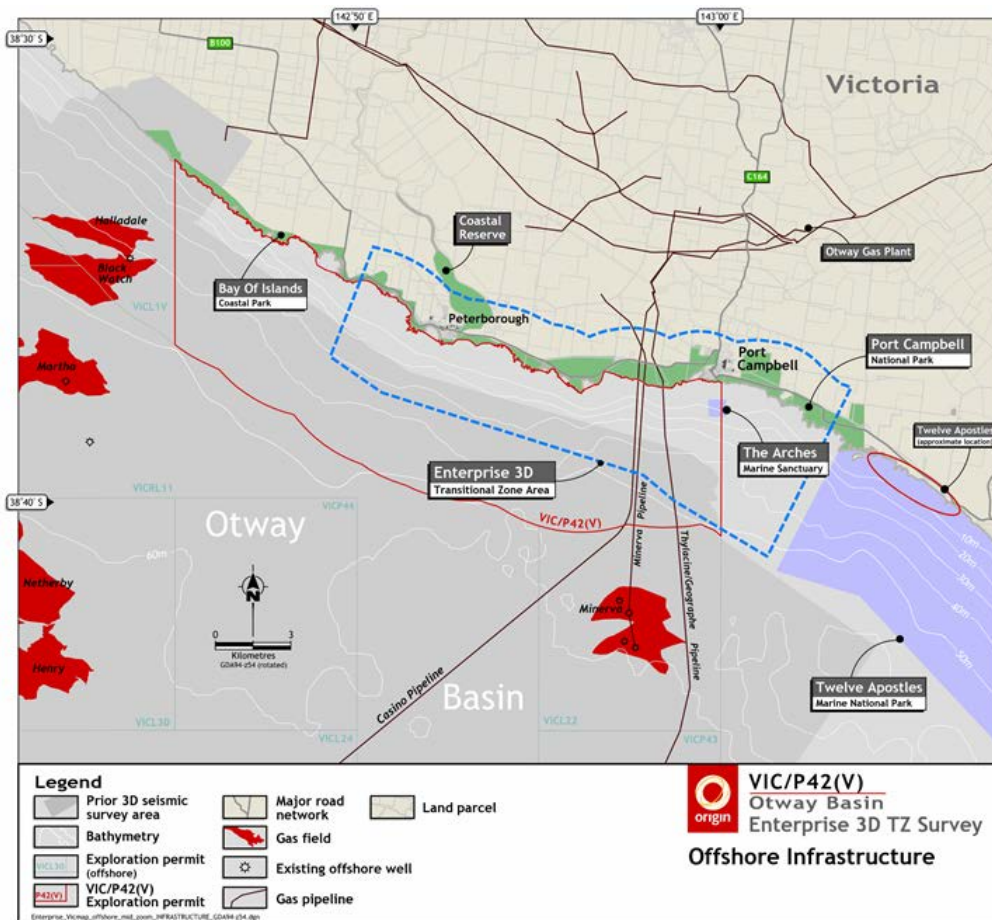


Figure 4.7. Offshore oil and gas infrastructure in the vicinity of the survey area

In 2014, production from the Origin, Santos and BHP Billiton Otway Basin operations was 703,733 bbl condensate, 726,081 bbl of LPG and 110,806 mmcf of sales gas.

Origin has recently developed the Halladale and Speculant gas fields in the Otway Basin. The gas fields are located in shallow waters offshore Nirranda (8 km west of the survey area) and were accessed by horizontally directionally drilling under the Bay of Islands Coastal Park. Production from the fields commenced in August 2016.

4.6.4 Commercial Fisheries

The survey area is overlapped by the jurisdiction of several Commonwealth and State-managed fisheries, as outlined below.

**Commonwealth-managed Fisheries**

Commonwealth fisheries are managed by AFMA, with Commonwealth fisheries operating from the 3 nm baseline out to 200 nm (the extent of the Australian Fishing Zone). The acquisition area lies within an area surrounded by several Commonwealth-managed fisheries, these being:

- Bass Strait Central Zone Scallop.
- Eastern Tuna and Billfish.
- Skipjack (eastern).
- Small Pelagic (western sub-area).
- Southern and Eastern Scalefish and Shark.
- Southern Bluefin Tuna.
- Southern Squid Jig.

None of these Commonwealth fisheries are known to fish within the survey area.

#### State-managed Fisheries

Victorian fisheries are managed by the DELWP (Fisheries) and may overlap Commonwealth fisheries areas. The acquisition area lies within an area encompassed by several State-managed fisheries, these being:

- Victorian Rock Lobster Fishery - operates throughout the acquisition area but is concentrated over 'the Big Reef', located 56 km south-southwest of the proposed acquisition area;
- Victorian Giant Crab Fishery - is concentrated around the continental shelf break with some operations further inshore;
- Abalone Fishery - operates nearshore in depths of up to 30 m (mainly using divers with a surface air supply), so is likely to occur within the acquisition area;
- Scallop Fishery - does not operate in the acquisition area (seabed substrate is too hard to support scallops);
- Wrasse Fishery - likely to operate within the acquisition area; and
- Snapper Fishery (Open Fishery Access Licence) - likely to operate within the acquisition area.

