Santos Limited

Otway 3D and VIC/RL7 Seismic Surveys

Environment Plan

May 2007
CR 1305_2a_v1

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Version/s:	**Distribution:**
CR 1305_2_v2 May 2007 (Via email)	Santos Limited – 1 copy DPI – 1 copy Enesar – 1 copy

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1. Introduction

1.1 Project Outline

1.1.1 Seismic Survey

Santos Limited ('Santos') proposes to undertake an offshore 3D seismic exploration program in the Otway Basin, western Victoria covering an area of up to approximately 725 km^2 in Commonwealth waters. The project is referred to as the Otway 3D Seismic Survey.

As an extension to this survey, Santos will be acting as agent operator for BHP Petroleum for the proposed acquisition of approximately 185 km^2 of 3D marine seismic data in Victorian Retention Lease VIC/RL7, also located within the Otway Basin, western Victoria. Both surveys are shown on Figure 1.1.

The WesternGeco seismic survey vessel 'MV Western Trident' will be contracted to undertake the proposed seismic operations and this vessel will complete long-axis acquisition transects of the survey areas by sailing along predetermined tracks in a northwest to southeast direction (hereafter referred to as the 'survey areas').

The vessel will tow twelve hydrophone cable streamers each 5,000 m long, with a total streamer spread of 700 m and a sail line spacing of approximately 400 m. The hydrophone cable streamers travel about 6 m below the sea surface controlled by mechanical devices called 'birds' to maintain the travel depth, and prevent the equipment from making contact with the seabed. The vessel will be required to make all turns outside of the proposed exploration area at the completion of each transect pass, due to the required turning circle of the vessel with cables in tow and the need to obtain full seismic coverage of the exploration area.

1.1.2 Project Justification

The purpose of the seismic program is to acquire 3D seismic data to identify and evaluate potential sub-surface geological structures that may contain oil and gas, and to meet exploration commitments for the permit.

1.1.3 Location

The Otway 3D Seismic Survey area is located within the offshore Otway Basin, western Victoria in Victorian Petroleum Permit Area VIC/P44, approximately 10 km west of Warrnambool and 19 km southeast of Port Fairy. Water depths in the survey area range from approximately 50 m to 90 m. Coordinates for the survey area are listed in Table 1.1.

The extension to this survey is also located within the offshore Otway Basin in Victorian Retention Lease VIC/RL7, approximately 39 km north northeast of Peterborough and 41 km north northeast of Port Campbell. Water depths in the survey area range from approximately 70 to 110m. Coordinates for the survey area are listed in Table 1.2.

1.1.4 Survey Timeframe

Data acquisition for the Otway 3D Seismic Survey is scheduled to occur for approximately 33 days, 10 of which are weather standby days, during the period May to June 2007.

Data acquisition for the extension to this survey will occur immediately after (expected in June 2007) for approximately 11 days, including 3 weather standby days. The precise commencement and completion dates are dependent on vessel availability and weather conditions. The maximum acquisition area that is proposed to be acquired is 185 km^2 of 3D survey. However, the survey parameters have not yet been finalised internally and the area actually acquired may be significantly reduced, (56 km^2 of 3D (4 days) or several 2D lines (2 days)). These options are all represented on Figure 1.1a.

1.2 Project Proponent

Santos (50%) is the operator for VIC/P44 on behalf of joint venture partners Mittwell Energy Resources Pty Ltd (25%) and Peedamullah Petroleum Pty Ltd (25%).

