VIC-9000-ENV-PLN-00007

Integrated Gas

CROWES FOOT 3D MARINE SEISMIC SURVEY

Environment Plan Summary

Review record

Rev	Date	Reason for issue	Author	Reviewer/s	Approver
A	10/11/2015	Issued for internal review	G. Pinzone	T. Hatfield V. Brady L. French P. Dubiodin N. Millar	
0	13/11/2015	Issued to NOPSEMA	T. Hatfield	-	E. Brand
1	2/12/2015	Re-issued to NOPSEMA	G. Pinzone	T. Hatfield	E. Brand

THE THREE WHATS

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

Table of contents

1. Introduction 4
2. Proponent 4
3. Location 4
4. Activity Description 6
   - 4.1 Timing 6
   - 4.2 Survey Programme 7
     - 4.2.1 Line Turns 8
     - 4.2.2 Air Guns 8
     - 4.2.3 Streamers 8
     - 4.2.4 Data Collection and Analysis 9
   - 4.3 Vessels 9
     - 4.3.1 Survey Vessel 9
     - 4.3.2 Support Vessels 10
     - 4.3.3 Maritime Safety 10
   - 4.4 Survey Summary 11
5. Stakeholder Consultation 12
6. Existing Environment 19
   - 6.1 Conservation Values and Sensitivities 19
     - 6.1.1 Commonwealth Marine Reserves 19
     - 6.1.2 World, Commonwealth and National Heritage Places 19
     - 6.1.3 Wetlands of International Importance 19
     - 6.1.4 Victorian Marine Protected Areas 19
     - 6.1.5 Key Ecological Features 20
   - 6.2 Cultural Environment 21
     - 6.2.1 Maritime Archaeological Heritage 21
     - 6.2.2 Aboriginal Heritage 21
   - 6.3 Physical Environment 22
     - 6.3.1 Climate 22
     - 6.3.2 Winds 22
     - 6.3.3 Ocean Currents 22
     - 6.3.4 Bathymetry 22
     - 6.3.5 Seabed Sediments 22
     - 6.3.6 Sea Temperature 23
     - 6.3.7 Ambient Underwater Sound Levels 23
     - 6.3.8 Coastal Environment 23
   - 6.4 Biological Environment 23
     - 6.4.1 Benthic invertebrates 23
     - 6.4.2 Plankton 24
     - 6.4.3 Invertebrates 24
     - 6.4.4 Fish 24
     - 6.4.5 Cetaceans 25
     - 6.4.6 Pinnipeds 29
     - 6.4.7 Marine Reptiles 29
     - 6.4.8 Avifauna 29
     - 6.4.9 Threatened Ecological Communities 30
   - 6.5 Socio-economic Environment 30
     - 6.5.1 Settlements 30
     - 6.5.2 Shipping 30
     - 6.5.3 Petroleum Exploration and Production 30
     - 6.5.4 Commercial Fisheries 31
7. Environmental Impact Assessment 33
8. Hydrocarbon Spill Preparedness and Response 38

9. Implementation Strategy 40
9.1 Environmental Management System 40
9.2 Key Roles and Responsibilities 40
9.3 Training and Awareness 40
9.4 Emergency Response and Preparedness 40
9.5 Incident Recording and Reporting 41
9.6 Environmental Monitoring 41
9.7 Audit and Review 41
10. Further Information 41

1. Introduction

Origin Energy Resources Limited (Origin) is proposing to undertake the Crowes Foot three-dimensional (3D) marine seismic survey (herein referred to as the 'survey') in the Otway Basin off southwest Victoria in exploration permits Vic/P69 and Vic/P43. The survey will predominantly be undertaken within Vic/P69 but will ingress Vic/P43 in order to produce seamless data coverage with existing seismic surveys.

The full fold coverage area for the survey (the 'acquisition area') will cover up to approximately 873 square kilometres (km^2) in water depths ranging from approximately 40 metres (m) to 90 m. Surrounding the acquisition area is an 'operational area', used for conducting operations ancillary to achieving coverage within the acquisition area.

At its nearest boundaries, the acquisition area for the survey is located 6.3 km (3.4 nm) southwest of Moonlight Head, Victoria and 66.8 km (36.1 nm) northwest of the northern tip of King Island, Tasmania (Figure 1).

The survey is expected to take place over approximately six weeks during the period 1st October to 31st January, 2015/16 or 2016/17. Exact timing is contingent on the confirmation of contractor resources and fair sea state conditions suitable for marine seismic acquisition.

The Environment Plan (EP) for the activity was approved by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) on the 4th of November 2015.

2. Proponent

Origin Energy (ASX: ORG) is the leading Australian integrated energy company with market leading positions in energy retailing (approximately 4.3 million customers), power generation (approximately 6,000 MW of capacity owned and contracted) and natural gas production (1,093 PJ of 2P reserves and annual production of 82 PJe). To match its leadership in the supply of green energy, Origin also aspires to be the number one renewables company in Australia.

Through Australia Pacific LNG, its incorporated joint venture with ConocoPhillips and Sinopec, Origin is developing Australia's biggest CSG to LNG project based on the country'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 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 is also in the process of developing the Halladale and Speculant gas fields, located in Victorian state waters (Vic/L1(V)) west of Port Campbell, that will tie in to the Otway Gas Plant.

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

3. Location

The area defined as the 'acquisition area' is located entirely within Commonwealth waters of the Otway Basin, with the coordinates provided in Figure 1. The acquisition area is the polygon of full fold coverage, which is 873 km^2. At its nearest point, the acquisition area is 15 km south of Princetown and 24 km south of Port Campbell.

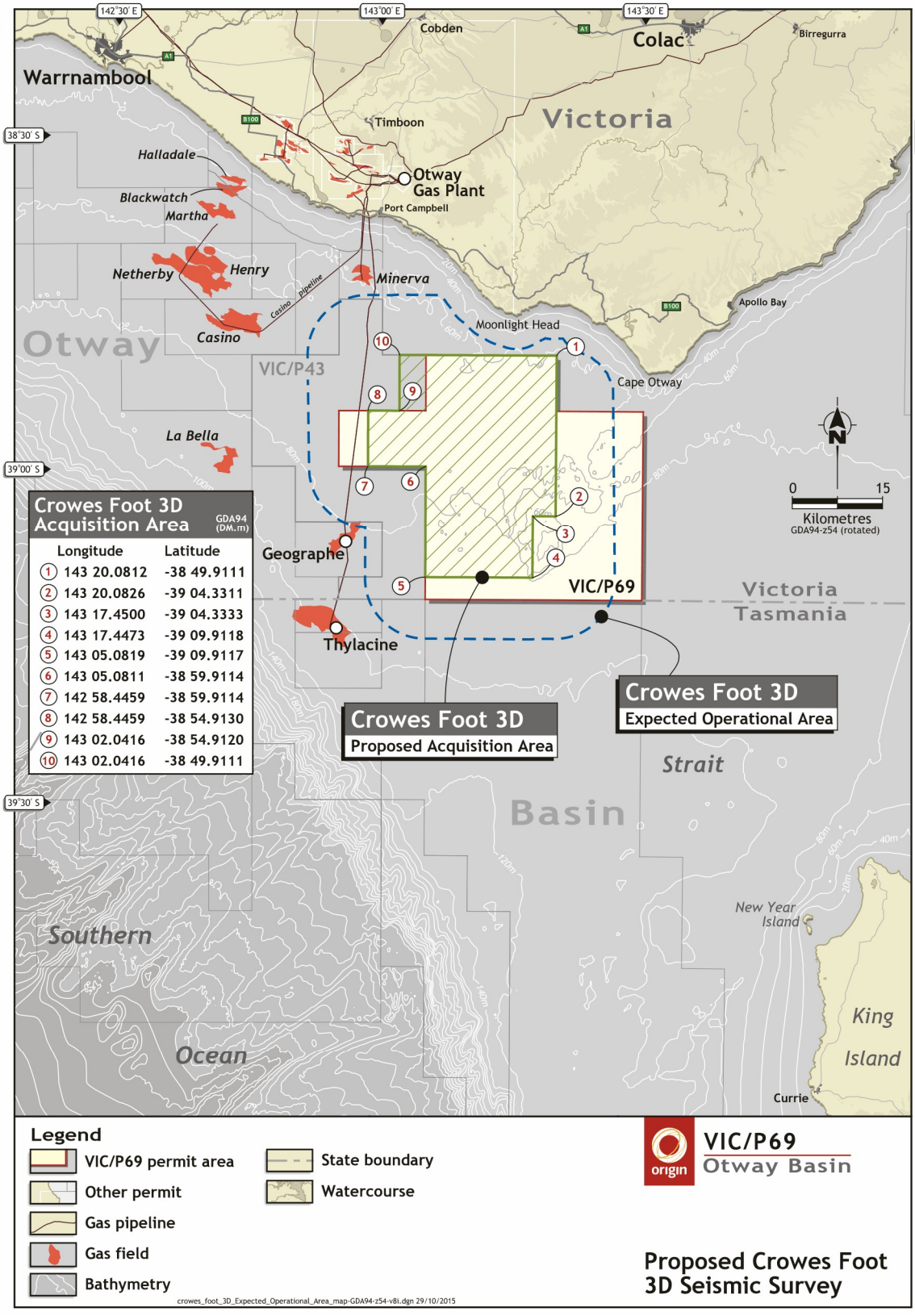


Figure 1. Crowes Foot 3D marine seismic survey location

The area defined as the 'operational area' is the physical area used for conducting operations ancillary to achieving coverage within the acquisition area, which generally encompasses a 10 km buffer around the acquisition area, though following the state waters boundary to the north. The operational area is 2,450 km^2. Activities conducted in the operational area include vessel approach, vessel turns, testing of the seismic source and miscellaneous maintenance operations. The vessel may sail beyond the operational area boundaries, including for vessel turns, during times of unfavourable environmental conditions (weather, currents, etc) or due to operational constraints (equipment maintenance/repair, obstructions, etc.). However, the source will not be activated outside the operational area.

The water depth of the operational area varies between 35 m to 90 m, with the deepest water depths situated in the south. The proximity of the acquisition area to key features in the region is listed in Table 1.

Table 1. Distance to key features in the region

Locality	Distance from acquisition area
Nearest landfall (Moonlight Head)	6.3 km (3.4 nm) north
King Island	69.5 km (37.5 nm) southeast
Commonwealth Marine Reserves	
Apollo	14.5 km (7.6 nm) east
Zeehan	69.4 km (37.2 nm) south
Victorian Marine Reserves	
Twelve Apostles Marine National Park	7.6 km (4 nm) north
The Arches Marine Sanctuary	21.3 km (11.5 nm) north
Marengo Reefs Marine Sanctuary	30 km (16.2 nm) east
Coastal towns	
Princetown	15.2 km (8.2 nm) north
Port Campbell	23.4 (12.6 nm) north
Peterborough	25.3 (13.6 nm) north-northwest
Oil and gas infrastructure	
Otway gas pipeline	Intersects both permits, but 1 km west of acquisition area at its closest point
Casino gas pipeline	12.5 km (6.7 nm) northwest
Minerva gas pipeline	15 km (8 nm) north

4. Activity Description

4.1 Timing

Origin has selected a survey window (1st October to 31st January in permit year 2015/16 or 2016/17) that balances operational requirements with environmental and socio-economic constraints, using recent past survey experience in the Otway Basin as a guide. Key considerations for survey timing are as follows:

- 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 peak pygmy blue whale feeding aggregation period near the operational area occurs from February to March (with a non-peak period either side of these months), which is outside the proposed survey window.
- Southern right whale peak mating and calving period occurs from mid-July to end of August, outside the proposed survey window.

- The rock lobster fishery opens on 15 November, so there is potential for overlap of activities if the Crowes Foot seismic survey occurs after this date. The abalone fishery operates all year but in near shore locations at depths of up to 30m (mainly using divers with a surface air supply) so is not likely to occur within the operational area. However, there is potential for some interference with this fishery if occurring near the northern boundary of the operational area.
- Australian fur-seals breed and feed during the proposed survey window, but this occurs onshore.
- Little penguins are present in the region year-round, with breeding occurring over the summer months.
- The Bonney Coast upwelling, with associated aggregations of krill that form an important feeding resource for the pygmy blue whale, peaks from December to April.
- Two recent seismic surveys undertaken by Origin in areas adjacent to the proposed Crowes Foot survey were conditioned by a Commonwealth regulatory agency to take place only in November and December (which were subsequently successfully undertaken during this these months).
- The first attempt to undertake the Astrolabe seismic survey during February 2010 had to be postponed due to the high number of whales encountered. This experience has been factored into 'lessons learned' for the planning of seismic surveys in nearshore areas of the Otway Basin.

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 uses of the area or periods of increased environmental sensitivity. Origin believes that the factors outlined above combine to make October to January the most suitable time to conduct the Crowes Foot seismic survey.

4.2 Survey Programme

The survey proposed by Origin is a typical 3D seismic survey similar to most others conducted in Australian marine waters (in terms of technical methods and procedures). No unique or unusual equipment or operations are proposed.

The survey vessel will acquire the seismic data by towing two acoustic source units operating alternatively, one discharging as the other recompresses. Each unit consists of up to 3 arrays of various sized airguns. There will be 6 to 14 hydrophone 'streamer' cables approximately 6,000 m long and 100 m apart towed behind the vessel at 6-50 m below the water surface (depending on bathymetry). The vessel will tow back and forth across the acquisition area in sail lines that are approximately 400m (8 streamers) to 600m (12 streamers) apart.

A series of acoustic pulses (discharged every 8 to 10 seconds) will be directed by the source down through the water column and seabed. The released sound will be attenuated and reflected at geological boundaries and the reflected signals are detected using hydrophones arranged along the streamers that are towed behind the vessel at an approximate depth of 6 m and 50 m. The reflected sound is evaluated to provide information on the structure and composition of the geological formation to identify and map hydrocarbon reserves below the seabed (Figure 2).

The survey will be conducted 24 hours a day except when sea states exceed operational parameters (~4.5 m significant wave height).