#### 4.6.5 Tourism

The key areas of tourism in the region include land-based sightseeing from the Great Ocean Road and lookouts along that road, helicopter sightseeing, private and chartered vessels touring into the Twelve Apostles Marine Park, diving and fishing. Land-based tourism in the region peaks over holiday periods and in 2011, Tourism Victoria reported a total of approximately 8 million visitors to the Great Ocean Road region.

Local vessels accessing the area generally launch from Boat Bay in the Bay of Islands or from Port Campbell. Given the available boat launching facilities in the area (Peterborough and Port Campbell), and the prevailing sea-state of the area, vessel-based tourism is limited.

#### 4.6.6 Recreational Diving

Recreational diving occurs along the Otway coastline. Popular diving sites near Peterborough includes a number of shipwrecks such as the *Newfield*, which lies in 6 m of water, the *Schomberg* in 8 m of water and the *Falls of Halladale* (4-11 m of water). These sites are all located within the survey area.

Consultation with local vessel charterers and providers of SCUBA tank fills has confirmed that diving activity near to the survey area is generally concentrated around The Arches Marine Sanctuary and the wreck sites of the *Loch Ard* (outside the acquisition area) and sometimes at the *Newfield* and *Schomberg* shipwrecks.

Diving activity peaks during the rock lobster season with the bulk of recreational boats accessing the area launching from Boat Bay at the Bay of Islands or Port Campbell.

### 4.7 Cultural Environment

#### 4.7.1 Maritime Archaeological Heritage

Shipwrecks over 75 years old are protected within Commonwealth waters under the *Historic Shipwrecks Act 1976* (Cth) and in Victorian waters under the *Victorian Heritage Act 1995* (Vic).

The stretch of coastline adjacent to the survey area is known as the 'Shipwreck Coast' because of the number of shipwrecks present with most wrecked during the late nineteenth century. The strong waves, rocky reefs and cliffs of the region contributed to the loss of these ships. Shipwrecks known to occur in the acquisition area, as illustrated in Figure 4.8, are:

- *Napier* - wrecked in 1878, the vessel was contracted to undertake salvage on the Loch Ard wreck. While returning to Port Campbell it lost sternway while rounding the eastern reef and bluff, and swell forced it onto rocks on the western side of the cove.
- *Nowra* – wrecked in 1891 after experiencing very bad weather after leaving Penguin (Tasmania). It was unable to reach Port Phillip Heads and was driven onto the 'London Bridge' rocks.
- *Newfield* – wrecked in 1892, the vessel struck rocks approximately 100m from shore one mile east of Curdies Inlet due to navigational error when Cape Otway light was mistaken for King Island lighthouse.



- *Young Australian* – wrecked in 1877 at Curdies Inlet while on a voyage from Maryborough (Qld) to Adelaide (SA) it struck heavy weather off Cape Nelson.
- *Schomberg* – wrecked in 1855 at Curdies Inlet as a result of a navigational error.
- *Falls of Halladale* –wrecked in 1908 at Massacre bay Peterborough as a result of a navigational error.
- *Unnamed* – located west of Peterborough in waters less than 10 m deep.

4.7.2 Aboriginal Heritage

Aboriginal groups inhabited the southwest Victorian coast as is evident from the terrestrial sites of Aboriginal archaeological significance throughout the area. Coastal Aboriginal heritage sites include mostly shell middens, some stone artefacts, a few staircases cut into the coastal cliffs, and at least one burial site.

4.7.3 Native Title

The National Native Title Tribunal (NNTT) database identifies a claim exists over the adjacent coastal shoreline (and terrestrial component of the survey area) by the Eastern Maar people. This claim, registered in 2013, extends seaward 100 m from the mean low-water mark of the coastline. There is currently no determination registered over the area of the claim (still active) in the National Native Title Register.