1.2.1 Santos

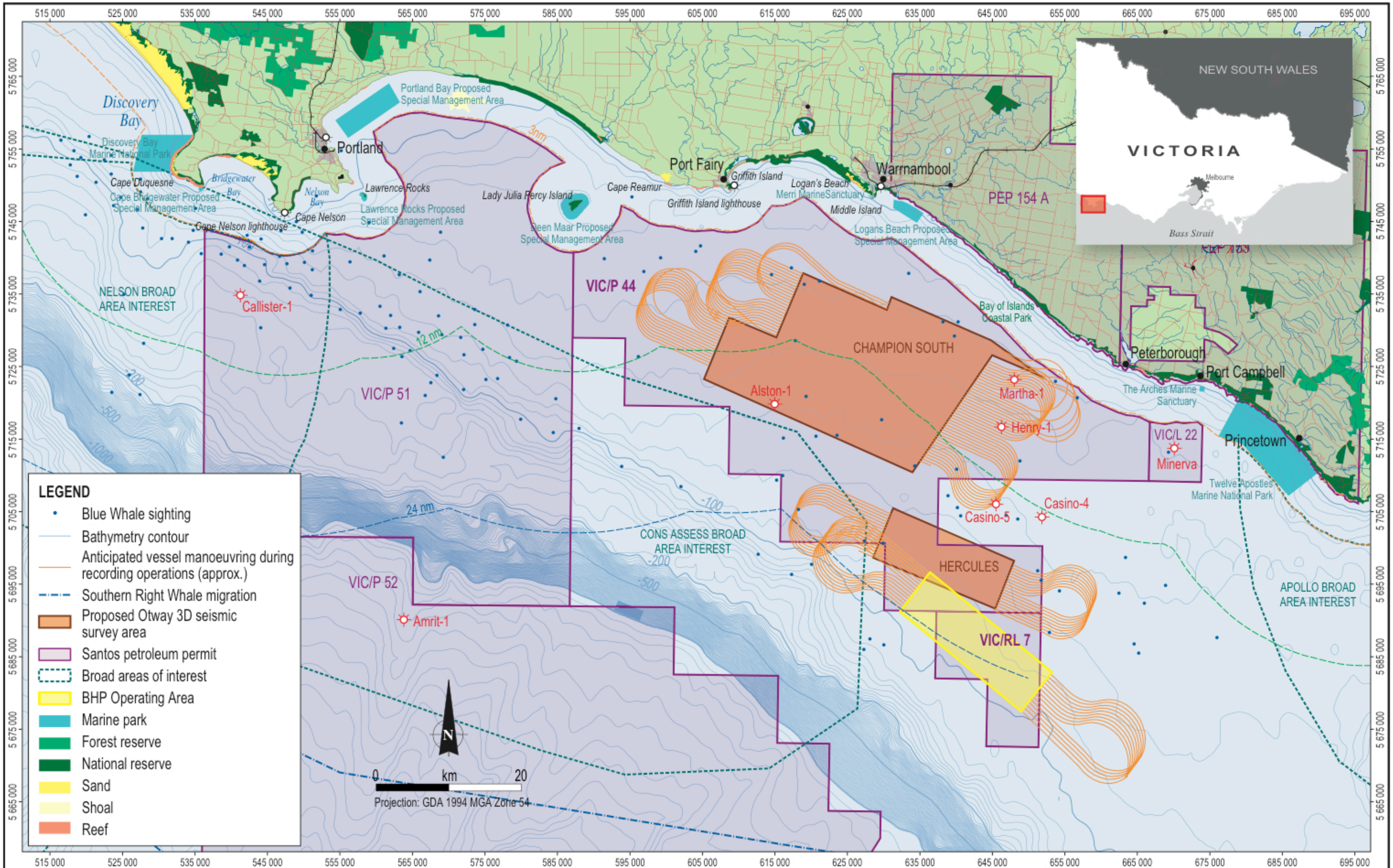
Santos was formed in South Australia in 1954 and is now a major Australian energy company. The core business of the company is oil and gas exploration and production with interests in every major Australian petroleum province. Santos is the largest producer of natural gas for the Australian market supplying all mainland States and Territories. Santos' head office is in Adelaide with offices also in Brisbane and Perth.

The core gas operations for Santos are in the Cooper Basin where gas is distributed to customers in South Australia, New South Wales, Queensland and the Australian Capital Territory. Santos is the operator for permit areas in the Northern Territory, Western Australia, Victoria and Tasmania, has exploration and production interests in the USA and Egypt and exploration acreage in Indonesia and Papua New Guinea.

Santos has been an operator of exploration acreage in the offshore Otway Basin since late 2001 and holds interests in three exploration permits (VIC/P44, VIC/P51 and VIC/P52) and is a joint venture partner in two retention licences (VIC/RL22 and VIC/RL7). Since this time Santos has undertaken seismic and exploration drilling activities in the Otway Basin exploration permit areas. Santos operates the Casino gas facilities in VIC/P44.

Santos' head office is located in South Australia at:

Santos House
91 King William Street
Adelaide, South Australia 5000.