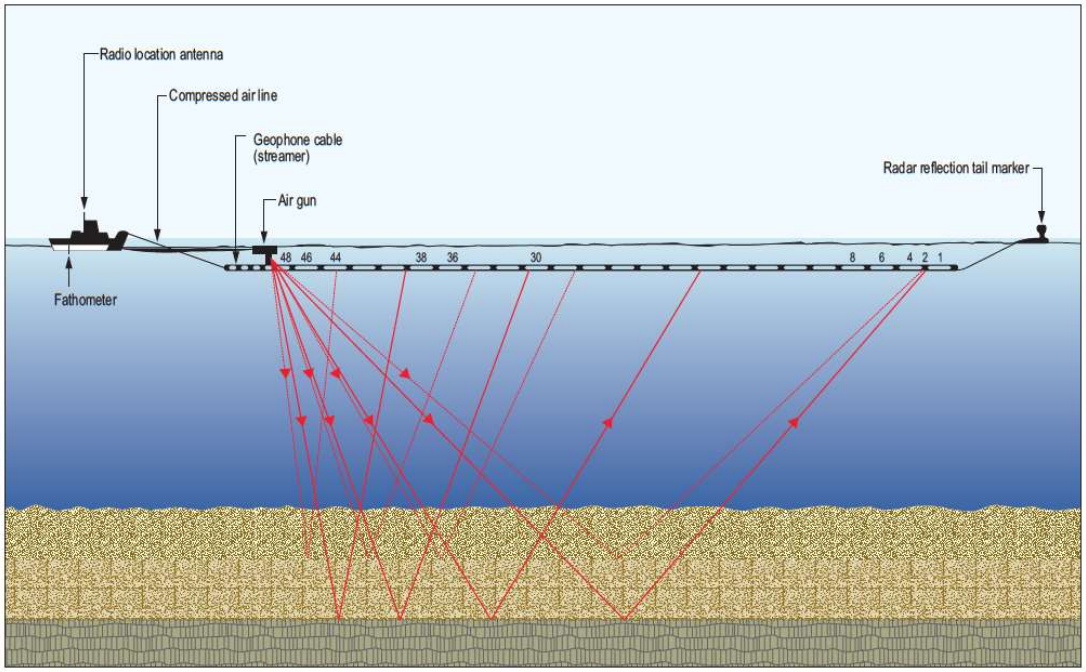


Figure 2. Typical marine seismic survey reflection schematic

4.2.1 Line Turns

The proposed survey will use the conventional methods of data acquisition where data is acquired along straight lines within the acquisition area, with air guns in use as the vessel turns (outside of the acquisition area) and runs into the next line. The number of sail lines has yet to be finalised, but is likely to be between 50 and 80 (dependent on streamer configuration), spaced approximately 400-600m apart. The orientation of the sail lines is yet to be decided, but is likely to be north-south.

4.2.2 Air Guns

The seismic energy source consists of individual airguns arranged in an array. The airguns in the array are strategically arranged to direct most of the sound energy vertically downward. The exact parameters of the airgun arrays will be finalized after Origin has chosen its seismic contractor. A generic description of possible airgun arrays is provided here and is meant to give the reader a sense of the range of array parameters that may be used.

The total volume of the airgun arrays utilized in the survey will be between 2,500 to 3,300 in^3, with a nominal operating pressure of 2,000 pounds per square inch (psi). The array will be towed at depths ranging from 5-8 m, approximately 100 m to 150 m astern of the seismic vessel.

The airgun arrays are suspended at a controlled depth and nominally generate an acoustic pulse every 18.75 m or approximately every 8-10 seconds. The distance and time between acoustic pulses may be adjusted if this will result in improved data.

4.2.3 Streamers

The streamers will be approximately 6,000 m in length with separations of 100 m between each (Figure 3). Each streamer will have depth controllers and emergency recovery units, and may have further positioning and steering units positioned not more than 600 m apart along the streamer length. The emergency recovery unit is a device attached to the streamer at intervals of ~300 m. It senses if the streamer sinks below a pre-determined depth, and in such events, deploys an automatic pressure-activated airbag to float the streamer back to the surface.

The streamers will be towed between 6-50 m under the water's surface, however, if deep streamer technology is available and the bathymetry of the selected acquisition area allows their use, the streamers may be tapered to depths less than 50 m. Streamers will not be deployed within 15 m of the seabed so as to avoid seabed features such as rocky reefs and shipwrecks. Spot checks of bathymetry will be performed using a standard onboard echo-sounder (essentially a 'fish finder') to validate the accuracy of the admiralty charts and ensure that streamer depths are appropriately set to avoid seabed features. Based on previous seismic surveys undertaken in the region, Origin notes that the admiralty charts are known to be very accurate.

An overall streamer spread width of between 700 m (8 streamers) and 1,100 m (12 streamers) is controlled by adjusting the rope lengths towing the barovane doors with an overall separation from door to door of approximately 900 m (8 streamers) to 1,300 m (12 streamers).

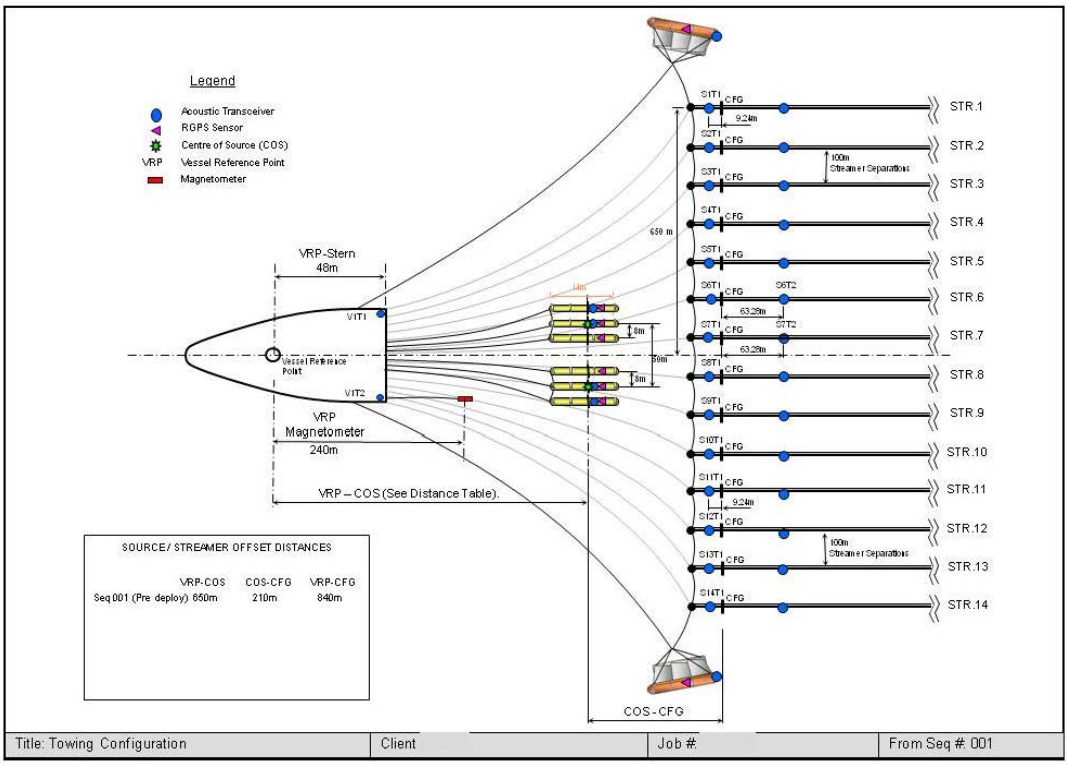


Figure 3. Typical towing diagram. As supplied by PGS.

The streamer medium will be either a solid foam construction or gel-filled. The streamers will display appropriate navigational safety measures such as lights and reflective tail buoys.

4.2.4 Data Collection and Analysis

The data is measured by hydrophones in the streamers and transmitted by fibre optics to the recording room on the seismic survey vessel. The data is 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 onboard check that the data has been acquired to a satisfactory quality.

After the data is 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.

4.3 Vessels

4.3.1 Survey Vessel

The survey will be conducted using a purpose-built seismic vessel with support duties provided by at least at least two smaller dedicated vessels. The survey vessel will be approximately 100 m in length and approximately 40 m wide and carry up to a total of 70 persons. While the specific survey vessel that will be used for this survey is yet to be determined, it is likely to be similar to the *MV Polarcus Asima* contracted by Origin for the 2014 Enterprise 3D seismic survey in the Otway Basin (Figure 4).

Figure 4. The *MV Polarcus Asima* during the Enterprise seismic survey

Given the duration of the survey, all vessels may require refuelling in order to complete the survey. All vessels will bunker with marine diesel. The survey vessel will undertake refuelling either at sea and/or in port.

4.3.2 Support Vessels

The survey vessel will be supported by a guard vessel and two scout vessels. Preference will be given to engaging local vessels for these support roles.

The guard vessel will be approximately 30 m in length and approximately 10 m wide and may carry up to a total of 15 persons. The guard vessel will be experienced with towing requirements.

The scout vessels will be approximately 20 m in length and 6 m wide, have a rope hauler and carry up to 7 persons. They will undertake scouting, marine mammal observation, chase duties and the removal of entanglement hazards as necessary for the safe conduct of the survey. The operators of the support vessels will be licensed to move any unattended fishing gear that may have been lost, drifted or been deployed in the area prior to, or during, the survey period. This avoids damaging fishing equipment and lowers risk of entanglement with the towed seismic equipment. The vessels will liaise with any fishermen nearby to minimise interactions between the survey and fishing.

4.3.3 Maritime Safety

The vessel and towed array of equipment will operate in accordance with the Convention on the International Regulations for Preventing Collisions at Sea (COLREG, 1972).

The guard vessel will actively monitor a safety zone around the survey vessel. The survey vessel operator will issue a vessel positioning notification to the Australian Hydrographic Service (AHS), who will in turn publish the survey location in the Notice to Mariners (published fortnightly). A daily Auscoast warning of the survey vessel's location will also be issued to all vessels by AMSA 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 Master and Officer of the Watch of the survey vessel are responsible for maintaining control of the seismic fleet vessel operations and for establishing and maintaining communication with other vessels and marine traffic during the survey. The support and guard vessels follow all instructions from the survey vessel and communicate with other marine traffic during the survey.

Supplementary to radar detection, the support and the guard vessels will have additional transmitting beacons fitted for the duration of the survey. The vessels will use 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 74).

4.4 Survey Summary

Table 2 summarises the proposed survey parameters.

Table 2. Summary of acquisition parameters for the proposed survey

Parameter	Detail
Earliest commencement date	1st October 2015
Latest end date	31st January 2017
Duration of survey	Approximately 6 weeks
Water depths	~35-90 m
Acquisition area	873 km^2
Operational area	2,450 km^2
Operating period	24 hours, 7 days per week
Survey exclusion period	February to September (inclusive)
Survey contractor	Unknown at the time of writing
Air guns	
Total volume of single source array	2,500 – 3,300 cui
Source operating pressure	2,000 psi
Source interval	18.75 m horizontal distance (8-10 seconds)
Compressed air source depth	5-8 m
Lines/streamers	
Number of sail lines	To be confirmed, based on streamer configuration
Orientation	Nominal north-south, though other azimuths may need to be acquired to obtain full-fold data acquisition
Line separation	To be confirmed, based on streamer configuration
Number of streamers	6 to 14
Streamer length	Approximately 6,000 m
Streamer depth (approx.)	6-50 m depending on bathymetry
Streamer separation (approx.)	100 m
Survey vessel details	
Name	Unknown at time of writing
Vessel speed (up to)	8–9 km/hr (i.e., 4–4.5 knots)
Refuelling	At-sea and/or in port
Support vessels	At least 2

5. Stakeholder Consultation

Origin developed a Stakeholder Engagement Plan (SEP) to provide guidance on how to communicate and engage with stakeholders in the development of the EP for the proposed Crowes Foot 3D seismic survey. The SEP provides an operating framework and structured approach to our interactions with external stakeholders.

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, including:

- Halladale and Speculant gas development (current);
- Enterprise 3D seismic survey (2014);
- Geographe pipeline installation (2013);
- Geographe drilling (2012-13);
- Astrolabe 3D seismic survey (2013); and
- Speculant 3D transition zone seismic survey (2010).

Further research was also undertaken to ascertain whether there were any other stakeholders (not previously identified) whom may be impacted by the proposed survey.

Origin proactively approached a wide range of stakeholders identified as having functions, interests or activities that may be affected by the proposed survey. Stakeholders were encouraged to advise if they believed there was any impact, raise concerns, ask questions and provide feedback via email or contact Origin directly to discuss or arrange to meet. The tools and methods that were, and continue to be used for stakeholder consultation include the distribution of a project information sheet, distribution of fishing effort maps, face-to-face meetings, distribution of survey information via fishing associations, establishment of a project hotline and dedicated project email, with all communication recorded in a stakeholder engagement log.

Table 3 summarises the stakeholder responses provided in response to implementation of the SEP. Origin has incorporated this stakeholder feedback into the EP, and communicated directly with stakeholders regarding Origin's assessment of merit of their feedback. In response to stakeholder feedback, Origin has incorporated specific measures in the EP submission to address issues raised during consultation. These measures include:

- Increasing the seismic source shut-down radius to 3 km for the blue whale and the southern right whale;
- Utilizing passive acoustic monitoring (PAM) during non-day light hours to detect the presence and location of whales;
- Holding a cetacean strategy meeting each evening during the survey to assess all available data on whale presence, to inform the operational strategy for the following day.
- Use of two support vessels to undertake marine fauna observations (cetaceans, seals, penguins and turtles) during daylight hours for the duration of the survey.
- Excluding an area above the 'Big Reef' from the acquisition area, including all areas above the 40m contour and 90% of the area above the 50m contour.

In accordance with standard operating procedures, Origin shall prepare another SEP for the ongoing engagement of stakeholders during the preparation, execution and close-out of the survey. The SEP will include revised stakeholder map, timelines, consultation approach, key concerns and messages, record keeping protocols, and objection assessment and response, among other things.