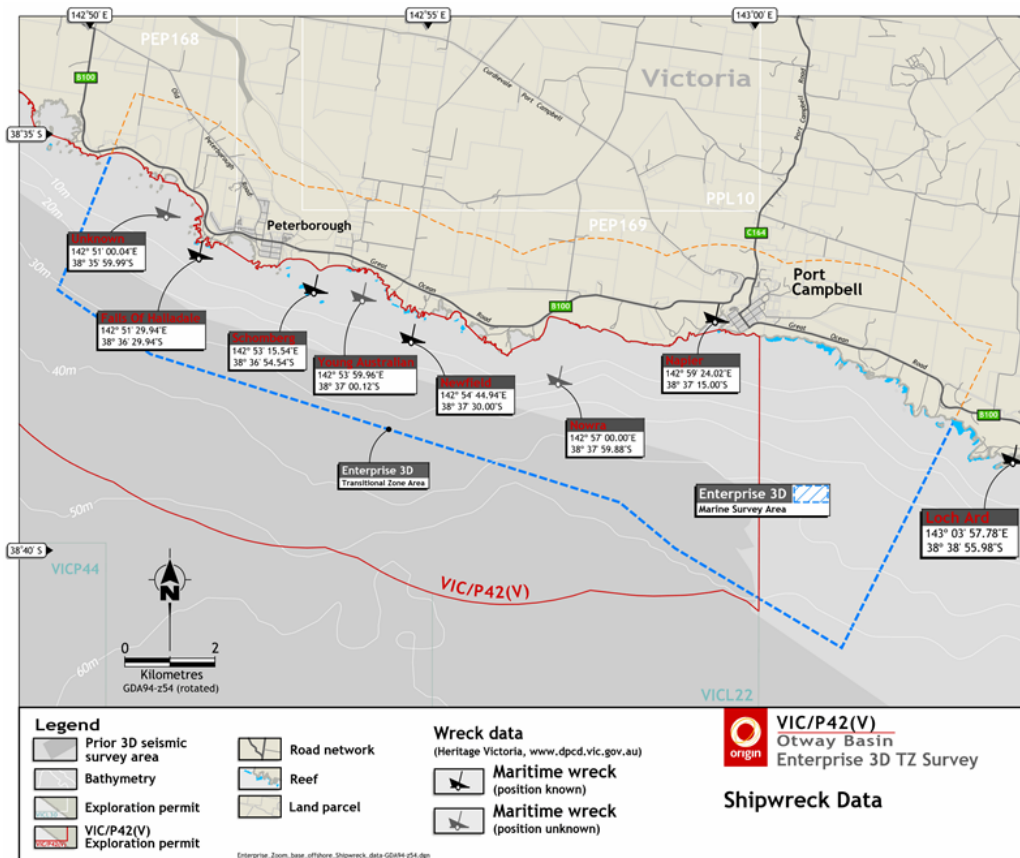


Figure 4.8. Shipwrecks within and in the vicinity of the acquisition area

## 5. Environmental Impact and Risk Assessment

A detailed environmental impact and risk assessment has been undertaken for the Enterprise 3DTZSS.

For this activity, Origin has determined that effects (or impacts) and risks, and the planned and unplanned events are defined as follows:

- **Impacts** result from **planned events** (i.e., there *will* be consequences [known or unknown] associated with the event occurring). Impacts are an inherent part of the event. For example, there will be combustion emissions with associated impacts as a result of vessel activity.
- **Risks** result from **unplanned events** (i.e., there *may* be consequences if the unplanned event actually occurs). Risk is a combination of the *consequences* of an event and the associated *likelihood* of its occurrence. For example, a hydrocarbon spill may occur if a vessel's fuel tank is punctured by a collision incident during the survey. The risk of this event is determined by multiplying the consequence of the impact (using factors such as the type and volume of fuel and the nature of the receiving environment) by the likelihood of this event happening (which may be determined objectively or subjectively, qualitatively or quantitatively).

Origin follows a detailed, step-by-step hazard assessment methodology for all its activities. One of the key steps in this process is the definition of each hazard and determining the maximum credible impact arising from the impact or risk without regards for controls. To this effect, Table 5.1 presents Origin's likelihood descriptors, Table 5.2 presents Origin's consequence descriptors (for natural environment and community/social/cultural heritage impacts only), while Table 5.3 presents the risk matrix, which determines the overall risk ranking when the likelihood and consequence are multiplied together.

Demonstrating 'as low as reasonably practicable' (ALARP) and acceptability are subject to rigorous assessment, the methodology for which are too detailed for inclusion in this summary.

Table 5.4 summarises the impact and risk assessment, and presents the controls put in place to ensure these impacts and risks are ALARP and acceptable. The impact consequences for impacts and risk ratings for risks are also included.

**Table 5.1 Origin's likelihood descriptions**

Likelihood	Definition
Remote	Less than 1% chance of occurring within the next year. Occurrence requires exceptional circumstances. Exceptionally unlikely event in the long-term future. Only occur as a 100 year event.
Highly unlikely	Greater than 1% chance of occurring within the next year. May occur but not anticipated. Could occur in years to decades.
Unlikely	Greater than 5% chance of occurring within the next year. May occur but not for a while. Could occur within a few years.
Possible	Greater than 10% chance of occurring within the next year. May occur shortly but a distinct probability it won't. Could occur within months to years.
Likely	Greater than 50% chance of occurring within the next year. Balance of probability will occur. Could occur within weeks to months.
Almost certain	99% chance of occurring within the next year. Impact is occurring now. Could occur within days to weeks.

**Table 5.2 Origin’s consequence descriptions**

Consequence	Natural environment	Community, social, cultural heritage
Catastrophic	Long term destruction of highly significant ecosystem or very significant effects on endangered species or habitats.	Multiple community fatalities. Complete breakdown of social order. Irreparable damage of highly valued items or structures of great cultural significance.
Critical	Major offsite release or spill, significant impact on highly valued species or habitats to the point of eradication or impairment of the ecosystem. Widespread long-term impact.	Community fatality. Significant breakdown of social order. Ongoing serious social issue. Major irreparable damage to highly valuable structures/items of cultural significance.
Major	Offsite release contained or immediately reportable event with very serious environmental effects, such as displacement of species and partial impairment of ecosystem. Widespread medium and some long-term impact.	Serious injury to member of the community. Widespread social impacts. Significant damage to items of cultural significance.
Serious	Moderate effects on biological or physical environment and serious short term effect to ecosystem functions.	Media attention and heightened concerns by local community and criticism by NGOs. Ongoing social issues. Permanent damage to items of cultural significance.
Moderate	Event contained within site. Minor short term damage to area of limited significance. Short term effects but not affecting ecosystem functions.	Medical treatment injury to a member of the community. Minor adverse local public or media attention and complaints. Minor medium term social impact on local population, mostly repairable.
Minor	Minor consequence, local response. No lasting effects. Low level impacts on biological and physical environment to an area of low significance.	Public concern restricted to local complaints. Low level repairable damage to common place structures.