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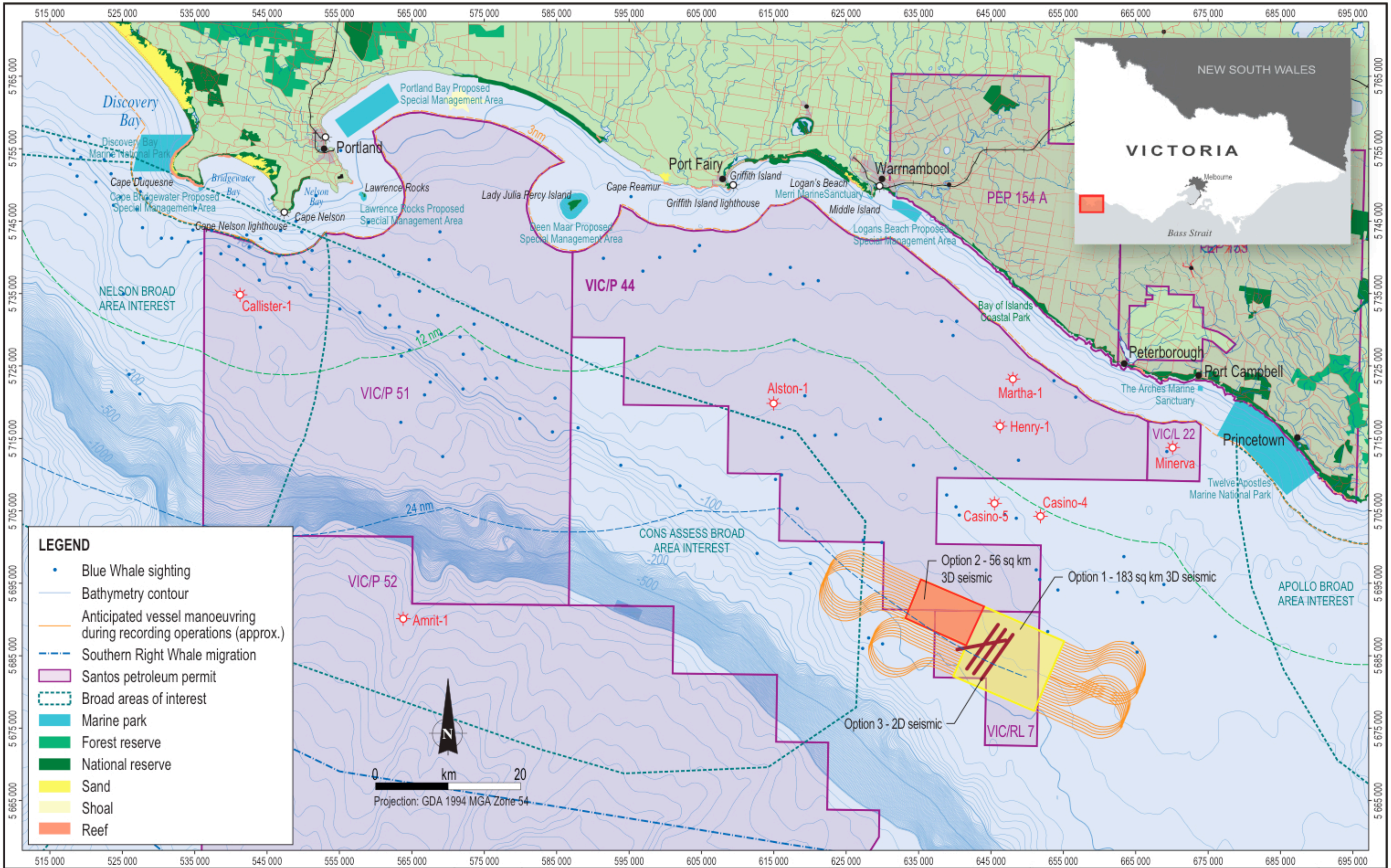
Santos Ltd

Environment Plan

Santos

Location of survey areas

Figure No: 1.1



Job No: 1305	Santos Ltd	Santos	Extended VIC/RL7 survey options	Figure No: 1.1a
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Table 1.1 VIC/P44 survey area coordinates

Area 1 – Champion South	
Latitude	*Longitude*
38°36’01”S	142°39’53”E
38°37’33”S	142°44’33”E
38°34’59”S	142°39’53”E
38°31’46”S	142°30’21”E
38°32’41”S	142°29’52”E
38°29’57”S	142°21’56”E
38°34’44”S	142°19’22”E
38°33’15”S	142°14’53”E
38°36’47”S	142°13’03”E
38°43’41”S	142°33’08”E
38°36’01”S	142°39’53”E

Area 2 - Hercules	
Latitude	*Longitude*
38°47’25”S	142°30’50”E
38°51’02”S	142°28’56”E
38°54’46”S	142°40’34”E
38°51’16”S	142°42’21”E

Table 1.2 VIC/RL7 survey area coordinates

Area 3 – BHP Operating Area	
Latitude	*Longitude*
38°52'42”S	142°33’45”E
38°57'06”S	142°47’40”E
39°02'23”S	142°44’55”E
38°59'55”S	142°37’03”E
38°57'34”S	142°38’16”E
38°55'39”S	142°32’16”E

1.3 Purpose of this Environment Plan

This Environment Plan (EP) has been prepared in accordance with the requirements of the Commonwealth Petroleum (Submerged Lands) (Management of Environment) Regulations (1999). It includes an assessment of the seismic acquisition programs from an environmental risk-based context and includes environmental performance objectives, standards and criteria.