Table 3. Stakeholder consultation summary

Stakeholder	Summary of Potential Impacts, Concerns, Claims of Stakeholder	Summary of Origin's Assessment and Response
Commonwealth Government		
Australian Fisheries Management Authority (AFMA)	Recommended Origin consult directly with fishing associations and refer to ABARES report. Under AFMA Deed of Confidentiality, responded to Origin's data request and provided data of fisheries overlapping operational area and fishing intensity, by way of number of vessels per month from 2009 to 2014.	Origin has reconciled this fishing effort with its stakeholder database, is confident that potentially affected stakeholders have been identified, survey will have minimal or no impact. Origin will maintain engagement before, during and after the survey.
Border Protection Control (BPC) Command	Forwarded information to relevant area within Border Protection Command. Advised no comment about proposed exploration activity was warranted but appreciated being informed.	Origin to provide updates as a courtesy.
Australian Maritime Safety Authority (AMSA)	Advised there will be significant shipping activity in permit area therefore collision risk, advised seismic vessel requirements, communication requirements from Origin.	Origin will engage throughout.
Department of Defence (DoD)	No objections. No comments.	Origin to provide updates as a courtesy.
Australian Hydrographic Service (AHS)	No concerns raised. Requested Origin to provide updates so they can issue notices to mariners.	Origin to ensure contractor provides updates so that AHS so they can issue notice to mariners.
Victorian Government		
Department of Economic Development, Jobs, Transport and Resources (DEDJTR) (Fisheries Victoria)	No concerns raised. Assisted Origin with supplying fishing effort data for state fisheries in operational area.	Origin will continue to engage the department and local Fisheries Victoria officers of survey activity, including dates once confirmed and any other updates that may assist them should they receive inquiries from commercial or recreational fishers.

Stakeholder	Summary of Potential Impacts, Concerns, Claims of Stakeholder	Summary of Origin's Assessment and Response
Department of Economic Development, Jobs, Transport and Resources (DEDJTR) (Earth Resources Regulation)	Confirmed that the DEDJTR has no regulatory role but expect to be kept informed generally. Also expected fishers in Victoria to take an interest in this survey and be concerned about risks to their commercial interests. In the case of any incident or issue that is likely to have an impact on Victoria (environment or otherwise) or an issue likely to receive community or media attention in the state of Victoria, asked that these be brought to their attention at the earliest possible time. Advised department is responsible for transport and Origin would be expected to link its emergency response and oil spill contingency plan arrangements seamlessly with those of the National Marine Oil Spill Contingency Plan 2011, Victorian Plan for Maritime and Environmental Emergencies and with Emergency Services Victoria in accordance with the applicable offshore legislation and NOPSEMA's direction.	Origin has and will continue comprehensive engagement with relevant persons with ongoing fishing activity in the proposed operational area. In the event that the survey is required to operate concurrently with fishing activity, Origin will engage with relevant fishers to identify any alternative operating arrangements to safely share the space and should this not be possible, will enter into compensation arrangements with relevant fishers.
Department of Environment, Land, Water and Planning (DELWP)	No response.	Provided information on mitigation measures for Southern Right Whales and Blue Whales. Will continue to engage before, during and after the survey.
Commercial Fishers		
Commonwealth Fisheries Association (CFA)	Recommended consultation best be undertaken at a fishing association level. Verified Origin's identification of fisheries potentially affected.	Origin made direct contact with SETFIA, SSFI, SSIA, VSFA. CFA will inform scallop members.
Seafood Industries Victoria (SIV)	Initial concerns: SIV has no capacity to engage members re proponents' EPs; consultation process doesn't allow feedback loop before EP submission; negative impact of seismic surveys on fish (discussions focussed on rock lobster); communication of compensation arrangements. Subsequent meeting: no further objections regarding impact; agreed to Origin's request to post details of survey to 433 members with licences for various fisheries in the operational area.	Origin understands that seismic survey activity has not impacted rock lobster larvae at the population level, supported by substantial catch variation over many years, with and without seismic survey activity, and advising established causes of variations. Explained approach to compensation. Ongoing engagement has enabled Origin to demonstrate response to feedback, knowledge of actual fishing activity in the operational area, distinct from licence holdings and breadth of engagement with stakeholders. Origin will engage further once survey dates are confirmed.

Stakeholder	Summary of Potential Impacts, Concerns, Claims of Stakeholder	Summary of Origin's Assessment and Response
Victorian Rock Lobster Association (VRLA) Markus Nolle, President and Apollo Bay rock lobster fisherman. Also representing Apollo Bay rock lobster fishermen.	Key concerns: seismic surveys occurring in prime fishing season; displacement and domino effect for fisherman; impact on eggs and larvae; milestone report on rock lobster research from UTAS that 'supports concerns'; frustrated at FRDC communications about research project. Advised a fair and more sustainable approach to compensation from Origin should require affected fishermen to remove pro-rata amount from season's quota so they don't get compensated by Origin whilst still fishing their whole quota which would cause displacement problems. Origin's fishing grid map is helpful in identifying fishermen. Supports communications to SIV members and placed notice of survey in VRLA newsletter. Sought information on improvements to seismic surveys / reduction of impacts, pre and post survey analysis in water columns.	Origin understands that seismic survey activity has not impacted rock lobster larvae at the population level, supported by substantial catch variation over many years, with and without seismic survey activity, and advising established causes of variations. Origin committed to further research through its co-funding of rock lobster research by IMAS/UTAS. FRDC advised of the danger of drawing conclusions from the milestone IMAS/UTAS rock lobster research report. Origin passed on feedback to FRDC about communication of research. Once survey dates are confirmed, Origin will re-engage affected stakeholders and plan to minimise impact on fishing due to timing and direction of survey and if this is not possible, will enter into agreement with relevant fishermen to compensate. Discussed history of seismic surveys, and alternative technologies for exploring for gas. Origin constantly assesses the latest technologies and would consider alternative technologies if they were commercially available and fit for the task. Re water column research, have discussed this with an international environmental consultancy who advised that it is not recommended during an active seismic survey. Plankton assemblages are extremely variable in space and time and any localised impacts from the seismic source are not likely to be distinguishable from natural variation. Origin will engage further once survey dates are confirmed.
Apollo Bay Fishermen's Coop (also VRLA members)	Concerned about number of seismic surveys and impact on gradual drop in quotas, drought years also cause poor catch, poor weather in October may prevent survey, if survey continues after 15 November would affect 3 fishermen who catch rock lobster off the Big Reef and would affect Apollo Bay Coop due to throughput of lobster sales and fuel. Understood mutual access rights and compensation principles.	Research shows no link between seismic survey activity and catch / effort outputs and there are many ecosystem / climate impacts on catch, therefore quotas. Origin will firstly plan to minimise impact on fishing due to timing and direction of survey and if this is not possible, will enter into agreement with relevant fishermen and coop to compensate. Origin will engage further once survey dates are confirmed.
South East Trawl Fishing Industry Association (SETFIA)	Initial concerns: assumed members would be affected but didn't know if trawling occurred in the operational area, critical of Origin's consultation and offered consulting services for stakeholder engagement. Appreciated Origin's visits to SETFIA at Lakes Entrance. Pleased at detailed maps tabled for discussion and based on these maps advised there didn't appear to be any or much trawling in the operational area. Noted Origin's commitment to advise further after data provided to Origin by AFMA. Felt that Origin should text known fishers in the area during survey operations. Confirmed Origin's assessment of minimal fishing effort in trawl areas, happy to forward emails from Origin to western trawl sector (before during and after survey)	In initial consultations Origin advised that the operational area was not generally subject to trawl fishing but requested SETFIA advise Origin if members were impacted. Origin subsequently verified from AFMA data, that there is relatively small fishing effort of Commonwealth managed fisheries in the operational area. Origin has reconciled this fishing effort with its stakeholder database, is confident that potentially affected stakeholders have been identified, the survey will have minimal or no impact on Commonwealth trawling activity. Nevertheless Origin will maintain engagement before, during and after the survey as a precaution, should fishermen change their intentions. Origin uses a text messaging system for this purpose, but will also pass on messages to SETFIA so they can advise their members. Origin will engage further once survey dates are confirmed.

Stakeholder	Summary of Potential Impacts, Concerns, Claims of Stakeholder	Summary of Origin's Assessment and Response
Port Campbell Professional Fishermen's Association	Remain opposed to marine seismic surveys which they believe have reduced rock lobster population in their region. Requested Origin carry out additional field research to place rock lobster pots under seismic survey. Advised members do not fish in operational area.	Origin understands that seismic survey activity has not impacted rock lobster larvae at the population level, supported by substantial catch variation over many years with and without seismic survey activity and, advising established causes of variations. Origin committed to further research through its co-funding of rock lobster research by IMAS/UTAS. Reviewed hypotheses and design of this research and believe further research is unnecessary until the published results of current research can be assessed. Will continue to inform survey dates as a precaution if fishing intentions change. Origin will engage further once survey dates are confirmed.
Warrnambool Professional Fishermen's Association	Remain opposed to marine seismic surveys which they believe impact larvae and have reduced rock lobster population in their region. No members have replied to advise an interest in the operational area.	Origin understands that seismic survey activity has not impacted rock lobster larvae at the population level, supported by substantial catch variation over many years with and without seismic survey activity and, advising established causes of variations. Origin committed to further research through its co-funding of rock lobster research by IMAS/UTAS. Origin will continue to inform survey dates as a precaution if fishing intentions change.
Portland Professional Fishermen's Association	No direct feedback from the President. One member advised sometimes fishes in area but will work around survey.	Will continue to inform survey dates for the one member who may fish in the area and as a precaution if fishing intentions change for others.
Victorian Abalone Divers Association (VADA)	No concerns raised. Has passed on information to members.	Will engage with members during operational planning for survey to verify if they plan to dive within 10km of the survey and if so, apply Origin's safe diving procedures.
Western Abalone Divers Association (WADA)	Advised they fish over 60 km away from operational area.	Inform as a courtesy.
Oil spill preparedness and response agencies		
DEDJTR (Emergency Risk & Resilience/Marine Pollution Team)	No specific comment regarding the survey. Advised their requirements in relation to offshore petroleum activities: http://www.transport.vic.gov.au/freight/marine-pollution	Acknowledged requirements and advised EP is being developed cognizant of stated requirements.
Australian Marine Oil Spill Centre Pty Ltd (AMOSC)	AMOSC expects to review all EPs and OSCPs in which AMOSC is named as part of the support mechanisms.	As a potential hydrocarbon spill from the seismic vessel would be dealt with directly by AMSA and would not receive AMOSC assistance or support, Origin has not formally consulted with AMOSC for this survey. A courtesy email was sent but no reply has been received.
Community, tourism, recreation		
Parks Victoria (Port Campbell & Apollo Bay)	Effective communication of survey in relevant recreational public boat ramps and ocean access points.	Will seek Parks Victoria cooperation to place information signage including survey timing, location, map, safe diving information and 24 hour phone contact number. Origin will continue to engage throughout.
Scuba Divers Federation of Victoria	Appreciative of notice of survey and shipwreck maps. No clubs operating in operational area but will pass onto Warrnambool, the closest club, plus general email list.	Origin has formal procedures to manage operations safely around diving activity and wish to meet and discuss if any dive events planned during the survey. Origin will advise survey dates once confirmed.

Stakeholder	Summary of Potential Impacts, Concerns, Claims of Stakeholder	Summary of Origin's Assessment and Response
Port Campbell Boat Charters. Surf 'n' Dive (Apollo Bay)	Main charters near survey are Loch Ard shipwreck. Don't often have long advanced notice of charters. Happy to have our contact details and work in with us if they do have a charter closer to the survey.	Origin has formal procedures to manage operations safely around diving activity and wish to meet and discuss if any dive events planned during the survey. Origin will advise survey dates once confirmed.
Victorian Recreational Fishers Association	Operational area supports a highly valued forage fish resource and also recreational fishing for southern blue fin tuna but pleased the survey timing is outside the peak tuna season and will consider implications for other marine species such as gummy sharks and snapper.	Normal practice for surveys to operate with scout vessels who communicate with any local recreational fishing vessels in the vicinity to manage safe survey operations. In addition, Origin advises AFMA who issue notices to mariners of approved exploration activity. Origin will communicate throughout.
Conservation interests		
The Blue Whale Study	Would like to see an Otway basin ecosystem approach to research and data sharing of whale species calving, foraging and migration and further aerial surveys, for which they can provide a service. Regarding aerial survey maps of whales done in the past for Origin, advised February 2011 survey was a good example of blue whales being close inshore, November 2012 showed them more widely spread across the continental shelf and December 2012 showed them concentrated near the outer shelf. Said there is no way of predicting where they will be in any given month, but this area has shown itself to be important feeding habitat for blue whales, even in recent poor upwelling seasons. Would prefer to see the 4-month possible survey window narrowed down to minimise potential impact with blue whales, especially during early summer.	Origin concurs with the feedback on variability of past blue whale sightings in the planned survey months and has reviewed available contemporary blue whale sighting data to tailor mitigation measures accordingly. Mitigation plans exceed standard requirements in EPBC policy 2.1, and have also been developed cognizant of past mitigation plans used by Origin in the Otway basin, and recently used by other proponents in adjacent permit areas. Advised window for this survey cannot be narrowed down at present, but will advise when confirmed. Origin will continue to engage throughout.