**Table 5.3 Origin’s risk matrix**

		Likelihood					
		Remote	Highly unlikely	Unlikely	Possible	Likely	Almost certain
Consequence rating	Catastrophic	H	H	S	S	E	E
	Critical	M	M	H	S	S	E
	Major	M	M	M	H	S	S
	Serious	L	M	M	M	H	S
	Moderate	L	L	M	M	M	H
	Minor	L	L	L	M	M	M

**Table 5.4 Summary of environmental impacts, risks and control measures for the Enterprise 3DTZSS**

Aspect	Known and potential impacts and risks	Control measures	Residual impact or risk
<b>Planned events</b>			<b>Impact consequence</b>
Generation of underwater sound from the seismic source.	Temporary disturbance, behavioural, physiological or pathological impacts to sound-sensitive species.	<ul style="list-style-type: none"> <li>The offshore survey is timed to avoid peak southern right whale presence, a species that comes in much closer to shore than blue whales.</li> <li>No survey activity (acquisition or node deployment) occurs in marine reserves.</li> <li>A trained and experienced Marine Mammal Observer (MMO) will be on present on the seismic vessel and the two receiver vessels and at two different cliff top locations directly adjacent to the offshore survey during seismic operations.</li> <li>Seismic survey operations are conducted in accordance with the EPBC Act Policy Statement 2.1 Part A, standard management procedures, to minimise acoustic disturbance to cetaceans.</li> <li>Seismic survey operations will incorporate additional management measures in general accordance with the EPBC Act Policy Statement 2.1 Part B and in accordance with the project EPBC Act Referral 'particular manner' conditions to minimise acoustic disturbance to blue and southern right whales.</li> <li>All crew aboard the seismic survey vessels are inducted into the EPBC Act Policy requirements.</li> <li>No survey acquisition is undertaken during hours of darkness.</li> <li>Control measures for potentially affected fisheries (Refer to Risk - Interference with third-party vessels and commercial fishing due to the presence of the survey vessels)</li> </ul>	Moderate
Emission of artificial light from vessels.	Localised light glow may act as an attractant to light-sensitive species, in turn affecting predator-prey dynamics.	<ul style="list-style-type: none"> <li>Lighting will be kept to the minimum required but in accordance with navigational standards.</li> <li>No vessel activity will be undertaken during hours of darkness.</li> </ul>	Minor
Emission of air pollutants from combustion of marine diesel.	Temporary and localised reduction in air quality. Contribution to the greenhouse gas effect.	<ul style="list-style-type: none"> <li>Marine-grade (low sulphur) diesel will be used, which contains less than 3.5% m/m sulphur.</li> <li>All combustion equipment will be maintained in accordance with the vessel's planned maintenance system (PMS).</li> <li>All solid waste will be returned to shore on a daily basis and not incinerated.</li> <li>Fuel use will be measured, recorded and reported in order to ensure abnormally high fuel consumption does not occur.</li> </ul>	Minor
Routine marine discharges of cooling water, brine, treated sewage and grey water, bilge water	If discharges occur, localised and temporary increase in sea surface temperature, increase in surface water nutrients and increase in scavenging	<ul style="list-style-type: none"> <li>No discharge of sewage or greywater, bilge water or putrescible waste overboard in state waters – wastes will be stored in holding tanks and transferred to shore for proper disposal via port facilities.</li> </ul>	Minor

Aspect	Known and potential impacts and risks	Control measures	Residual impact or risk
and putrescible waste.	behaviour of marine fauna and seabirds.		
Disturbance to visual amenity.	Potential for reduced visitor experience at local coastal lookouts.	<ul style="list-style-type: none"> <li>• Survey vessels will be the same size as those currently operating in the region.</li> <li>• Source and receiver equipment will be below the surface of the water.</li> <li>• Survey is acquired in 'segments' on a daily basis (i.e., the whole survey area is not surveyed on a daily basis).</li> <li>• Pre-survey stakeholder consultation takes place to keep stakeholders informed about the survey location and timing.</li> </ul>	Minor
Seabed disturbance from OBN deployment.	Localised seabed turbidity. Displacement of seabed habitat.	<ul style="list-style-type: none"> <li>• The survey design avoids known sensitive areas of seabed contact (e.g., a 50 m buffer is maintained from the boundary of The Arches Marine Sanctuary for the deployment of OBN).</li> <li>• Vessels are suitable for shallow water operations.</li> <li>• Acquisition procedures, reflecting survey design that accommodated seabed sensitivities, are implemented during the survey (e.g., detailed bathymetric mapping and GPS will be used by vessel skippers so that shipwrecks can be avoided and depth sounders used to ensure clearance between source equipment and the seabed).</li> <li>• Contractors will adhere to the approved procedures for OBN deployment and retrieval.</li> <li>• Divers will recover dropped and/or snagged objects, where safe to do so.</li> <li>• The location of suspected shipwrecks not marked on admiralty charts will be reported to authorities.</li> <li>• ROV will be used to recover dropped and/or snagged objects, where safe to do so.</li> </ul>	Minor
<b>Unplanned events</b>			<b>Risk rating</b>
Accidental overboard discharge of hazardous and non-hazardous waste	Pollution of surface waters or seabed. Fauna injury or death.	<ul style="list-style-type: none"> <li>• Locations of nodes will be tracked and recorded</li> <li>• A vessel Garbage Management Plan (or equivalent according to class) will be in place and implemented.                             <ul style="list-style-type: none"> <li>○ Waste is segregated, stored and handled appropriate to classification.</li> <li>○ Crew members are inducted into waste management procedures.</li> <li>○ Safety Data Sheets and registers are available at key locations.</li> </ul> </li> <li>• Hydrocarbon or chemical spills on the vessels are prevented from being discharged overboard.                             <ul style="list-style-type: none"> <li>○ Hydrocarbon and chemical storage areas are banded and drain to bilge tank.</li> <li>○ Scupper plugs (or equivalent) are readily available to block drains in the event of a spill to deck.</li> </ul> </li> <li>• Spills on deck will be rapidly cleaned up.                             <ul style="list-style-type: none"> <li>○ Spill response kits are available and vessel crew are trained in their use.</li> </ul> </li> </ul>	Low