The assessment aims to identify and assess the potential environmental impacts associated with the seismic surveys and to recommend suitable mitigation measures to avoid and/or minimise any adverse impacts to the marine environment, including:

- A description of the marine environment in the proposed survey areas.

- Identification of potential effects and risks from the project.
- Procedures and controls for minimising impacts and for monitoring.
- Implementation strategy, including communications and responsibilities.
- Procedures for auditing and reporting.

1.4 Background

Seismic exploration is undertaken to map the subsurface geology of an area and enable identification of potential petroleum reservoir rocks, such as sandstones. Marine seismic surveys are conducted using a specialised seismic survey vessel towing an acoustic source airgun and one or more hydrophone detector cables towed behind the vessel. The acoustic source in this instance will comprise two source arrays, operating alternately at approximately 8 second intervals, which generate a pressure wave pulse which travels as a seismic signal down through the geological layers and is reflected back and recorded by the hydrophones. The seismic pulse is in the order of 220-240 dB re 1μPa (the measure of underwater sound intensity and pressure one metre from the source) at frequencies extending up to approximately 110 Hz, the low end of sound detected by the human ear (McCauley, 1994). These levels vary depending on sound propagation characteristics of the area (McCauley, 1994), such as water depth and seabed features, and decrease logarithmically with distance from the source.

During a seismic survey, the acoustic pulse is directed downwards to the seabed and reflected from the boundaries separating the rock layers in the subsurface, and the reflected signals are recorded by many hydrophones towed in a cable several kilometres long (Figure 1.2).

1.5 Stakeholder Consultation

Impact mitigation planning and implementation relies significantly upon consultation with key stakeholders. In the course of planning seismic and development programs within the Otway Basin over the past three years, Santos has undertaken extensive consultation with all relevant stakeholders in the region to identify regulatory processes, potential environmental issues and management requirements. Santos will undertake ongoing consultation to ensure the seismic survey management arrangements and communications are in place.

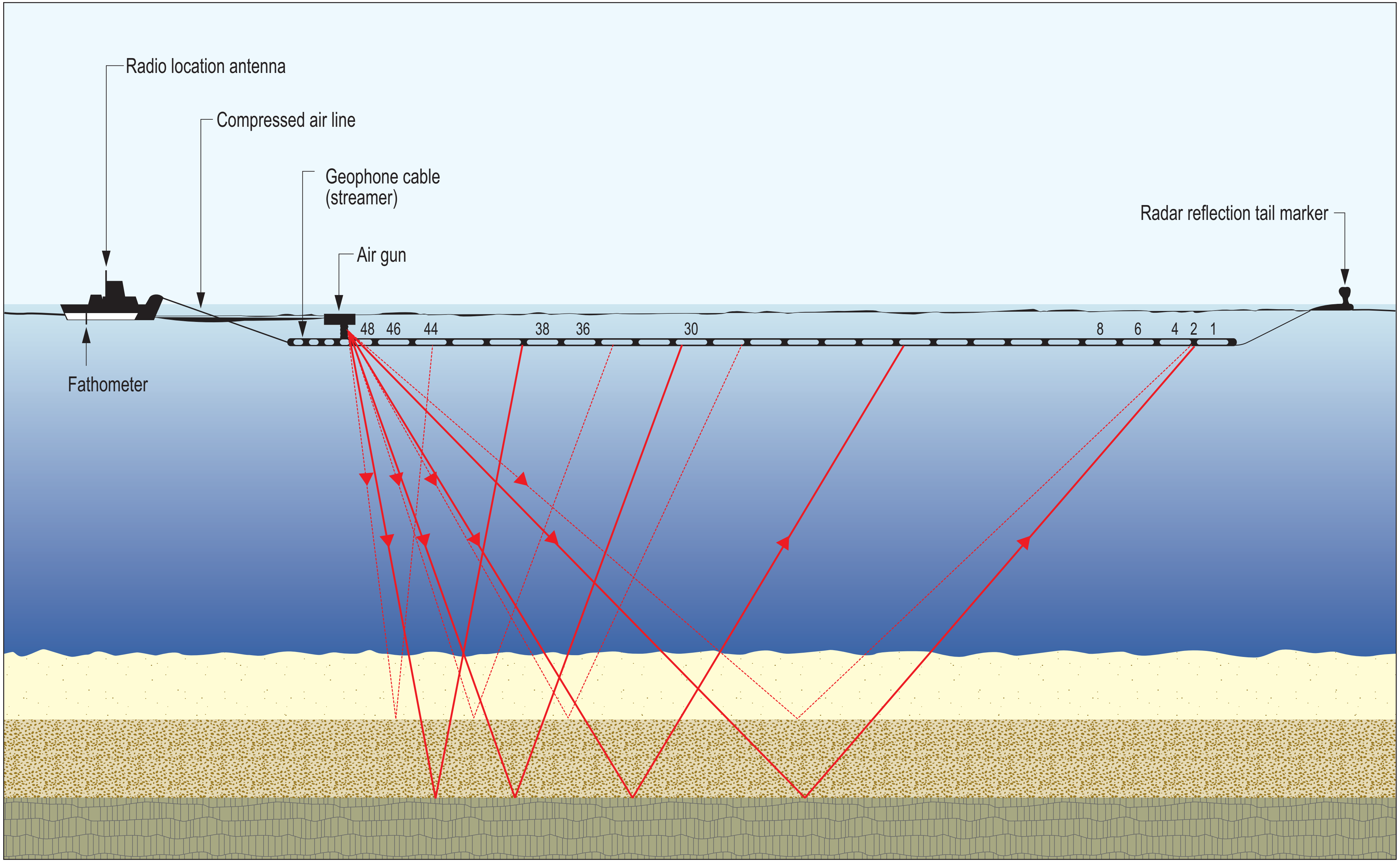
Stakeholders of relevance to the seismic surveys include:

Commonwealth Government:

- Department of the Environment and Water Resources (DEW).
- Department of Industry, Tourism and Resources (DITR).
- Australian Fisheries Management Authority (AFMA).

Victorian State Government:

- Department of Primary Industries (Minerals and Petroleum Regulation Branch).
- Department of Primary Industries (DPI) Fisheries.
- Department of Sustainability and Environment.



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enesar people and place	Job No: 1305	Santos Ltd	Santos	Typical marine seismic survey schematic	Figure No: 1.2
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Commercial fishing and other groups:

- Portland Professional Fishermen's Association.
- Warrnambool Fishermen's Association.
- Port Campbell Rock Lobster Fishermen's Association
- Seafood Industries Victoria.
- Deakin University (Warrnambool) blue whale research group.

Consultation and information dissemination has been, and will continue to be, undertaken through a range of media including:

- Meetings with regulators.
- Meetings and correspondence with key stakeholders.
- Invitation for public comment on the EPBC referrals via the DEW website.
- Provision of detailed survey maps.
- Daily schedule communications to fishing operators.
- Vessel communication systems with maritime traffic.

Further consultation with the above groups and others, including Australian Fisheries Management Authority (AFMA) and Australian Maritime Safety Authority (AMSA) will occur up to the time of the surveys.

In addition, Santos will report on seismic operations in accordance with regulatory requirements to demonstrate that the environmental performance objectives and standards outlined in this Environment Plan have been met (see Section 6).

A summary of the fishers consulted with is provided in Appendix 2.

2. Applicable Legislation, Treaties and Codes of Practice

2.1 Legislative Framework

This section provides a brief summary of the legal framework applicable to the surveys.

The principal offshore legislation for production activities beyond three nautical miles is the Commonwealth *Petroleum (Submerged Lands) Act 1967* (P(SL)A) and continues to the outer extent of the Australian Exclusive Economic Zone (EEZ) at 200 nautical miles.

The Commonwealth P(SL)A is administered by a Joint Authority between the Victorian and Commonwealth Governments. The Victorian Department of Primary Industries, on behalf of the State Minister, acts as the Designated Authority (DA) for the Commonwealth for the management of day-to-day decisions and approvals processes.

A variety of Commonwealth legislation, industry procedures and guidelines and international treaties and obligations may apply in relation to the conduct of the surveys. Environmental approvals for the seismic surveys are to be assessed under the *Petroleum (Submerged Lands) Act 1967* and Petroleum (Submerged Lands)(Management of Environment) Regulations 1999.

This document has been produced to fulfil the requirements of the Petroleum (Submerged Lands)(Management of Environment) Regulations 1999.