Stakeholder	Summary of Potential Impacts, Concerns, Claims of Stakeholder	Summary of Origin's Assessment and Response
Deakin University (Associate Professor John Arnould, School of Life and Environmental Sciences)	Potential for impacts on all of the top marine predators in survey area, directly or via impacts on the prey populations they depend on. Proposed dates coincide with the breeding seasons of the main resident seabird (penguins, shearwaters, gannets) and marine mammal (Australian and New Zealand fur seal) species. Potential for effects to have substantial demographic impacts. Acquisition area is mostly out of the foraging range of little penguins from the London Bridge colony, but is well within the known foraging areas of the other species. Unfortunately, the direct effects of seismic surveys on shearwaters, gannets and fur seals, and the effects on their prey species, is not known, so not possible to estimate impacts of survey. As with the tracking of penguins before, during and after a seismic survey that was conducted last year (analysis still in progress), John's research group has the capacity to do the same with the gannets, shearwaters and fur seals as part of ongoing projects. John offered for discuss the possibilities with Origin further.	Seismic surveys have been conducted in the Otway Basin and central and eastern Bass Strait for several decades and, as far as Origin is aware, there is no evidence indicating negative impacts at the population level on these resident bird and fur seal species attributable to seismic surveys. Major influences on pinniped populations in Bass Strait appear to be recovery post-sealing (Kirkwood *et al.* 2009 and Kirkwood *et al.* 2010). Australasian gannet populations have increased (Bunce *et al.* 2002) and little penguin populations appear at least stable (Schuman *et al.* 2014) in central Bass Strait over this period. The very large short-tailed shearwater population may be in a declining trend (Schumann 2014). As such, Origin does not envisage conducting monitoring of seabirds or seals during the proposed survey. This position will be reviewed once the results of the little penguin monitoring during the Enterprise survey are available, as Origin will be in a better position to evaluate the contribution such monitoring can make to further understanding impacts of seismic surveys.
International Fund for Animal Welfare (IFAW)	Requested information from blue whale aerial surveys undertaken in 2010-2013 and the MMO sighting records from the Astrolabe survey (Nov 2013). Did not consider Origin to have provided sufficient information until this information was provided. Considers the proposed time window of 1/10/2015 to 31/1/2016 to be inappropriate as it coincides with the arrival and presence of blue whales in this area. Believes that conducting the survey during October poses unacceptable risks to southern right whales due to proximity of breeding grounds. Concerned about cumulative impact from the numerous seismic surveys in this region and requested Origin provide further information on cumulative impacts as part of the environmental planning. Believes mitigation measures employed should go beyond the requirements of the EPBC Policy Statement 2.1 should this survey go ahead and requested that Origin provide detailed information about the intended mitigation methods to be employed aimed at reducing risk to marine mammals from noise pollution.	Provided information from MMO sightings and aerial surveys commissioned by Origin. Advised reasons for established timing window for marine seismic surveys in the Otway basin is in accordance with government guidance to minimise environmental impact particularly for avoidance of southern right whale calving. Explained assessment of potential impacts to southern right whales and results from acoustic monitoring and modelling to advise that Origin believes any impacts can be adequately managed. Noted IFAW concerns with cumulative impacts and advised Origin will meet all requirements contained in EP approved by regulator. Outlined additional mitigation measures (beyond standard measures in EPBC policy 2.1) to further mitigate potential impacts on blue whales and southern right whales, including: pre-survey scouting; number of scout vessels and MMOs; passive acoustic monitoring system; soft start ups; and shut-down procedures if whales are sighted. Origin will continue to inform throughout.

6. Existing Environment

The physical, biological and socio-economic environment in and around the operational area and the 'region' in general are described in this chapter, together with the values and sensitivities of the region.

6.1 Conservation Values and Sensitivities

6.1.1 Commonwealth Marine Reserves

The acquisition area is located in the vicinity of two Commonwealth Marine Reserves (CMR), as described below:

- Apollo – located 14 km to the east. The Apollo CMR is located off Apollo Bay on Victoria's west coast in waters 80 m to 120 m deep on the continental shelf. The reserve covers 1,184 km^2 of ocean, including the Otway Depression, an undersea valley that joins the Bass Basin to the open ocean. Apollo is a relatively shallow reserve with big waves and strong tidal flows, while the rough seas are habitats for fur seals and school sharks. The entire CMR is classified as a Multiple Use Zone.
- Zeehan – located 69 km to the south. The Zeehan CMR covers an area of 19,897 km^2 to the west and south-west of King Island in Commonwealth waters surrounding north-west Tasmania. It covers a broad depth range from the shallow continental shelf of about 50 m to the abyssal plain that is over 3,000 m deep. Four submarine canyons incise the continental slope, extending from the shelf edge to the abyssal plains. A rich community made up by large sponges and other permanently attached or fixed invertebrates is present on the continental shelf, such as giant crab (*Pseudocarcinus gigas*). Concentrations of larval blue warehou (*Seriolella brama*) and ocean perch (*Helicolenus spp*.) demonstrate the role of the area as a nursery ground. Rocky limestone banks provide important seabed habitats for a variety of commercial fish species including the giant crab.

6.1.2 World, Commonwealth and National Heritage Places

There are no marine or coastal World Heritage Properties, Commonwealth or National Heritage places in the vicinity of the operational area. World Heritage Properties and National Heritage Places are classed as a Matter of National Environmental Significance (MNES) under the EPBC Act.

6.1.3 Wetlands of International Importance

There are no marine or coastal Wetlands of International Importance (Ramsar-listed wetlands) in the vicinity of the operational area. The closest Wetlands of International Importance, which are classed as a MNES under the EPBC Act, are Livinia on King Island (83 km southeast) and the Western District Lakes (60 km northeast of the operational area).

6.1.4 Victorian Marine Protected Areas

Victoria has a representative system of 13 Marine National Parks and 11 Marine Sanctuaries established under the *National Parks Act* 1975 (Vic). Several of these, as well as the non-marine Port Campbell National Park, are located in the vicinity of the operational area, these being:

- Twelve Apostles Marine National Park - located 7.6 km north of the acquisition area.
- Port Campbell National Park - located on the coast, 14.5 km north of the acquisition area.
- The Arches Marine Sanctuary - located 21 km north of the acquisition area.
- Bay of Islands Coastal Park - located on the coast, 25 km northwest of the acquisition area.
- Marengo Reefs Marine Sanctuary – located 30 km east of the acquisition area.
- Merri Marine Sanctuary - located 70 km northwest of the acquisition area.
- Eagle Rock Marine Sanctuary - located 80 km northeast of the acquisition area.
- Point Addis Marine National Park – located 70 km north east of the acquisition area

The seven parks that may be subject to increased sound levels from the survey or may be at risk from a diesel spill are briefly described below.

The Twelve Apostles Marine National Park 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 (and covers an area of 75 km^2. 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 contains calcarenite reef supporting the highest

diversity of intertidal and sub-tidal invertebrates found on that rock type in Victoria. The park includes large sandy sub-tidal areas that are extremely high in biodiversity, with 860 species recorded in a 10 m^2 area. Port Campbell National Park

The Port Campbell National Park covers a long section of the coastline (~27 km), 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.

The Arches Marine Sanctuary protects 45 ha of ocean directly south of Port Campbell. Located 19 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. Due to the shaded underside of the underwater arches, habitats here are typical of those found in the deeper waters of Bass Strait. A diverse array of life including gorgonians, sponges, bryozoans and hydroids exists 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. These habitats support schools of reef fish, seals and a range of invertebrates such as lobster, abalone and sea urchins.

The Marengo Reefs Marine Sanctuary (12 ha) is located to the north east of Cape Otway. The sanctuary is comprised of two small reefs that provide a wide variety of microhabitats. Protected conditions on the leeward side of the reefs are unusual on this high wave energy coastline and allow for dense growths of bull kelps and other seaweed. There is an abundance of soft corals, sponges, and other marine invertebrates, and over 56 species of fish have been recorded in and around the sanctuary. Seals rest on the outer island of the reef and two shipwrecks (the *Grange* and *Woolamai*) occur in the sanctuary.

Merri Reefs Marine Sanctuary (25 ha) is located near Warrnambool and 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.

The Eagle Rock Marine Sanctuary covers 17.9 hectares and extends from the high water mark around the base of Split Point between Castle Rock and Sentinel Rock in the township of Aireys Inlet. It extends offshore for about 300 m and includes the 20 m high Eagle Rock and Table Rock. The main habitats protected by the sanctuary include intertidal and subtidal soft sediment, intertidal and subtidal reefs, and the water column.

Point Addis Marine National Park is located east of Anglesea and covers 4,600 ha. This park protects representative samples of sub-tidal soft sediments, subtidal rocky reef, Rhodolith beds and intertidal rocky reef habitats. The park also provides habitat for a range of invertebrates, fish, algae, birds and wildlife. The world-famous surfing destination of Bells Beach is within Point Addis Marine National Park.

6.1.5 Key Ecological Features

The Conservation Values Atlas indicates that the operational area does not intersect any Key Ecological Features (KEF). The closest KEF to the operational area is the West Tasmanian Canyons, located approximately 24 km to the southwest of the nearest operational area boundary. These canyons can influence currents and act as sinks for rich organic sediments and debris. Sponges are known to be concentrated near the canyon heads, with the greatest diversity between 200 and 350 m water depth.

Of more relevant to the survey however is the Bonney Upwelling, mapped in the Conservation Values Atlas as occurring approximately 100 km west from the closest point of the operational area. The Bonney Upwelling is a prominent and classical oceanographic upwelling. Surface upwelling of cold, nutrient rich water typically occurs in the summer and autumn along the narrow continental shelf between Robe, South Australia, and Portland, Victoria.

The primary ecological importance of the Bonney Upwelling is as a feeding area for the blue whale (*Balaenoptera musculus*). The upwelled nutrient-rich re-heated Antarctic intermediate water promotes blooms of coastal krill (*Nyctiphanes australis*), which in turn attracts blue whales to the region to feed. The upwelling is one of only three identified feeding areas consistently used by blue whale for feeding Australian coastal waters, which occurs during November to April.

6.2 Cultural Environment

6.2.1 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 north of the operational area is known as the 'Shipwreck Coast' because of the number of shipwrecks, most of which were 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 and around the acquisition and operational areas are:

Within acquisition area

- *Minerva* – wrecked in 1849 in about 80 m of water. Little is known and recorded about this shipwreck. Although the actual position of this wreck is unknown, Heritage Victoria mapping indicates an indicative position near the eastern edge of the acquisition area.

Within operational area

- *Selje* – wrecked in 1929 west of Cape Otway, off Wreck Beach, in water depths of 70-80 m. This means the wreck may lie within the north-western section of the operational area.
- *BAT* – wrecked in 1882, and has not been located, but is thought to be located near the Selje wreck.

Outside of but in proximity to operational area

- *City of Rayville* – wrecked in 1940 after striking a German mine, this was the first US vessel lost in World War II, It is located on the eastern edge of the Vic/P69 permit boundary, ~9 km east of the operational area, in ~70 m of water.
- *Fiji* – wrecked in 1891 at Wreck Beach, about 6.6 km north of the operational area.
- *Marie Gabrielle* – wrecked in 1859 at Wreck Beach, located about 6.6 km north of the operational area.
- *Jenny* – wrecked in 1854 at Moonlight Head, though the main site of the vessel has not been located. It is located about 6.6 km north of the operational area
- *Joanna* – wrecked in 1843 on Joanna Beach between Moonlight Head and Rotten Point, about 6.6 km north of the operational area.

None of the shipwrecks on the Victorian west coast are covered by shipwreck protected zones declared under Section 103 of the *Victorian Heritage Act* 1995, with the nine protected zones that do exist occurring within Port Phillip Bay and adjacent to the west Gippsland coast.

The Australian National Shipwreck Database indicates there are no historic shipwreck protection zones in or around the operational area.

6.2.2 Aboriginal Heritage

Aboriginal groups inhabited the southwest Victorian coast as is evident from the terrestrial sites of Aboriginal archaeological significance throughout the area. During recent ice age periods (the last ending approximately 14,000 years ago), sea levels were significantly lower and the coastline was a significant distance seaward of its present location, enabling occupation and travel across land that is now submerged. However, it is highly unlikely that any evidence of occupation or sites of significance would remain in or near the operational area.

A search of the National Native Title Tribunal (NNTT) database indicates there are no claims for Native Title over the operational area.

6.3 Physical Environment

6.3.1 Climate

The operational is located in the western Bass Strait. The area is typical of a cool temperate region with cold, wet winters and warm dry summers. It is influenced by rain-bearing cold fronts that move from south-west to north-east across the region, producing strong winds from the west, north-west and south-west.

6.3.2 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.

Winds in this section of the Otway basin and western Bass Strait generally exceed 13 knots (23.4 km/h) for 50% of the time. Winds contribute to the predominant moderate to high wave-energy environment of area and are predominantly south-westerly cycling to north-westerly.

6.3.3 Ocean Currents

Ocean currents in Bass Strait are primarily driven by tides, winds and density-driven flows. During winter, the South Australian current moves dense, salty warmer water eastward from the

Bight (GAB) into the western margin of the Bass Strait. 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.

6.3.4 Bathymetry

Gradients are generally mild with water depth varying from 60 m near the northern boundary of the operational area to approximately 90 m near the southern boundary of the operational area.

The central portion of Bass Strait, the Bassian Plain, contains a depression that exchanges water from the west via flow to the north of King Island. South of King Island a ridge extends to northwest Tasmania. Nearer Cape Otway, a subsea high extends seaward and rises to a depth of approximately 35 m from biogenic sediments over a calcarenite crust approximately 80 m deep. This feature (known locally as the 'Big Reef') occurs adjacent to the south-east corner of the acquisition area is well known by local professional fisherman who collect rock lobster from the summit.

6.3.5 Seabed Sediments

The Otway continental margin is a swell-dominated, open, cool-water, carbonate platform. A conceptual model divides the Otway continental margin into six depth-related zones – shallow shelf, middle shelf, deep, shelf, shelf edge and upper slope.

In the shallow shelf are exhumed limestone substrates that host dense encrusting mollusc, sponge, bryozoan and red algae assemblages. The middle shelf is a zone of swell-wave shoaling and production of mega-rippled bryozoan sands. The deep shelf is described as having accumulations of intensely bioturbated, fine, bioclastic sands. At the shelf edge and top of slope, nutrient-rich upwelling currents support extensive, aphotic bryozoan/sponge/coral communities. The upper slope sediments are a bioturbated mixture of periplatform bioclastic debris and pelleted foraminiferal/nanno-fossil mud. The lower slope is crosscut by gullies with low accumulation rates, and at the base of the slope the sediments consist of shelf-derived, coarse-grain turbidites and pelagic ooze.

A sampling survey of the surficial sediments, benthic invertebrates and demersal fishes of Bass Strait was undertaken by the Victorian Museum between 1979 and 1983, with 18 sites sampled within or adajcent to the operational area. These samples indicate that surficial sediments throughout the operational area are dominated by carbonate rich medium to coarse sands.

Adjacent to the south east boundary of the acquisition area the 'Big Reef' subsea high rises to a depth of approximately 35 m bsl from the limestone platform at 80m. Traverses of the 'Big Reef' and five other smaller rises to the east of the acquisition area were undertaken in 1986 with 12 basalt boulders obtained from the summits of three of the rises. Grab samples from the 'Big Reef' were also obtained during 1987 at reported depths of 34 and 38 metres respectively. Fresh and weathered basalt was obtained from these samples.

These results indicate that the rises are submerged volcanoes which lie on the Torquay Fault. The rises are estimated to be of Upper Pliocene age (3.6-2.5 mya), with evidence of basalt being discharged sub aerially (on land) at a time of low sea level.