Aspect	Known and potential impacts and risks	Control measures	Residual impact or risk
Seabed disturbance from anchoring and dropped equipment.	Temporary and localised seabed turbidity and displacement of seabed habitat.	<ul style="list-style-type: none"> <li>• Vessels will avoid anchoring in known sensitive areas.</li> <li>• Large bulky items are securely stored on the deck to prevent loss at sea.</li> <li>• Vessels are suitable for shallow water operations.</li> <li>• Divers will operate to recover dropped equipment and recover snagged objects, where safe to do so.</li> <li>• The location of suspected shipwrecks not marked on admiralty charts will be reported to authorities.</li> <li>• ROV will be used to recover dropped and/or snagged objects, where safe to do so.</li> </ul>	Low
Interference with third-party vessels and commercial fishing due to the presence of the survey vessels.	Disruption to commercial vessel movements. Exclusion from commercial fishing grounds and loss of fish catches. Damage to or loss of fishing equipment.	<ul style="list-style-type: none"> <li>• No fishing exclusion zones will be in place in the survey area.</li> <li>• Origin will undertake ongoing consultation with potentially impacted third-party marine users and commercial fishers.</li> <li>• Origin's fisheries compensation framework, including claim form, shall be provided to commercial fishers likely to be impacted by the survey.</li> <li>• Cumulative (24-hour) underwater SEL modelling results have been considered in fisheries compensation agreements.</li> <li>• The location of the active nodal patch will be communicated to other marine users.                             <ul style="list-style-type: none"> <li>○ Issuing of a 'Notice to Mariners' through AMSA and/or Transport Safety Victoria.</li> <li>○ Prior engagement with known local commercial fishers and recreational fishing groups.</li> <li>○ Signage at local boat launching ramps.</li> </ul> </li> <li>• The vessels and source quipment will be readily identifiable to other vessels.</li> </ul>	Low
Interference with commercial and recreational divers.	Exclusion from fishing or recreational sites. Acoustic-induced injury to divers in the vicinity of the active seismic source.	<ul style="list-style-type: none"> <li>• Consultation has occurred and will continue occur with known diving stakeholders, including abalone divers and professional dive clubs, before and during the survey.</li> <li>• Project signage will be in place at boat ramps and beach access points used by divers in the area.</li> <li>• Visual monitoring for dive flags in the survey area will occur during the survey.</li> <li>• The Enterprise 3DTZSS Safe Diver Distances Protocol will be enforced:                             <ul style="list-style-type: none"> <li>○ Communication zone (5 km).</li> <li>○ Observation and monitor zone (5 km).</li> <li>○ Shut down zone (40 m).</li> </ul> </li> </ul>	Medium
Introduction of invasive marine species from vessel hulls and/or ballast	Loss of diversity and abundance of native species.	<ul style="list-style-type: none"> <li>• Origin will conduct pre-survey assurance checks of contracted vessels.</li> <li>• The vessels are cleared to enter Australian waters (if sourced from outside Australian waters).</li> <li>• Vessels have anti-fouling paint applied to hulls and internal niches.</li> </ul>	Medium