2.2 Statutory Approvals

2.2.1 *Petroleum (Submerged Lands) Act 1967*

The proposed seismic programs are subject to, and will be undertaken in accordance with, the requirements of the Commonwealth *Petroleum (Submerged Lands) Act* 1967 (PSLA) for activities in Commonwealth waters. The Commonwealth *Petroleum (Submerged Lands) (Management of Environment) Regulations* 1999 (PSLMER) require an Environment Plan (EP), comprising a description of the environmental effects and risks and proposed mitigation measures, as well as detail of stakeholder consultation.

Part 2, Division 2.3 (sections 13, 14, 15 and 16) of the PSLMER requires an EP, comprising a description of the environmental effects and risks and proposed mitigation measures, to be accepted by the Designated Authority prior to any activities being undertaken. The Designated Authority for seismic exploration proposals in State and Commonwealth waters is the Victorian Department of Primary Industries (DPI).

2.2.2 *Environment Protection and Biodiversity Conservation Act 1999*

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), enables the Commonwealth to join with the States and Territories in a national scheme of environment protection and biodiversity conservation. Under the EPBC Act, actions that are likely to have an effect on matters of national environmental significance will trigger Commonwealth assessment and approval.

Matters defined as national environmental significance include:

1. World Heritage properties.
2. Ramsar wetlands of international importance.
3. Nationally threatened animal and plant species and ecological communities.
4. Internationally protected migratory species.
5. Commonwealth land and marine areas.
6. Nuclear actions.

A referral and assessment process determines the application of the EPBC Act. Where activities are deemed by the Minister to have a potential for significant impacts on matters of national environmental significance, the project is deemed to be a controlled action and assessment under the EPBC Act is triggered.

A referral for the Otway 3D Seismic Survey under the EPBC Act was submitted to the DEW (Referrals and Assessment Section) for assessment on 23 March 2007.

A referral for the extension to this survey under the EPBC Act was submitted to the DEW (Referrals and Assessment Section) for assessment on 4 May 2007.

2.3 Other Applicable Legislation

2.3.1 Commonwealth Legislation

- *Australian Heritage Commission Act 1975.*
- *Hazardous Waste (Regulation of Exports and Imports) Act 1989.*
- *Historic Shipwrecks Act 1976.*
- *Navigation Act 1912.*
- *Ozone Protection Act 1989.*
- *Protection of the Sea (Civil Liability) Act 1981.*
- *Protection of the Sea (Oil Pollution Compensation Fund) Act 1993.*
- *Protection of the Sea (Powers of Intervention) Act 1981.*

2.4 International Treaties and Obligations

Australia is a signatory to numerous international conventions and agreements that obligate the Commonwealth government to take action to prevent pollution and to protect specified habitats, flora and fauna. Those conventions and agreements relevant to offshore seismic exploration operations include:

- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) (1979).
- UN Convention on the Law of the Sea (1982).
- *London Convention (1972), and 1996 Protocol, formerly* London (Dumping) Convention (1972).
- International Convention for the Protection of Pollution from Ships (1973) and Protocol (1978).

- International Convention on Oil Pollution Preparedness, Response and Co-operation (1990).
- International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (1969).
- International Convention on Civil Liability for Oil Pollution Damage (1969).
- United Nations Convention on the Law of the Sea (UNCLOS) (1994).
- Convention on Conservation of Nature in the South Pacific (Apia convention) (1976).

2.5 Industry Codes of Practice and Guidelines

The petroleum production industry operates within an industry code of practice and individual member environmental policies, as follows:

- Australian Petroleum Production and Exploration Association (APPEA) Code of Environmental Practice.
- Department of Environment and Water Resources Guidelines on Interactions between Offshore Seismic Operations and Larger Cetaceans.
- International Association of Geophysical Contractors (IAGC) Environmental Guidelines for Worldwide Geophysical Operations.

2.6 Environmental Policy Statement

The Santos environmental policy is outlined in Box 2.1.

Box 2.1 Santos' environmental policy

Environmental Policy

Santos

Our Environmental Vision:

"We will lighten the footprint of our activities"

Santos is an Australian energy company producing oil and natural gas in both onshore and offshore localities throughout Australia and overseas.

At Santos we are adopting the principles of sustainable development. We recognise our responsibility to meet community expectations and we are committed to the continuous improvement of our environmental performance. We believe that environmental stewardship is both a management obligation and the responsibility of every employee.