6.3.6 Sea Temperature

The waters of Bass Strait have average surface temperatures ranging from 14°C in winter to 21°C in summer. However, subductions of cooler nutrient-rich water (upwellings) occur along the seafloor during mid to late summer, though this is usually masked in satellite images by a warmer surface layer.

6.3.7 Ambient Underwater Sound Levels

Natural sea sound sources in the Otway Basin 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.

Actual measurements of ambient sound levels in the Otway Basin have been undertaken as part of impact assessment activities for the petroleum industry. Acoustic monitoring prior to the development of the Thylacine wells and platform, adjacent to the south western corner of the Crowes Foot operational area, recorded broadband underwater sound of 93 to 97 decibels dB re 1 µPa. Passive acoustic monitoring commissioned by Origin from April 2012 to January 2013, 5 km offshore from the coastline east of Warrnambool, identified that ambient underwater noise in coastal areas are generally higher than further offshore, with a mean of 110 dB re 1 µPa and maximum of 161 dB re 1 µPa.

Typical Australian continental limestone shelf seabeds result in relatively poor propagation of low-frequency sound, except in narrow frequency bands. The measurements and modelling are important in the context of sound impacts of seismic surveys as they show that man-made (and natural) noise signals in the major frequency bands of whale vocalization attenuate rapidly.

6.3.8 Coastal Environment

The section of coast described below relates to the area that may be contacted in the event of a diesel spill from the survey vessel (with a sea surface threshold of 10-25 g/m^2 and shoreline coating threshold of >100 g/m^2), which stretches (discontinuously) from Port Fairy to Torquay.

The Port Fairy to Lady Bay (Warrnambool) coastline is dominated by sandy beaches, while the section of coast between Warrnambool and Cape Otway (covering a distance of ~100 km) is dominated by intertidal rocky shore (backed by steep rocky cliffs) and sub-tidal rocky reefs, interspersed with small sections of sandy beach.

Lady Julia Percy Island, 9 km off the coast offshore Yambuk (west of Port Fairy), is a triangular shaped, offshore remnant volcanic island (Australia's only one), dominated by tall rocky cliffs on all sides, with a sheltered cove on the northern side. It is an important breeding colony for the Australian fur seals, New Zealand fur seals, little penguins and shearwaters.

The Twelve Apostles limestone rock formations, a popular tourist attraction with nearby cliff top viewing platforms, lies east of Port Campbell within the Twelve Apostles Marine National Park.

Intertidal rocky shores stretch east to Marengo, with forest of the Great Otway National Park reaching the cliffs. From Marengo east to Anglesea, the coastline is dominated by long stretches of sandy beach interspersed with intertidal rocky shores and sub-tidal rocky reefs.

6.4 Biological Environment

A search of the EPBC Act Protected Matters Search Tool (PMST) lists 27 threatened species that may occur in or near the operational area and 30 migratory species that may pass through the operational area. These species are described in this section. These and other species and communities are described in this chapter.

6.4.1 Benthic invertebrates

The dominant benthic habitat throughout the operational area, as indicated by sampling and video studies, is medium to coarse carbonate sands with areas of low relief exposed limestone.

Carbonate sands in the Otway middle shelf support a benthic fauna dominated by bryozoans, infaunal echinoids and assemblages of sponges. Other components include bivalves (commonly *Mysella donaciformis* and *Legrandina bernadi*), *Chlamys sp*. scallops and small gastropods. The sand octopus (*Octopus kaurna*) also inhabits sandy sediments.

Within the inner shelf, benthic communities associated with hard limestone substrates consist of sponges, encrusting and branching coralline algae, poysonellid algae, bryozoa, benthic forams, brachiopods, bivalves, gastropods, fleshy red algae and kelp.

A benthic survey of inner shelf sediments in the vicinity of the Minerva Gas Field development, directly inshore form the operational area, found the seafloor was composed of coarse, well-sorted sand. This

survey identified 196 species and a total of 5,035 individuals comprised of 63% crustaceans, 15% polychaetes, 8% molluscs and 5% echinoderms.

Demersal fishes likely to be associated with carbonate sands on the middle and inner shelf include; eastern stargazer (*Kathetostoma laeve*), elephant shark (*Callorhynchus milli*), greenback flounder (*Rhombosolea taoarina*), gummy shark (*Mustelus antarcticus*), long-snouted flounder (*Ammotretis rostraus*), saw shark (*Pristiophorus nudipinnis*), southern sand flathead (*Platycephalus bassensis*) and southern school whiting (*Sillago bassensis*).

There is no published information on the species assemblages of the basalt rises in the south east and east of the operational area, other than general information on their importance as a southern rock lobster fishing area. In general, deep reef biota is typified by invertebrate animals rather than algae, usually in the form of sessile, filter feeding fauna. Organisms such as sponges, octocorals, bryozoans and ascidians usually dominate rock faces on deep reefs. The most common algae present on deep reefs are encrusting coralline red algae that are able to tolerate low levels of penetrating light.

6.4.2 Plankton

There have been relatively few studies of plankton populations in the Otway and Bass Strait regions, with most concentrating on zooplankton. A high diversity of zooplankton is reported in eastern Bass Strait, with over 170 species recorded. However, only 80 species in their surveys of western and central Bass Strait.

Plankton distribution is dependent upon prevailing ocean currents including the East Australia Current, flows into and from Bass Strait and Southern Ocean water masses. Populations near the operational area are expected to be highly variable both spatially and temporally and are likely to comprise characteristics of tropical, southern Australian, central Bass Strait and Tasman Sea populations.

6.4.3 Invertebrates

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

Invertebrate diversity is high in southern Australian waters, although the distribution of species is patchy, with little evidence of any distinct biogeographic regions.

6.4.4 Fish

According to the EPBC Act PMST, four species of fish listed as ‘threatened’ or ‘migratory’ may occur in or around the operational area. These species are briefly described below.

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, including Wilsons Promontory (approximately 265 km east of the operational area) and the Skerries (approximately 555 km east of the operational area). Given their transitory nature and the proximity of known congregation areas to the operational area, it is likely that great white sharks may transit the operational area on occasion.

The shortfin mako shark (*Isurus oxyrinchus*) is a pelagic species with a circum-global oceanic distribution in tropical and temperate seas. It is widespread in Australian waters, commonly found in water with temperatures greater than 16°C. Populations of the shortfin mako are considered to have undergone a substantial decline globally. These sharks are a common by-catch species of commercial fisheries. Due to their widespread distribution in Australian waters, shortfin mako sharks may be encountered in the operational area, albeit in low numbers.

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 is most commonly found over food-rich banks on the outer continental shelf, but does make occasional forays close to shore or into the open ocean, down to depths of approximately 1,300 m. It also conducts long-distance seasonal migrations, generally shifting between shallower and deeper water. The porbeagle shark may occasionally transit the operational area but is not expected to occur in significant numbers.

The Australian grayling (*Prototroctes maraena*) typically inhabits the coastal streams of New South Wales, Victoria and Tasmania, migrating between streams and the ocean. Most of its life (including spawning) is spent in fresh water, with parts of the larval or juvenile stages spent in coastal marine

waters, though its precise marine habitat requirements remain unknown. They are a short-lived species, usually dying after their second year soon after spawning.

Australian grayling has been recorded from the Gellibrand River (its mouth being on the coast directly north of the operational area), making it likely that it occurs in coastal waters north of, or in the northern parts of, the survey's operational area. As marine waters are not part of the species' spawning grounds, these waters are not likely to represent critical habitat for the species.

All of the marine ray-finned fish species (26 of them) identified in the EPBC PMST are sygnathiformes, which includes seahorses and their relatives (seadragaon, 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 sygnathiforme species listed for the acquisition area are widely distributed throughout southern, south-eastern and south-western Australian waters. So although the water depths of the operational area are mostly greater than 50 m, and thus unlikely to provide habitat for high numbers of sygnathiformes, it is still possible that low numbers may exist within the operational area.

6.4.5 Cetaceans

Seven species of whales and fives species of dolphin (collectively referred to as cetaceans) are identified in the EPBC Act PMST as 'migratory' or 'threatened' with the potential to occur within or around the operational area. These are:

- Minke whale (*Balaenoptera acutorostrata*)
- Blue whale (*B. musculus*)*
- Bryde's whale (*B. edeni*)
- Pygmy right whale (*Caperea marginata*)
- Southern right whale (*Eubalaena australis*)*
- Humpback whale (*Megaptera novaeangliae*)*
- Killer whale (*Orcinus orca*)
- Common dolphin (*Delphinus delphis*)
- Risso's dolphin (*Grampus griseus*)
- Dusky dolphin (*Lagenorhynchus obscures*)
- Indian Ocean bottlenose dolphin (*Tursiops aduncus*)
- Bottlenose dolphin (*Tursiops truncates*)

The species listed as 'threatened' under the EPBC Act (*) are described below.

6.4.5.1 Blue whale

The blue whale (*Balaenoptera musculus*) (listed as 'Endangered' under the EPBC Act) 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 sub-species of blue whale in Australian waters; the true blue whale (*Balaenoptera musculus intermedia*) and the pygmy blue whale (*B. musculus brevicauda*). 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. Acoustic monitoring has found the presence of true blue whales in the Otway region to be rare.

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 (130 km northwest of the operational 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 GAB 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 3 illustrates that the Otway region is a Biologically Important Area (BIA) for foraging of the pygmy blue whale according to the DoE's National Conservation Values Atlas.

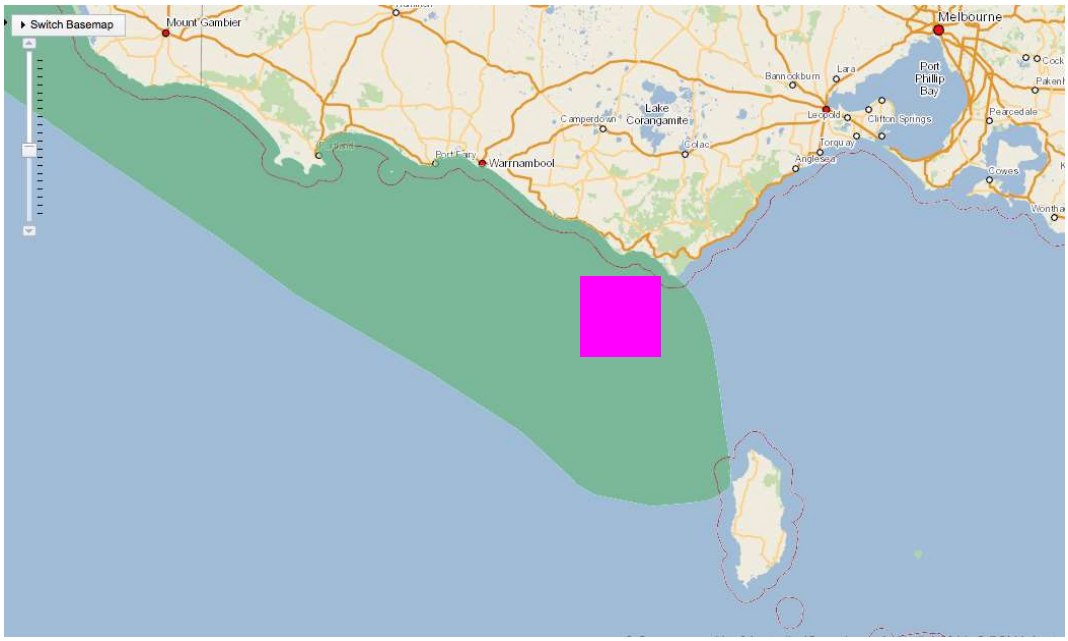


Figure 3. Pygmy blue whale biologically important area for foraging.
(Magenta box represents approximate operational area location)

The Blue Whale Conservation Plan, released by the DoE in October 2015, updates the 2005 plan and includes 16 management actions aimed at ensuring the long-term recovery of the species in Australian waters. Three of these management actions have relevance to the Crowes Foot seismic survey, these being:

1. Ensure that anthropogenic noise in biologically important areas is managed such that any blue whale continues to utilise the area without injury and is not displaced from a foraging area;
2. The EPBC Act Policy Statement 2.1 (Interaction between offshore seismic exploration and whales) is applied to all seismic surveys; and
3. Ensure the risk of vessel strikes on blue whales is considered when assessing actions that increase vessel traffic in areas where blue whales occur and, if required, appropriate mitigation measures are implemented.

Measures to mitigate risks to the blue whale from underwater sound and collisions to ensure the Crowes Foot seismic survey will comply with these management actions are outlined in Table 7.

In 69 seasonal aerial surveys for blue whales between Cape Jaffa and Cape Otway undertaken over six seasons (2001-02 to 2006-07), it was found that the general pattern of seasonal movement of blue whales is from west to east, with whales foraging in between the GAB and Cape Nelson in November and spreading further east in December. The whales are typically widely distributed throughout Otway shelf waters from January through to April. Evidence indicates that statistically the peak months for presence of blue whales in the operational area are likely to be February and March. This species, however, has been previously recorded in the region surrounding the operational area during November and December.

There were no confirmed sightings of the blue whale during Origin's:

- Enterprise 3D seismic survey undertaken during late October and early November 2014 (15 km north of the operational area).
- Astrolabe 3D seismic survey (adjoining the operational area to the south) undertaken during early November 2013; and
- Speculant 3D transition zone seismic survey undertaken during November and December 2010 (10 km north of the operational area);

Hence while the proposed timing of the Crowes Foot 3D survey has been selected in part to minimise the scope for interactions with blue whales by avoiding the period of statistical peak abundance (February/March), it is possible that blue whales will be present. The likelihood and extent of the interaction is dependent on broad scale environmental factors affecting the abundance and distribution of blue whale feeding resources.

6.4.5.2 Southern right whale

The southern right whale (*Eubalaena australis*) (listed as 'Endangered' under the EPBC Act) is 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 migrating 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.

Several breeding populations (Argentina/Brazil, South Africa and south-west Australia) of southern right whales have shown evidence of strong recovery post whaling, with a doubling time of 10-12 years. Estimated population sizes (1,600 mature females in 1997, and approximately twice that number in 2007) and the strong observed rate of increase in some well-studied parts of the range, indicate the species, although still scarce relative to its historic abundance, is not considered under threat at the hemispheric level.

The operational area is within the range of the south-east Australian breeding population. Whilst there are some signs of slow recovery in the south-east Australian population, abundance remains very low in comparison with expectations based on historical evidence of occupation.