Aspect	Known and potential impacts and risks	Control measures	Residual impact or risk
water.		<ul style="list-style-type: none"> <li>Non-regional vessels are dry-docked and cleaned prior to the survey.</li> <li>Vessels only discharge low-risk domestic ballast water into Victorian state waters in accordance with the requirements of the <i>Victorian Environment Protection (Ships' Ballast Water) Regulations 2008</i> and the <i>EPA Protocol for environmental management: domestic ballast water management in Victorian waters</i>.</li> </ul>	
Vessel strike or entanglement with marine mammals with the survey vessels or source equipment.	Injury to or death of whales, dolphins and seals.	<ul style="list-style-type: none"> <li>The MMOs will implement the Australian Guidelines for Whale and Dolphin Watching for sea-faring activities (2005) to reduce the risk of collisions.</li> <li>Cetacean observations will be recorded and reported to the DoEE.</li> <li>Entanglements with marine fauna will be reported to the DELWP for rescue service guidance or assistance.</li> <li>Any survey-related fauna injury or death will be reported to regulatory authorities (DoEE and DELWP).</li> </ul>	Medium
Diesel spill due to a vessel-to-vessel collision (no refuelling will take place in the survey area)	Temporary decrease in water quality. Injury and/or death of exposed marine fauna. Habitat damage where spill residue reaches shorelines.	<ul style="list-style-type: none"> <li>As per 'interference with third-party vessels.'</li> <li>Vessels will have an approved Shipboard Marine Pollution Emergency Plan (SMPEP) (or equivalent appropriate to class) and the survey will have an accepted project-specific Oil Pollution Emergency Plan (OPEP), which are implemented in the event of a spill.</li> <li>Vessel Masters will initiate action to reduce fuel loss in the event of a tank rupture.</li> <li>Reporting and monitoring of spills will take place in accordance with the OPEP.</li> </ul>	Medium
Vessels remain on location conducting retrieval activities until 30 April 2017	Increase in Risk to the Environment and Stakeholders due to extended retrieval activities.	<ul style="list-style-type: none"> <li>MMOs will be on duty to undertake marine fauna observations.</li> <li>Beach Liaison Personnel will provide on the ground engagement with local communities</li> <li>Retrieval operation monitoring impact to marine substrate</li> <li>ROV will be used to recover dropped and/or snagged objects, where safe to do so.</li> <li>Locations of nodes will be tracked and recorded</li> </ul>	No increase in existing project risk profile.

## 6. Training and Performance Monitoring

This section outlines measures that ensure that each employee or contractor working on, or in connection with, the activity is aware of his or her responsibilities in relation to the EP and has the appropriate competencies and training. It also summarises environmental monitoring requirements for the survey.

### 6.1 Training and Awareness

#### 6.1.1 Competence and Training

A competent, fully-resourced organisation and vessel is a key component to ensure all personnel are aware of the environmental obligations.

As part of the contractor selection process, Origin conducted thorough due diligence to ensure that Geokinetics has in place procedures to ensure the correct selection, placement, training and ongoing assessment of employees, with position descriptions for key personnel being readily available.

Geokinetics has in place procedures to identify the training needs of an individual to competently perform his/her role, including the need to undertake corporate and vessel inductions. This is managed through Geokinetics' Competence and Training procedures, which include guidelines on personnel training, orientation and a 'green hands' (new crew) program. The Health, Safety and Environment (HSE) Training Program Guidelines address Geokinetics' commitment and responsibilities with regard to corporate training.

Geokinetics maintains a Training Matrix and a Training Needs Analysis Matrix to ensure all personnel are appropriately trained in the tasks required to safely and effectively perform in the position they hold. All personnel are supplied and coached through their Job Descriptions that outline the process required to complete the task and the QHSE Responsibilities and Accountabilities that are enforced while doing so.

Task-specific training is conducted by Content Experts for personnel assigned to roles that are traditionally exposed to heightened but managed levels of risk. Content Experts are almost exclusively Department Supervisors who possess the required competencies to firstly impart their knowledge and provide the necessary tools for safe execution of the job and secondly, are able to monitor the performance of personnel under their supervision.

Regular QHSE training is conducted by the onsite HSE Advisors. Geokinetics will review all personnel training matrices for completion of the minimum Geokinetics and Origin training requirements prior to mobilising to the project site.

#### 6.1.2 Emergency Response Exercises

Origin's Southern Australia bridging Emergency Response Plan (ERP) will be tested:

- Prior to the commencement of the survey;
- When there is a significant amendment to the Bridging ERP;
- Not later than 12 months after the most recent test; and
- In accordance with Origin's Emergency Response Exercise Planning and Reporting Procedure.

The OPEP details the OPEP review triggers, the training and competency requirements for personnel involved in the survey activity and the required OPEP testing frequency, together with the objectives of those exercises.

#### 6.1.3 Environmental Inductions

All personnel working on the survey will be provided with Origin 'Leading HSE' training.

A survey-specific HSE induction for all project personnel will also be undertaken prior to the survey commencing.

#### 6.1.4 Oil Spill Response Training

Regular training of vessel crew in SMPEP procedures is a MARPOL requirement for vessels over 400 gross registered tonnes (Annex 1, Regulation 37). SMPEPs are in place for the nominated vessels. During the contractor selection process, Origin ensured that Geokinetics has been implementing this requirement (as appropriate) or for smaller class vessels, equivalent training is undertaken.



### 6.1.5 Marine Mammal Observers

Origin has contracted appropriately trained and experienced MMOs for the survey.

The MMOs will provide an information session to vessel survey personnel at the start of the survey regarding their fauna observation duties and the communication protocols required with the survey operators to ensure shut downs and power downs occur efficiently.

### 6.1.6 Toolbox Talks and Sunday HSE Meetings

Environmental matters will be included in daily toolbox talks as required for the specific task being risk assessed. Environmental issues will also be addressed in weekly HSE meetings, where all survey crew will participate with the Origin Field Manager and Survey Party Manager in discussing HSE matters that have arisen during that week's operations, and issues to consider for the following week.

## 6.2 Emergency Response and Preparedness

Survey-specific emergency response procedures for the proposed survey are included in the Bridging ERP. The ERP contains instructions for vessel emergency, medical emergency, search and rescue, reportable incidents, incident notification and emergency contact information.