To achieve this we will:

- Maintain and continuously improve the Environment, Health and Safety Management System (EHSMS) across the organisation.
- Ensure that all personnel, contractors and consultants receive adequate training to fulfil their individual EHSMS responsibilities.
- Apply a systematic approach to identifying hazards and managing environmental risks to reduce these to as low as reasonably practicable.
- Develop annual environmental objectives and targets and implement programs to achieve them.
- Comply with relevant legal and other requirements, and where opportunities exist, participate in the development and review of legislation and guidelines.
- Ensure that we have the resources and skills necessary to achieve our environmental commitments.
- Incorporate environmental performance in the annual appraisal of employees and contractors, and recognise accordingly.
- Implement strategies to reduce and prevent pollution, manage waste effectively, use water efficiently and address relevant cultural heritage and biodiversity issues.
- Formally monitor, audit, review and report annually on our environmental performance against defined objectives.
- Review the environmental impact of goods and services being provided by our suppliers.

As the Managing Director, I am committed to working with Santos personnel to ensure that this policy is communicated, understood, accepted and successfully implemented by all employees and contractors.

John Ellice-Flint
Managing Director
September 2004

Santos Ltd ABN 80 007 550 923 File No: POLICY P040

3. Description of Environment

This chapter describes the existing environment in the vicinity of the survey areas. Potential impacts are discussed in Chapter 4.

3.1 Physical Environment

3.1.1 Climate and Meteorology

Table 3.1 outlines the climate and meteorology of the survey areas based on recordings from nearby Warrnambool weather station.

Table 3.1 Climate of the seismic survey areas

Parameter	Warrnambool (VIC)
Climate classification[1]	No dry season, mild summer
Average annual rainfall (mm)	743
Mean number of rain days	167
Mean daily maximum temperature (°C)	18
Mean daily minimum temperature (°C)	10
Mean relative humidity (9 am) (%)	77
Mean relative humidity (3 pm) (%)	69
Mean wind speed (9 am) (km/hr)	11
Mean wind speed (3 pm) (km/hr)	15

Source: Bureau of Meteorology, 2007.

3.1.2 Oceanography

High energy wave conditions are characteristic of the survey areas, with more severe wave conditions occurring in winter. Wave heights in the Port Campbell region commonly range between 2.0 to 3.5 m for 50% of time however in winter they can reach 7.6 m (BHP Petroleum and Santos (BOL) Ltd, 1999).

Tidal range is considered microtidal, 0.8 – 1.2 m (IMCRA, 1998). There are two high tides and two low tides per day with levels in Port Campbell varying from 0 to 1.1 m (Woodside, 2003).

Wind driven currents are the most predominant in the area, generally running parallel to the coast and in a majority of the cases from west to east (BHP Petroleum and Santos (BOL) Ltd, 1999; Woodside, 2003).

Tidal currents are in the order of 0.1 m/s and run in an east to south-east direction for most of the time, and occasionally currents swing around to the west and northwest (BHP Petroleum and Santos (BOL) Ltd, 1999).

The typical thermocline temperature is 16.5°C, with surface temperature varying from 14.5 to 19°C and bottom temperatures in the area of 13.5°C to 14.5°C. There is a seasonal thermocline at a depth of 30 m in December which moves to 100 m in May and is then rapidly destroyed as mixing occurs during winter months (BHP Petroleum and Santos (BOL) Ltd, 1999).

Upwelling is known to occur along the Bonney Coast (Robe, SA to Portland, Vic) and extends through to the study area throughout the summer period (November-March) (Butler et al., 2002). This 'Bonney Upwelling' is a result of south-east winds generating water movements to the surface away from the coast. This water is replaced by colder water drawn from greater depths off the continental shelf that is generally nutrient-rich and plays an important role in the generation of plankton blooms (Woodside, 2003).

3.1.3 Seabed Bathymetry

The Otway 3D Seismic Survey area in VIC/P44 is located in water depths ranging from 50 to 90 m. The extension of this survey in VIC/RL7 is located in water depths ranging from 70 to 110 m.

The seabed is likely to consist of calcarenite, limestone, sandstone, marl and granite, with areas of sand of varying grain size. Benthic substrate can be expected to consist of sand, silt, gravel, calcareous gravel and calcareous ooze. Deep rocky reefs are likely to occur in the shallower waters to the north of the survey areas.

3.2 Biological Environment

The Interim Marine and Coastal Regionalisation for Australia (IMCRA) (IMCRA, 1998), has adopted an ecosystem-based classification system for marine and coastal environments. The area of the seismic surveys encompasses several classifications, as outlined in Table 3.2 below.