The species is regularly present along the Australian coast during their breeding season of 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 2–3 months. Other population classes stay in coastal areas for shorter and more variable periods, and generally depart the coast earlier then female-calf pairs.

Southern right whales generally occur within two kilometres off shore and tend to be distinctly clumped in aggregation areas. Aggregation areas are well known with the largest being in Western Australian and at the Head of Bight in South Australia. A smaller established area (regularly occupied) occurs at the Warrnambool region in Victoria. Small but possibly growing numbers of non-calving whales regularly aggregate for short periods of time in coastal waters off Peterborough, Port Campbell, Port Fairy and Portland in Victoria.

The closest known calving/nursery grounds to the operational area occur at Logan's Beach off the coast of Warrnambool in southwest Victoria (approximately 65 km northwest of the closest point of the acquisition area) and intermittently at Portland (125 km northwest of the acquisition area). The operational area is adjacent to the potential emerging aggregation area at Port Campbell but is not located in any recognised BIA (feeding, breeding or aggregation areas) for southern right whales identified in the national conservation values atlas (Figure 4).

Figure 4. Southern right whale biologically important areas.
(Magenta box represents approximate operational area location)

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. Southern right whales are thought to be solitary during migration, or accompanied by a dependent calf or occasionally a yearling offspring.

The Southern Right Whale Conservation Management Plan includes 10 management action areas aimed at ensuring the long-term recovery of the species in Australian waters. Two of these management actions have relevance to the Crowes Foot seismic survey, these being:

1. Assessing and addressing anthropogenic noise; and
2. Addressing vessel collisions.

Measures to mitigate risks to the southern right whale from underwater sound and vessel collisions to ensure the Crowes Foot seismic survey will comply with these management actions are outlined in Table 7.

The proposed timing of the Crowes Foot 3D survey reduces the likelihood of encountering southern right whales by avoiding peak times for coastal migration and inshore nursing. It is possible, however, that southern right whales may be present in adjacent coastal areas and may transit through the operational area during their migration to the Southern Ocean if the survey is undertaken during October.

6.4.5.3 Humpback whale

Humpback whales (*Megaptera novaeangliae*) (listed as 'Vulnerable' under the EPBC Act) 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 around November and December. A discrete population of humpback whales have been observed to migrate along the west coast of Tasmania and through Bass Strait, and these animals may pass through the operational area. 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.

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 habitat for migrating humpback whales is Twofold Bay, a resting area off the NSW coast 620 km to the northeast of the operational area (Figure 5).

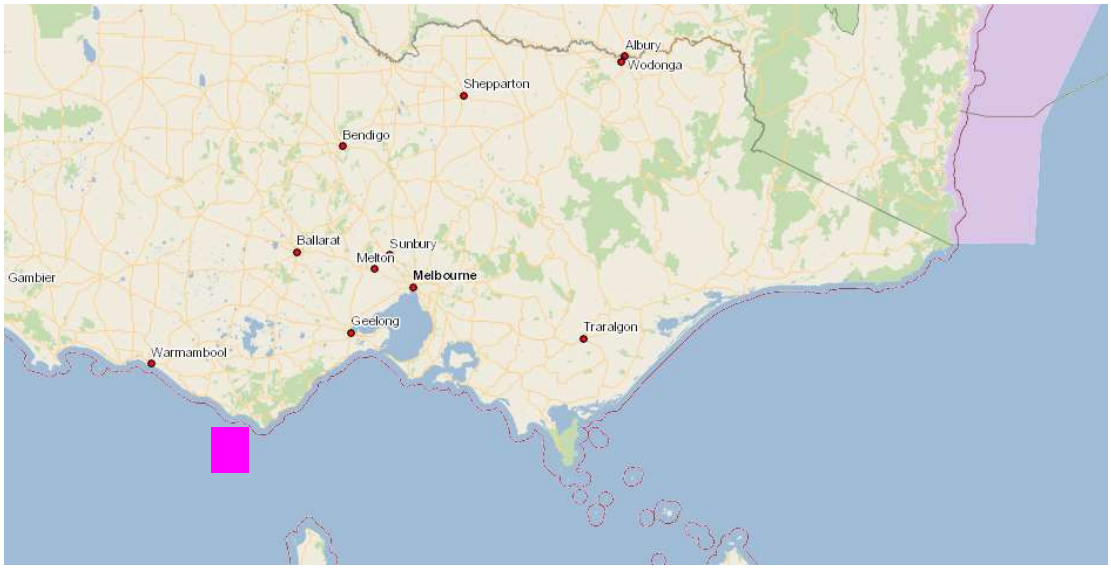


Figure 5. Humpback whale biologically important area for migration.
(Magenta box represents approximate operational area location)

Although the operational area is located west of the humpbacks' normal summer migration route, during Origin's Enterprise 3D seismic survey undertaken during early November 2014 (15 km north west of the operational area), 16 humpback whales were sighted. As such, there is some chance that humpback whales may be sighted during this survey.

6.4.6 Pinnipeds

Australian fur seals (*A. pusillus*) and New Zealand fur seals (*Arctocephalus forsteri*) are listed marine species under the EPBC Act.

Australian fur seals 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 (Hofmeyr *et al.,* 2008).

Their preferred habitat, especially for breeding, are rocky islands with boulder or pebble beaches and gradually sloping rocky ledges. A large breeding colony (about 650 individuals) of the Australian fur seal is located at Cape Bridgewater (91 km northwest of the operational area) while small non-breeding colonies occur in caves at the same location. 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 (91 km northwest of the operational 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.

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. It is therefore possible that seals will move through the operational area.

New Zealand fur seals may forage throughout waters around the southern part of Australia, with population studies for New Zealand fur seals in Australia carried out in 1990 estimating an increasing population of about 35,000. The species breeds in southern Australia at the Pages Islands, and on Kangaroo Island, which produces about 75% of the total pups in Australia.

6.4.7 Marine Reptiles

Three threatened marine reptile species (turtles) are listed as potentially occurring in western Bass Strait, these being the loggerhead turtle (*Caretta caretta*), leatherback turtle (*Dermochelys coriacea*) and green turtle (*Chelonia mydas*). There are no identified BIAs for these reptiles in western Bass Strait and the operational area is distant from their normal tropical habitats. As such, they are unlikely to be present throughout the operational area.

6.4.8 Avifauna

A diverse array of seabirds and terrestrial birds utilise the Otway region and may potentially forage within or fly over the operational area, resting on islands during their migration. Infrequently and often associated with storm events, birds that do not normally cross the ocean are sometimes observed over the Otway shelf, suggesting the birds have been blown off their normal course or are migrating.

Twenty-six (26) bird species are listed by the EPBC Act PMST as possibly occurring in or around the operational area, as described below.

Albatrosses and petrels (comprising 18 of the 26 species listed) 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 albatross within the immediate vicinity of the operational area. Albatross Island, supporting a breeding population of approximately 5,000 shy albatross (*Thallassarche cauta*), is the closest breeding colony of threatened seabird to the operational area, located approximately 165 km to the southeast.

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 operational 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 operational area.

The orange-bellied parrot (*Neophema chrysogaster*) (listed as 'Critically Endangered' under the EPBC Act) migrates from the mainland across Bass Strait to King Island and Tasmania. Birds depart the mainland for Tasmania in September and November. Orange-bellied parrots arrive at King Island in March and depart in June. 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 ground or in low vegetation. The orange bellied parrot may overfly the operational area however the

species is not likely to be impacted as there are no suitable resting, nesting or feeding sites in proximity to the survey.

The short-tailed shearwater (*Puffinus tenuirostris*) (not listed as threatened under any State or Commonwealth legislation) 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 is the only petrel species that breeds exclusively in Australia. The shearwaters winter in the North Pacific, and return to southern Australia in summer to breed, and feeds on krill, small fish and other marine creatures, mostly feeding on the water surface. During consultation with Parks Victoria in June 2012, it was noted that a colony of approximately 12,000 short-tailed shearwaters nest on Mutton Bird Island in Victorian State waters from September through to April. This nesting location is 10 km north of the operational area.

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 usually builds nests at the end of September, incubate the eggs in October and raise their nestlings through November and December. The nearest breeding populations to the operational area are the Twelve Apostles (London Arch) (8.5 km to the north) and Bay of Islands (19 km to the northwest).

6.4.9 Threatened Ecological Communities

The giant kelp marine forests of South East Australia' is listed as a threatened ecological community (TEC) and protected under the EPBC Act.

Giant kelp (*Macrocystis pyrifera*) is a large brown algae that grows on rocky reefs from the sea floor 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, which occurs 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.

Species known to shelter within the kelp forests include weedy seadragons (*Phyllopteryx taeniolatus*), six-spined leather jacket (*Mesuchenia freycineti*), brittle star (*Ophiuroid sp*), urchins, sponges, blacklip abalone (*Tosia spp*) and southern rock lobster (*Jasus edwardsii*).

The largest extent of the ecological community is in Tasmanian coastal waters. Some patches may also be found in Victoria and South Australia. Inshore of the operational area, giant kelp forest may be present in the Arches Marine Sanctuary, Twelve Apostles National Park and other areas where rocky reef occurs in waters 8 m or deeper.

Surveys of macroalgal communities along the Otway Shelf from Warranambool to Portland in western Victoria found that overall brown algal cover decreases with depth, particularly below 22 m water depth. Water depths at the closest inshore sections of the operational area are in the vicinity of 60 m, which is too deep to support this TEC. The shallowest water depth within the operational area is approximately 35 m. This water depth is at the extreme limit for giant kelp. It is therefore highly unlikely that the giant kelp marine forests of South East Australia TEC occurs within the operational area.

6.5 Socio-economic Environment

6.5.1 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.

6.5.2 Shipping

The South-east Marine Region is one of the busiest shipping regions in Australia. AMSA has advised Origin that there are established converging shipping routes which lead to and from Bass Strait and major southern ports through the operational area. As a result it is likely that there will be substantial volumes of shipping traffic within the operational area.

6.5.3 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, coming from five gas fields using 700 km of offshore and onshore pipeline.

In 2010-11, there was 97 megalitres (ML) of condensate production from the Otway Basin, down from 120 ML in 2008-09, and 148 ML of liquefied petroleum gas (LPG) in 2010-11, up from 6 ML in 2007-08 (more recent figures are not available).

There are a number of production fields located in the Otway Basin 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) (~5 km southwest of the southwest corner of the operational area), offshore and onshore pipelines and a gas processing plant located about 6 km north of Port Campbell.
- The Casino Gas Project, developed by Santos in 2005, comprises subsea wellheads and pipeline to shore (35 km offshore and 12 km onshore) to Energy Australia's Iona gas plant for processing and distribution.
- The Minerva Gas Development is operated by BHP Billiton and commenced production in April 2005. This development involved the drilling and installation of two subsea wells in shallow waters (60 m deep and 10 km from the coast), which were tied back to an onshore gas plant (4.5 km inland) via a single pipeline.

6.5.4 Commercial Fisheries

The operational area is overlapped by the jurisdiction of several Commonwealth and State-managed fisheries, as outlined in Table 4.

Table 4. Commercial fisheries operating in or around the operational area

Fishery	Target species	Intersects operational area?
Commonwealth		
Bass Strait Central Zone Scallop Fishery	Scallops (*Pecten fumatus*).	**No** Fishing effort is concentrated around King and Flinders islands (2012 and 2013-14 data). Recent AFMA data verifies this.
Eastern Tuna and Billfish Fishery	Albacore tuna (*Thunnus alulunga*). Bigeye tuna (*T. obesus*). Yellowfin tuna (*T. albacares*). Broadbill swordfish (*Xiphias gladius*). Striped marlin (*Tetrapturus audux*).	**No** Fishery effort is concentrated along the NSW coast and southern Queensland coast (2012 and 2013-14 data). No Victorian ports are used. Recent AFMA data verifies this.
Skipjack Fishery (Eastern) (Sub-area 03, southern inshore area)	Skipjack tuna (*Katsuwonus pelamis*).	**No** Fishery effort concentrated in the GAB and north of Eden, NSW (2012 and 2013-14 data). Recent AFMA data verifies this.
Small Pelagic Fishery (western sub-area)	Jack Mackerel (*Trachurus declivis, T. symmetricus, T. murphyi*). Blue Mackerel (*Scomber australasicus*). Redbait (*Emmelichthys nitidus*). Australian Sardine (*Sardinops sagax).*	**No** Fishery effort concentrated in the near-shore GAB, west and south of Port Lincoln (2012 and 2013-14 data). Recent AFMA data verifies this.
Southern and Eastern Scalefish and Shark Fishery (SESSF) (Commonwealth Trawl Sector [CTS] and Gillnet, Hook & Trap sectors)	Blue Grenadier (*Macruronus novaezelandiae*). Tiger Flathead (*Platycephalus richardsoni*). Pink Ling (*Genypterus blacodes*). Silver Warehou (*Seriolella punctata*).	**Unlikely** 2012 and 2013-14 data fishing data indicates that fishing in the CTS is concentrated along the 200 m bathymetric contour and there is a low fishing intensity around Portland and west of Cape Otway for the Shark Gillnet sector. Recent AFMA data verifies this.
Southern Bluefin Tuna Fishery	Southern bluefin tuna (*Thunnus maccoyii*).	**No** Fishery effort concentrated in the GAB and the southern NSW coast 2012 and 2013-14 data. Recent AFMA data verifies this.
Southern Jig Squid Fishery	Arrow squid (*Nototodarus gouldi*).	**Unlikely** 2012 and 2013 data fishing data indicates that fishing is concentrated along the 200 m bathymetric contour with highest fishing

		intensity south of Portland and Warrnambool. Recent AFMA data verifies this.
Victorian		
Rock Lobster Fishery	Predominantly southern rock lobster (*Jasus edwardsii*), along with small quantities of eastern rock lobster (*J. verreauxi*).	**Yes** Fishery effort is throughout the operational area but concentrated over the 'Big Reef' adjacent to the south-east corner of the proposed acquisition area and near shore rocky reefs. The survey will impact on fishing activity should it proceed past 16 November, which is the re-opening of the season
Giant Crab Fishery	Giant crab (*Pseudocarcinus gigas*).	**Likely** Although concentrated on the continental shelf, fishing effort does occur in on the outer perimeters of the operational area. Given licence holdings are linked to rock lobster licences, impact on fishing is similar, albeit limited to a small number of commercial fishers.
Abalone Fishery	Blacklip abalone (*Haliotis rubra*) and greenlip abalone (*H. laevigata*).	**Unlikely** Due to proximity of dive activity to shoreline (generally to depths of 30 m) it is unlikely that this fishery operates in the operational area. Engagement is required with this fishery, however, due to Origin's safe diving procedures in the vicinity of seismic surveys.
Scallop Fishery	Scallop (*Pecten fumatus*).	**No** Mostly fished from Lakes Entrance and Welshpool. Fisheries Victoria data showed no scallop fisheries in the operational area.
Snapper Fishery (Ocean general licence)	Snapper (*Pagrus auratus*).	**Likely** Snapper Fishery licences in the operational area are generally held by rock lobster fishermen (as verified by Fisheries Victoria). About 92% of the snapper catch is from Port Phillip Bay, with 3% from Corner Inlet and the remaining 5% from coastal waters (that may include areas in or around the survey acquisition area).