In the event of an emergency of any type, the relevant Vessel Master will assume overall onsite command and act as the Emergency Response Coordinator (ERC). All persons aboard the vessel/s will be required to act under the ERC's directions. The Origin Seismic Field Manager will maintain communications with the Origin Emergency Team Leader and/or other emergency services in the event of an emergency. Emergency response support will be provided by Origin as required by the situation.

Survey vessels will have equipment aboard for responding to emergencies, including but not limited to lifesaving appliances, medical equipment, firefighting equipment and oil spill response equipment.

### 6.2.1 Adverse Weather Protocols

During adverse weather, Vessel Masters are responsible for the following:

- Ensuring the safety of all personnel on-board;
- Monitoring all available weather forecasts and predictions;
- Initiating the vessel safety management system, vessel HSE procedures and/or vessel ERP;
- Keeping the Survey Party Manager and Origin Seismic Field Manager fully informed of the prevailing situation and intended action to be taken;
- Assessing and maintaining security, watertight integrity and stability of vessel; and
- Proceeding to identified shelter location(s) as appropriate.

Other appropriate responsibilities shall be taken into consideration as dictated by the situation.

In addition to in-vessel VHF marine radio weather services, daily weather forecasting from a designated weather forecast will be provided to monitor weather within the acquisition area over the duration of the survey.

### 6.2.2 Vessel Emergencies and Oil Spills

Geokinetics will have a vessel-specific SMPEP and an ERP (or equivalent appropriate to vessel class). The vessel-specific documentation will include procedures for the following:

- Vessel incidents – collision, grounding, hull damage, man overboard, equipment failure;
- Waste management;
- Hazardous materials and handling; and
- Hydrocarbon and chemical spills.

The SMPEP (or equivalent) includes information about initial response, reporting requirements and arrangements for the involvement of third parties having the appropriate skills and facilities necessary to respond effectively to oil spill issues. The SMPEP will be the principal working document for the vessel and crew in the event of a marine oil spill incident. This document will include specific emergency procedures including steps to control discharges for spills relating to hull damage, grounding and stranding, fire and explosion, collisions, vessel listing, tank failure, sinking, and vapour releases. The SMPEP (or equivalent) also includes requirements for regular drills of the plan and revision following drills or incidents.

The Vessel Master will ensure that all crew on board are fully aware of the vessel-specific requirements and that drills and exercises for vessel-related incidents are conducted.

### 6.3 Routine and Incident Recording and Reporting

All breaches of this EP are considered non-compliances. Non-compliances may be identified during an audit, inspection, crew observation or as a consequence of an incident. Detailed routine and incident recording and reporting requirements are outlined in the full EP.

### 6.4 Monitoring

#### 6.4.1 Environmental Monitoring

Origin will maintain a quantitative record of emissions and discharges as required under OPGGS Regulation 16(7). Table 6.1 summarises the monitoring requirements for the survey.

**Table 6.1. Summary of the Enterprise 3DTZSS environmental monitoring program**

Aspect	Monitoring requirement	Frequency
<b>Planned activities</b>		
Underwater sound	MMO megafauna visual observations during seismic data acquisition.	Continuous during survey.
Atmospheric emissions	Fuel use.	Tallied at end of survey from daily reports and/or bunker receipts.
Waste disposal	Weight/volume of wastes sent ashore (including bilge waters, sewage and putrescible waste, solid/hazardous wastes).	Tallied at end of survey from the survey-specific waste manifest. Updated during each backload in the Garbage Record Book.
<b>Unplanned activities</b>		
Interference with merchant and fishing vessels	Ongoing patrol for, and communications with, third-party vessels by the survey scout vessel.	Continuous during survey.
Interference or damage to shipwrecks	Ongoing surveillance and reporting of disturbance to shipwrecks within the acquisition area.	Continuous during survey.
Introduction of IMS to acquisition area	Ongoing surveillance and reporting of suspected IMS within the acquisition area.	Continuous during survey.
Vessel strike or entanglement with cetaceans	MMO continuous megafauna observations.	Daily for duration of survey.
Diesel spill	Monitoring in line with the OPEP.	As required.
Commercial & recreational diving impacts	Diver complaints as a result of the survey	Continuous during survey.

### 6.5 Audit and Review

Environmental performance of the survey will be reviewed in a number of ways. These reviews are undertaken to ensure that:

- Environmental performance standards to achieve the environmental performance objectives are being implemented, reviewed and where necessary amended;
- Potential non-compliances and opportunities for continuous improvement are identified; and
- All environmental monitoring requirements have been met before completing the activity.

The following arrangements will be established to review environmental performance of the activity:

- Due diligence pre-survey audit – audit(s) of the vessels will be carried out prior to the survey (and after contract award) to ensure that procedures and equipment for managing routine discharges and emissions are in place to enable compliance with the EP.
- Internal operations inspections – the Origin Seismic Field Manager will continually supervise the survey, ensuring adherence to the environmental controls specified in this EP. Regular inspections using an environmental checklist will be completed and issued to Origin's Survey Project Manager.

A summary of the EP commitments for the activity will be distributed aboard the vessels, and implementation of the environmental performance standards will be monitored by the Origin Seismic Field Manager.

Any non-compliance with the environmental performance standards outlined in this EP will be subject to investigation and follow-up action.