7. Environmental Impact Assessment

No activity is without its impacts and risks, some of which are known or planned, some of which are unknown or unplanned. For the Crowes Foot 3D marine seismic survey, Origin has undertaken its environmental impact in accordance with the following methodology.

- **Planned events** are those impacts that **will** occur as a consequence of undertaking the activity (i.e., noise and light emissions).
  - Planned events are assessed for their *consequence* to determine their impacts (defined as a change to the environment, whether positive or negative). No assessment of likelihood is required, given that the event will occur. Consequence is rated from minor through to catastrophic, as outlined in Table 5.
- **Unplanned events** are those impacts that may occur as a result of undertaking the activity (i.e., unauthorised release of chemicals or hydrocarbons) and as such have an element of risk associated with them (i.e., the likelihood that the event could be realised).
  - Unplanned events are assessed for their known *risk* (the effect of uncertainty on objectives), based on an assessment of consequence and likelihood. The assignment of likelihood and consequence is based on the knowledge and experience of those involved in the risk assessment as well as utilising historical data on event probabilities (e.g., vessel collision frequencies). Risk is rated from low through to extreme, as outlined in Table 6.

The purpose of impact and risk evaluation is to assist in making decisions, based on the outcomes of analysis, about the sorts of controls required to reduce an impact or risk to ALARP. Planned and unplanned events are subject to this step in the same manner.

Risk evaluation involves comparing the level of risk found during the analysis process with risk criteria established when the context was considered. Based on this comparison, the need for treatment can be considered.

The EP provides detailed analysis to demonstrate that all risks are reduced to as low as reasonably practicable (ALARP) and that all risks are acceptable.

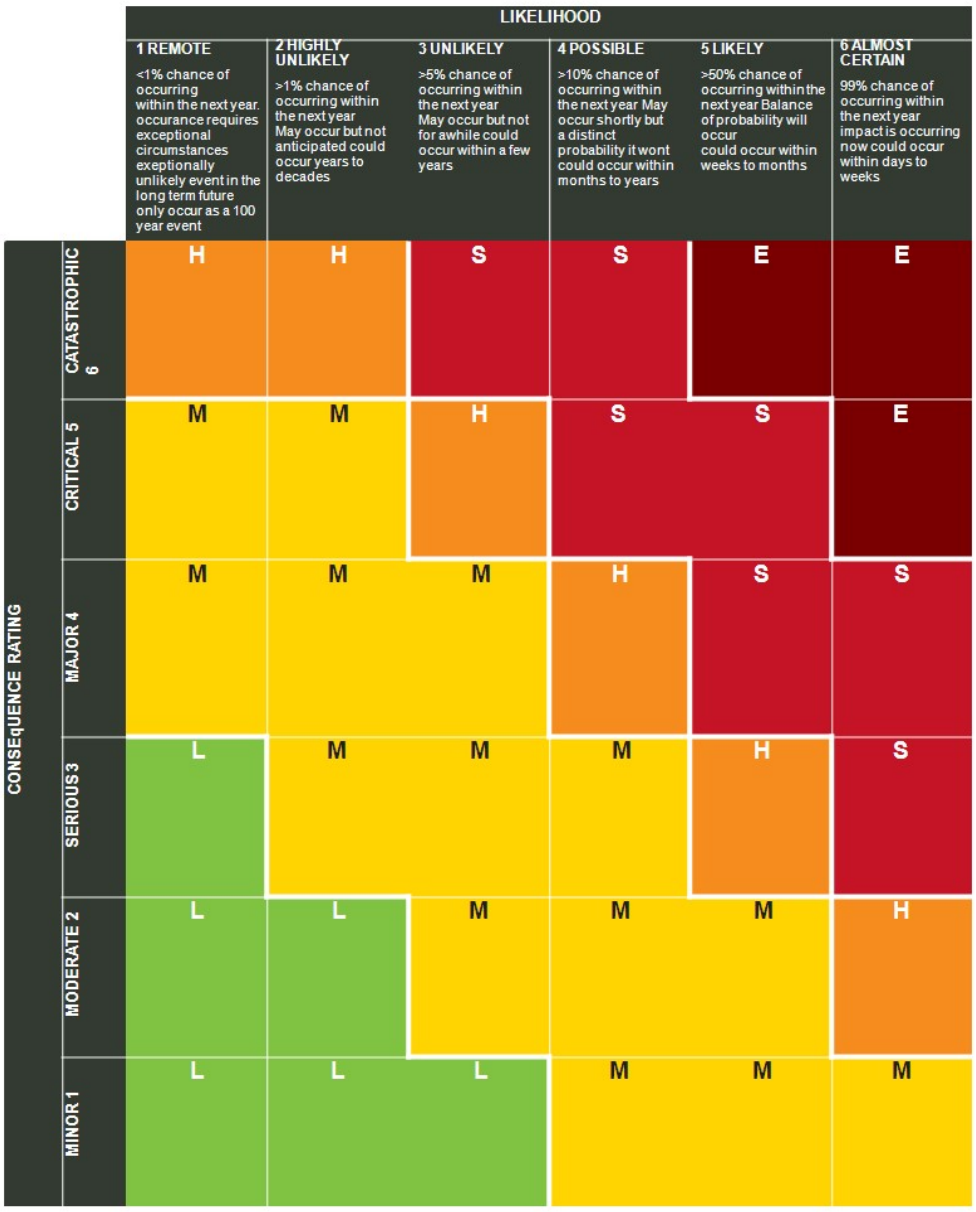
Table 7 presents a summary of the environmental impact assessment.

Table 5. Origin's consequence matrix

CONSEQUENCE CATEGORIES (B)+(D)

	Impact to Origin or contracting personnel	Natural environment	Community damage/ impact/ social/ cultural heritage	Financial impact (eg. due to loss of revenue, business interruption, commodity trading, asset loss)	Damage to reputation, services interruption, customer interruption	Breach of law or criminal prosecution or civil action (eg. OHS, environment, industrial relations, trade practices, industry acts)	
CATASTROPHIC 6	Multiple fatalities >4 or severe irreversible disability to large group of people (>10).	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.	EBIT: Impact, loss or deterioration from expectation greater than $100m. CASH FLOW: Severe cash flow crisis, unable to source funds.	Negative international or prolonged national media (e.g. 2 weeks). Continued severe degradation of services to customers > 1 month or > 10,000 customer days.	Potential jail terms for executives and or very high fines for the Company. Prolonged multiple litigations.	CONSEQUENCE RATING
CRITICAL 5	1-3 fatalities or serious irreversible disability (>30%) to multiple persons (<10).	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.	EBIT: Impact, loss or deterioration from expectation greater than $30m but less than $100m. CASH FLOW: Severe cash flow crisis, difficulty to source funds. Probable credit rating downgrade.	Negative media national for 2 days or more. Significant public outcry. Severe degradation of services to customers up to 1 month or >5,000 customer days	Very significant fines and prosecutions. Multiple prosecution and fines.	
MAJOR 4	Serious permanent injury/ illness or moderate irreversible disability (<30%) to one or more persons.	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.	EBIT: Impact, loss or deterioration from expectation greater than $3m but less than $30m. CASH FLOW: Loss of flexibility and/or increase in cost to source funds. Market explanation required.	Negative national media for 1 day. Individual customers or segments disadvantaged up to 1 week. Customer interruption >500 customer days. NGO adverse attention.	Major breach of regulation and significant prosecution including class actions.	
SERIOUS 3	Serious reversible/ temporary injury/illness (e.g. lost time >5 days or hospitalisation or Alternate/Restricted Duties > 1 month).	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.	EBIT: Impact, loss or deterioration from expectation greater than $0.3m but less than $3m. CASH FLOW: Material impact to cash flow.	Negative state media. Heightened concern from local community. Service interruption up to 1 day or > 10 customer days. Criticism by NGOs.	Serious breach of law/regulation with investigation or report to authority with possible prosecution. Performance Infringement Notice (PIN).	
MODERATE 2	Reversible temporary injury/illness requiring Medical Treatment (e.g. lost time <5 days or Alternate/Restricted Duties for < 1 month).	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.	EBIT: Impact or loss greater than $30K but less than $0.3m. CASH FLOW: Impact to project or business unit cash flow.	Public concern restricted to local complaints Negative local media. Internal escalation to senior management. Few hours service interruption. Adverse local public attention.	Breach of law/regulation or non-compliance. Minor legal issues, minor litigation possible.	
MINOR 1	Injury/illness requiring Medical Treatment (no lost time, no Alternate/ Restricted Duties), First Aid, Report Only.	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.	EBIT: Impact or loss greater than $3K but less than $30K. CASH FLOW: No significant impact.	Public concern restricted to local complaints.	Local investigation, minor breach of regulation, on the spot fine or technical non-compliance. Prosecution unlikely.	

Table 6. Origin's risk management action matrix



Risk Management Action

Level of Risk	Action Required	Escalation and Approval of Treatment Plans	Acceptance Authority
Extreme	• Risk treatment Plan must be in place immediately • Risk reviewed monthly by Risk owner	Managing Director for review and approval of the treatment plan	Managing Director
Severe	• Risk treatment must be considered • Risk reviewed monthly by Risk owner	executive general Manager for review and approval of associated treatment plan (if applicable)	executive general manager
High	• Risk treatment must be considered • Risk reviewed twice per year by Risk owner	general Manager for review and approval of associated treatment plan (if applicable)	general Manager
Medium	• Risk treatment may be considered • Risk reviewed annually by Risk owner	group/asset/Project Manager	group/asset/Project / site Manager
Low	• no risk treatment required • Risk reviewed annually by Risk owner	site/activity Manager	site/activity Manager

Table 7. Summary environmental impact assessment

Potential risk	Potential consequences	Key avoidance, mitigation & management measures	Residual risk ranking
Planned events			

Underwater sound	Temporary and localised disturbance, physiological or pathological impacts to sound-sensitive fauna, such as cetaceans.	• The survey will be conducted outside of peak whale migration seasons (survey to occur between 1st October and 31st January).
		• The survey operations will be conducted in accordance with EPBC Act Policy Statement 2.1 (Section A.2 to A.3), using MMOs to implement the policy. This involves:
		  ○ Use of a trained crew.
		  ○ Pre-start up visual observation.
		  ○ Soft-start procedure.
		  ○ Start-up delay procedure.
		  ○ Operations procedure.
		  ○ Stop-work procedure.
		  ○ Night-time and low-visibility procedures.
		• A support vessel will survey the operational area for one (1) day prior to survey commencement with one (1) experienced MMO on duty to undertake marine mammal observations during daylight hours. If blue whales or southern right whales are detected by the support vessel, the pre-start up and visual observation procedure will not commence unless whales are outside the shutdown radius of the initial acquisition point, or they are not seen for 1 hr.
		• An experienced MMO will be on duty on the seismic vessel and two support vessels to undertake marine fauna observations (cetaceans, seals, penguins and turtles) during daylight hours for the duration of the survey.
		• The acoustic source will be shut down if a southern right whale or blue whale approaches within 3 km of the seismic source. Soft start procedures will commence once the whale has been observed to move outside the 3 km zone or has not been observed for 1 hr.
		• The acoustic source will be shut down if any other species of whale approach within 2 km of the seismic source. Soft start procedures will commence once the whale has been observed to move outside the 2 km zone or has not been observed for 30 minutes.
		• A passive acoustic monitoring (PAM) system will be used during non-daylight hours when the source is active and during pre-starts to provide supplementary information regarding whale presence.
		• If PAM is unavailable at any point during the survey (for example, due to equipment malfunction), non-daylight acquisition will not occur if there have been three consecutive days of three or more whale instigated shut-downs.
		• In the event that Origin is made aware of the potential for another survey/s to take place in the same area at the same time as the Crowes Foot survey, at least a 40 km (21 nm) separation will be maintained between active sources the surveys to ensure sound from one source doesn't interfere with sound from the other and to reduce the possibility of cumulative sound impacts.
		• An area of 57 km^2 over the 'Big Reef' has been excised from the acquisition area to minimise potential for impacts to site-attached species.
		• A cetacean strategy meeting will be held each evening during the survey to assess all available data on whale presence. This information will be used to inform the operational strategy for the following day.
			Moderate

Light emissions	Attractant to fauna, temporary increase in predation rates on fauna attracted to lights.	• Vessel lighting will be managed in accordance with maritime safety standards.	Minor
Atmospheric emissions	Temporary and localised reduction in air quality.	• Marine-grade (low sulphur) diesel will be used. • Fuel use will be monitored and abnormally high consumption investigated in order to minimise excessive air pollution. • Vessel engines and machinery will be maintained in accordance with the vessel's planned maintenance system. • Only a MARPOL-approved incinerator is used to incinerate solid waste. Oil and other noxious liquids will not be incinerated.	Minor
Cooling and brine water discharge	Temporary and localised elevation in surface water temperature and salinity.	• Cooling water and reverse osmosis systems will be maintained in accordance with the vessel's planned maintenance system.	Minor
Sewage, grey water and putrescible waste discharge	Temporary and localised reduction in water quality from increased nutrient and pathogen load. Increase in scavenging behaviour or marine fauna and seabirds.	• All sewage and grey water is discharged via a MARPOL-approved sewage treatment plant. • The sewage treatment plant will be maintained in accordance with the vessel's planned maintenance system. • No discharge of sewage and putrescible waste will take place within 12 nm of land. • Putrescible waste will be macerated to <25 mm in size prior to discharge.	Minor
Bilge water drainage	Temporary and localised reduction in water quality from trace volumes of hydrocarbons and chemicals.	• All bilge water is treated through an oil-in-water (OIW) treatment system, with no water discharges greater than 15 ppm OIW. • Oil captured from the OIW treatment system will be transferred to shore for disposal. • Chemical storage and fuel transfer areas are bunded. • Scupper plugs or equivalent drainage control measures are readily available to the deck crew so that deck drains can be blocked in the event of a hydrocarbon or chemical spill on deck to prevent or minimise discharge to the sea.	Minor
Unplanned events			