#### 6.5.1 Management of Non-compliance

In response to any non-compliances with the EP, a non-conformance report (NCR) is issued by the Origin Seismic Field Manager to the Survey Party Manager, and a corrective action request (CAR) is generated by the Survey Party Manager.

The corrective action will specify the remedial action required to fix the breach and prevent its reoccurrence and is delegated to the person deemed most appropriate to fulfil the CAR. The corrective action is closed out only when the remedial action has been verified by the Vessel Master and signed off. This process is maintained by the Origin HSE Supervisor through the Origin Collective Intelligence System (OCIS) incident tracking system.

Non-compliances are communicated to the offshore crew during daily toolbox meetings before each shift and at weekly HSE meetings.

Origin will carry forward any non-conformances identified during the project for consideration in future surveys to assist with continuous improvement in environmental management controls and performance outcomes in future operations.

All personnel have the authority to stop work at any time if HSE incidents breach or threaten to breach Origin's HSE standards and/or this EMP's commitments, or if the Origin Seismic Field Manager is not satisfied that measures are in place to avoid a repeat of the incident.

## 7. Oil Pollution Response Summary

This section summarises the OPEP arrangements in place for marine hydrocarbon spill incidents associated with the survey, which supports the survey vessel's SMPEP (or equivalent according to class).

### 7.1 Oil Pollution Emergency Plan

A complete outline of the arrangements in place to deal with hydrocarbon or chemical spill incidents associated with the survey is provided in the Enterprise 3DTZSS OPEP (VIC-9000-ENV-PLN-11023635) and ERP (VIC-9000-ENV-PLN-11003479).

#### 7.1.1 Objectives

The specific objectives of a response to any oil spill relating to the survey are:

- Minimise any further discharge of oil from the vessel;
- Contain any spilled oil products on board the vessel;
- Limit the spread of oil at sea;
- Recover spilled oil, as far as safely practicable within the capabilities of the vessel resources, to prevent oil reaching environmentally sensitive areas or impacting on commercial or other values of the area; and
- Ensure rapid notifications of any spill or potential spill in accordance with regulatory requirements and to facilitate any escalation of the response beyond Level 1.

#### 7.1.2 Response

Due to the small volumes of marine diesel that may be spilled in the event of a vessel-to-vessel collision or vessel grounding, the nature of marine diesel, the generally rough nature of the nearshore seas and the generally rocky cliffs present in and around the survey area, the chosen spill response strategy is to allow for natural remediation and to monitor the spill.

Many of the other response strategies available to deal with hydrocarbon spills are not viable for marine diesel, given the quick spreading nature of diesel and the short time taken to reach shore.

#### 7.1.3 Response Equipment

The survey vessels will be equipped with a spill response kit suitable for the response to a Level 1 spill of oil on deck.

In the event of a Level 2 spill, equipment will be provided by the relevant Control Agency, potentially accessing additional resources through AMOSC as required.

AMSA's aerial surveillance capability includes its fleet of Dornier Search and Rescue aircraft. If AMSA aircraft are unavailable, aerial surveillance capability can be leveraged through an existing Origin agreement with Adagold Aviation who provides 24/7 support for any Origin charter need. These fixed wing aircraft can be used to support AMSA and provide aerial surveillance capability.

Origin also has existing contacts in place to support its aviation requirements of the Otway Basin through Bristow.

A trained observer must be present on surveillance aircraft to identify oil on the water and suitably experienced observers can be obtained through AMOSC or AMSA.

#### 7.1.4 Oil Spill Response Preparedness

The OPEP shall be reviewed and updated as necessary in response to one or more of the following:

- At least once every 12 months;
- Following any project changes that may affect the Oil Spill Response coordination or capabilities;
- Following routine testing of the plan; and/or
- After any activation of the plan.

At a minimum, this OPEP will be tested through desktop exercises:

1. Prior to the commencement of the survey;
2. When a significant modification to the plan has occurred; and/or

3. At least once per year.

Exercises shall be undertaken in accordance with the Origin Emergency Response Exercise Planning and Reporting Procedure. This details responsibilities, accountabilities, types of exercises, scenarios and reporting.

Scenario exercises shall be run to test and verify the adequacy of staff training, the emergency response systems and procedures in place and the response to potential major accident events.

## 7.2 Operational and Scientific Monitoring Program

Operational (Type 1) monitoring is the responsibility of the Combat Agency and provides information on the extent and characteristics of the spill, the predicted fate of the spilled hydrocarbon and its immediate consequences, and assess the efficacy of response activities that are being undertaken. If the relevant combat agency requires additional support to conduct operational monitoring, Origin has the ability to engage aviation resources for aerial observations, oil spill modelling and subject matter experts through AMOSC.

Scientific (Type 2) monitoring following a significant spill is the responsibility of Origin. Depending on the nature and extent of the spill, the need for scientific monitoring will be determined by the Origin Emergency Response Team, in consultation with relevant government agencies, to determine the environmental effect, and the rate and success of recovery of the affected habitats.

Relevant monitoring that may be initiated from the Origin Otway Basin scientific monitoring plan has been included in Section 9 of the OPEP, including triggers for initiation. This plan will be implemented in accordance with the OSMP Implementation Plan for Origin's operations in the Otway Basin and contains information and arrangements for resources required to execute scientific monitoring at the time of an incident including vessels, consultants and laboratories.