Hazardous and non-hazardous solid waste discharges	Temporary and localised water pollution.
	Fauna injury or death.
		• A Vessel Waste Management Plan will be in place and implemented (for vessels >400 gross tonnes or certified to carry 15 persons or more):
		  ○ Crew are inducted into waste management procedures.
		  ○ A Safety Data Sheet (SDS) register is maintained and available in key locations.
		  ○ Solid wastes bagged and sent ashore for disposal.
		  ○ All bins secured to deck and covered with lids.
		  ○ Only small volumes of chemicals kept on board.
		  ○ Waste streams will be sorted on board according to shore-based recycling capabilities.
		  ○ Garbage Record Book will be maintained.
		• Hydrocarbon and chemical storage areas are bunded and drain to the bilge water tank.
		• Spills on deck are rapidly cleaned up by a competent deck crew that has access to appropriate response resources.
			Low

Seabed disturbance	Temporary and localised turbidity and displacement of seabed habitat.	• Vessel anchoring will only occur in an emergency and outside of the operational area (e.g., lee of King Island) in areas free of significant environmental features. • Large bulky items will be securely stored on the deck. • Deep streamer technology is not deployed within 10 m of the seabed. • Streamers will be raised to above 15 m of the seabed during line changes. • The location of suspected shipwrecks not marked on admiralty charts will be reported to authorities.	Low
Interference with third-party (merchant and fishing) vessels	Exclusion from fishing grounds. Damage to and/or loss of fishing equipment. Loss of commercial fish catches. Disruption to commercial shipping activities.	• Ongoing stakeholder consultation will take place with potentially impacted commercial rock lobster fishers. • Origin's fisheries management plan (including claim form) will be provided to commercial rock lobster fishermen likely to be impacted by the survey where actions to reduce overlap of activities cannot be identified. • The vessel and streamers will be readily identifiable to other vessels through the use of anti-collision monitoring equipment. • The survey vessel location will be communicated to other users via the Notice to Mariners and AusCoast warnings. • Vessels will employ standard maritime safety measures (e.g., lighting, 24-hr visual, radio and radar watch). • The support vessels will liaise/interact with third-party vessels to avoid damage to the seismic survey streamers and/or the third-party vessels and their equipment.	Medium
Interaction with divers	Disturbance to divers.	• Consultation will occur with diving stakeholders on the activities to be undertaken during the Crowes Foot campaign and the timing of these events. • The support vessels will liaise/interact with diving vessels in the area.	Medium
Introduction of invasive marine species	Loss of diversity and abundance of native species.	• Vessels will have anti-fouling paint applied to their hulls and internal niches. • Vessels are cleared to enter Australian waters (if previously mobilised from outside Australian waters) in accordance with the Australian Ballast Water Management Requirements.	Medium
Vessel strike or entanglement with cetaceans	Injury or death to cetaceans (whales and dolphins).	• The Australian Guidelines for Whale and Dolphin Watching (2005) for sea-faring activities will be implemented. • Cetacean observations will be reported to the Department of the Environment. • Incidents of vessel strike or streamers causing known or suspected injury or death to threatened fauna will be reported to the Department of the Environment within 2 hours.	Medium
Diesel spill (refuelling spill or vessel-to-vessel collision)	Injury or death to marine fauna through ingestion or contact. Temporary decrease in water quality. Habitat damage in the case of shoreline contact.	• As per 'Interference with third-party vessels'. • The vessel bunkering procedure will be implemented. • Refuelling equipment will be maintained in the accordance with the vessel's planned maintenance system. • Shipboard Oil Pollution Emergency Plan (SOPEP) and Emergency Response Plan (ERP) will be in place, and implemented in the event of a diesel spill. • Diesel spill will be promptly reported internally and externally in accordance with the project Oil Pollution Emergency Plan (OPEP), which is described in Section 8 below. • Operational and scientific monitoring will take place to support the spill response and characterise environmental impacts.	Medium

Any updates to plans of management for listed species or marine reserves will be used to improve risk assessment processes and findings. Any proposed operational change to the survey will also trigger a review and assessment process.

8. Hydrocarbon Spill Preparedness and Response

An OPEP is in place for the Crowes Foot survey that addresses the potential scenario of a diesel spill caused by ship-to-ship fuel transfers or vessel collision resulting in damage to one or more fuel tanks (using a credible, albeit conservative estimate of a loss of 300 m^3 in the latter scenario).

The hierarchy of protection priorities for the survey, reflecting NatPlan criteria, is as follows:

1. Human health and safety;
2. Habitat and cultural resources;
3. Threatened flora and fauna;
4. Commercial resources; and
5. Amenity.

The following oil spill response priorities have been identified for this survey in the event of a Level 2 spill:

- Remove marine users from areas that present a safety hazard;
- Minimise exposure to diesel to threatened species that may transit area; and
- Prevent exposure to the spill by commercial fisheries in proximity to the operational area.
- Prevent, or minimise, diesel exposure to the coast through physical agitation of the diesel slick in deeper waters.

The response structure for hydrocarbon spill depends on the size of the spill, as outlined below.

- A Level 1 spill (typically < 10 tonnes) will be managed solely by the personnel on board the vessel.
- A Level 2 spill (typically 10 – 100 tonnes) will involve onshore vessel contractor and Origin personnel, and possibly government personnel.
- Level 3 spills (typically >100 tonnes) are not a credible scenario for the survey.

On release, marine diesel is expected to undergo a rapid spreading and evaporative loss with the remainder becoming dispersed in the water column. Although classed as ‘persistent oil’, a diesel slick tends to break up quickly. During evaporative weathering, low molecular weight aliphatic and aromatic hydrocarbons and phenols are lost from the oil, leaving higher concentrations of less volatile, higher molecular weight hydrocarbons. The heavier components have a strong tendency to entrain in the upper water column as oil droplets in the presence of wind/waves but can re-float to the surface if these energies abate.

8.1 Response Strategies

Origin has prepared a strategic Net Environmental Benefits Analysis (NEBA) for the options available to respond to a spill of diesel off the Victorian coastline, and determined that the following response strategies can be implemented:

- Monitoring and allowing for natural remediation – to be undertaken from vessels, rotary-wing and fixed-wing aircraft. This will involve activating the support of AMOSC for personnel and vessels, AMSA for fixed-wing aircraft, the Victorian DoT for personnel and vessels and Bristows for helicopters. Origin will commission real-time oil spill trajectory modelling through RPS-APASA to assist with the monitoring effort.
- Oiled wildlife response – where oiled wildlife is discovered and able to be safely recovered, Origin will ensure that the relevant response agencies (e.g., AMOSC and the Victorian DoT) are activated to capture, assess, treat and rehabilitate affected wildlife.

Response strategies discounted based on the weathering characteristics of diesel and the spill modelling results include on-water recovery (booming and skimming), dispersant use, shoreline protection and deflection and shoreline cleanup. The latter takes into account that waxy residues that may wash up on beaches are not toxic to wildlife, that parts of the coast dominated by steep cliffs are ‘self-cleaning’ due to their high wave energy, and that more environmental damage is likely to be created by an active shoreline cleanup than allowing the weathered diesel to degrade naturally.

A real-time (‘operational’) NEBA will be prepared at the time of a spill to test whether the assumptions in the strategic NEBA hold true for the circumstances of the day.

In accordance with the National Plan, Origin (in consultation with AMOSC, AMSA and the Victorian DoT) will continually assess the on-going requirement for marine response as new data is received, through the ongoing revision of the NEBA, until it is determined that the response will not provide any further environmental benefit or is no longer feasible (i.e., surface diesel no longer visible).

Termination of the response will occur when the following three termination criteria are met:

1. Spill is no longer visible (as defined below) from the survey vessel;
2. Aerial surveillance (if mobilised) determines that the appearance of the spill reaches a silvery/grey sheen (< 0.5 micron / 0.5 g/m^2 thickness) on the sea surface (as per the Bonn Agreement Oil Appearance Code), which is considered to be the limit of visibility for a spill; and
3. Modelling/predictions and surveillance (if mobilised) determines that the spill is unlikely to reach any shoreline or sensitive area.

Termination of the response will be communicated to all parties by the Incident Controller.

8.2 Emergency Response Preparedness

At a minimum, the OPEP will be tested:

4. Prior to the commencement of acquisition;
5. When a significant modification to the plan has occurred; and
6. At least once per year.

Exercises shall be undertaken in accordance with the Origin Emergency Response Exercise Planning and Reporting Procedure (OEUP-1000-PRO-SAF-158). 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. Planning for the scenarios will include defining clear objectives to be achieved in order for the exercise to accomplish a specified outcome (e.g., what systems are tested, inclusion (or not) of third party emergency services, and timing of responses expected).

8.3 Operational and Scientific Monitoring

Operational and scientific monitoring following a significant spill is the responsibility of Origin and an Operational and Scientific Monitoring Program (OSMP) has been included in the OPEP. To enable rapid implementation of scientific monitoring, an OSMP Implementation Plan has been developed for Origin's operations in the Otway Basin. The OSMP implementation plan contains information and arrangements for resources required to execute scientific monitoring at the time of an incident in the Otway Basin including vessels, consultants and laboratories. Origin has an agreement in place with the RPS Group for the provision of personnel and equipment to implement the OSMP. OSMP studies include:

- Oil fate and effects assessment;
- Inshore and shoreline ecological ground surveys; and
- Wildlife impact assessment surveys.

9. Implementation Strategy

Origin retains responsibility as the Titleholder of the activity and is responsible for ensuring that the survey is implemented in accordance with the performance objectives outlined in the EP. Day-to-day management of the survey vessel, however, will be the responsibility of the survey contractor.

9.1 Environmental Management System

Origin's Health, Safety and Environmental (HSE) Policy commitments are communicated and implemented through its HSE Management System (HSEMS). Origin's HSEMS is based on the continual improvement methodology of Commit-Plan-Do-Check and Review. The HSEMS is aligned with recognised international and national standards including ISO 14001, OHSAS 18001, ISO 31000 and AS 4801.

9.2 Key Roles and Responsibilities

The organisation structure for the survey consists of onshore and offshore Origin and survey contractor representatives.

Day-to-day implementation of the EP will occur on the survey vessel under the leadership of the Party Chief and the Client Site Representative. The Origin Project Manager will have oversight of the performance of the project against the EP and other project plans, and will initiate reviews and audits as required. In the event of a vessel incident, the Origin Emergency Response Team (ERT) will work together with HSE and technical advisors and government combat agencies as required to respond.

9.3 Training and Awareness

During its contractor selection process, Origin will conduct thorough due diligence to ensure that the chosen contractor has in place procedures to ensure the correct selection, placement, training and ongoing assessment of employees, with position descriptions (including a description of HSE responsibilities) for key personnel being readily available.

A shore-based desktop exercise of Origin's Southern Australia ERP will be conducted by Origin prior to the survey commencing.

All offshore personnel working on the survey and support vessels will be provided with Origin 'Leading HSE' training. A survey-specific HSE induction for the same personnel will also be undertaken prior to the survey.

Regular (quarterly) training of vessel crew in SOPEP procedures is a MARPOL requirement for vessels over 400 GRT (Annex 1, Regulation 37). During its contractor selection process, Origin will ensure that the chosen contractor has been implementing this requirement.

Only appropriately qualified and experienced MMOs and PAM operators will be hired by the survey contractor. There is now a large pool of such personnel in Australia spread across various consultancies (e.g., RPS, Blue Planet Marine, etc). This is linked to HSEMS Standard 18 (Environmental effects and management).

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

Environmental matters will be included in daily toolbox talks as required by the specific task being risk assessed (e.g., waste management). Environmental issues will also be addressed in Weekly HSE Meetings, where each shift will participate with the Client Site Representative, Party Chief and Vessel Master in discussing HSE matters that have arisen in the previous week, and issues to consider for the following week.

9.4 Emergency Response and Preparedness

Survey-specific emergency response procedures for the proposed survey are included in the Survey HSE Plan. The Survey HSE Plan 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 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 survey vessel Client Site Representative 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.

The survey and support vessels will have equipment aboard for responding to emergencies, including but not limited to lifesaving appliances, medical equipment, fire fighting equipment and oil spill response equipment.

9.5 Incident Recording and Reporting

All breaches of the EP are considered non-compliances. Non-compliances may be identified during an audit, inspection, crew observation or as a consequence of an incident.

All EP non-compliance issues must be communicated immediately to appropriate offshore and onshore management personnel. This expectation will be reinforced at inductions, daily toolbox meetings and weekly HSE meetings. Any EP non-compliances will be investigated as per the survey contractor's and Origin's investigation procedures. Following an investigation, remedial actions will be developed to prevent recurrence and these actions will be tracked to completion.

Recordable and reportable environmental incidents will be reported to NOPSEMA and other regulatory agencies in accordance with detailed requirements listed in the EP.

9.6 Environmental Monitoring

Origin will maintain a quantitative record of emissions and discharges as required under Regulation 14(7) of the OPGGS(E). This record will include all emissions and discharges to the air and water and can be monitored and audited against the environmental performance standards. Results will be reported in the end-of-survey EP performance report submitted to NOPSEMA.

9.7 Audit and Review

Environmental performance of the survey will be reviewed in a number of ways to ensure that:

- Environmental performance standards to achieve the environmental performance outcomes 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:

- An inspection(s) of the vessels will be carried out before or during the survey to ensure that procedures and equipment for managing routine discharges and emissions are in place to enable compliance with the EP.
- A summary of the EP commitments for the activity will be distributed aboard the survey vessel, and implementation of the environmental performance standards will be monitored by the Client Site Representative.

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

10. Further Information

For further information, please contact:

Linda French
Community Relations Specialist
321 Exhibition Street, Melbourne VIC 3000
Phone: 1800 797 011
Email: community.team@ originenergy.com.au