Table 3.2 IMCRA bioregional classification of the survey areas

Name	Classification	Scale Hierarchy	Description
Otway	Meso-scale (Provincial)	100s-1000s of km^2	Characterised by very steep to moderate offshore gradients. Wave energy is high, currents are generally slow, and the waters are cold temperate, subject to localised, regular and cold nutrient-rich coastal upwelling.
West Bassian Biotone	Demersal province	89,000 km^2	Zone of faunal overlap of elements from the Tasmanian and Bassian Provinces to the east, and a small suite of extra-limital species from the Central Eastern Province.
Southern Pelagic Province	Pelagic province	482,000 km^2	Extends from near Albany, WA, to Lakes Entrance, Victoria, encapsulating all of Bass Strait. Comprised of temperate species, with the endpoint disjunctions representing the southern limits for tropical species.

Provinces and biotones are based on a classification of demersal fish species diversity and richness.

3.2.1 Marine Fauna

Fauna of national significance that may be encountered within the project areas are listed in Table 3.3 for the Otway 3D Seismic Survey and Table 3.4 for the extension to this survey, based on a search of the DEW EPBC Online Database (DEH, 2007a). Marine birds are not listed in the tables below as they are mostly migratory, and may overfly the project area but are highly unlikely to be impacted by the surveys. Of the birds that may overfly the survey areas, there are 12 species of albatross listed, all of which are migratory species whose status is threatened (three species are endangered and nine are vulnerable). There are also two threatened species of petrel (one species is endangered and one is vulnerable) that may overfly the area.

Table 3.3 EPBC-listed species that may occur in the VIC/P44 survey area

Category	Species	Common Name	Status
Cetaceans	*Balaenoptera musculus*	Blue whale	T, E, M, C
	Eubalaena australis	Southern right whale	T, E, M, C
	Megaptera novaeangliae	Humpback whale	T, V, M, C
	Balaenoptera edeni	Bryde's whale	M, C
	Caperea marginata	Pygmy right whale	M, C
	Orcinus orca	Killer whale, Orca	M, C
	Lagenorhynchus obscurus	Dusky Dolphin	M, C
Sharks	*Carcharodon carcharias*	Great white shark	T, V, M
Other cetaceans	*Balaenoptera acutorostrata*	Minke whale	C
	Delphinus delphis	Common dolphin	C
	Grampus griseus	Risso's dolphin, Grampus	C
	Tursiops aduncus	Spotted Bottlenose Dolphin	C
	Tursiops truncatus s. str.	Bottlenose Dolphin	C
Other Listed Marine Species	20 species	Pipefish	L
	2 species	Seahorse	L
	2 species	Pipehorse	L
	2 species	Seadragon	L
	Arctocephalus pusillus	Australian Fur-seal	L
	Arctocephalus forsteri	New Zealand fur-seal	L

Key: T-threatened; M-migratory; E-endangered; V-vulnerable; L-listed, C-Cetacean

Table 3.4 EPBC-listed species that may occur in the VIC/RL7 survey area

Category	Species	Common Name	Status
Cetaceans	*Balaenoptera musculus*	Blue whale	T, E, M, C
	Eubalaena australis	Southern right whale	T, E, M, C
	Megaptera novaeangliae	Humpback whale	T, V, M, C
Sharks	*Carcharodon carcharias*	Great white shark	T, V, M
Fishes	*Hoplostethus atlanticus*	Orange Roughy, Deep-sea Perch	T, CD
Other cetaceans	*Balaenoptera bonaerensis*	Antarctic Minke whale	M, C
	Balaenoptera edeni	Bryde's whale	M, C
	Caperea marginata	Pygmy right whale	M, C
	Orcinus orca	Killer whale, Orca	M, C
	Physeter macrocephalus	Sperm whale	M, C
	Lagenorhynchus obscurus	Dusky Dolphin	M, C
	Balaenoptera acutorostrata	Minke whale	C
	Berardius arnuxii	Arnoux's Beaked whale	C
	Delphinus delphis	Common dolphin	C
	Globicephala macrorhynchus	Short-finned Pilot whale	C

	Globicephala melas	Long-finned Pilot whale	C
	Grampus griseus	Risso's dolphin, Grampus	C
	Kogia breviceps	Pygmy Sperm whale	C
	Kogia simus	Dwarf Sperm whale	C
	Lissodelphis peronii	Southern Right Whale Dolphin	C
	Mesoplodon bowdoini	Andrew's Beaked whale	C
	Mesoplodon densirostris	Blainville's Beaked whale	C
	Mesoplodon hectori	Hector's Beaked whale	C
	Mesoplodon layardii	Strap-toothed Beaked whale	C
	Mesoplodon mirus	True's Beaked whale	C
	Pseudorca crassidens	False Killer whale	C
	Ziphius cavirostris	Cuvier's Beaked whale	C
	Tursiops truncatus s. str.	Bottlenose Dolphin	C
Other Listed Marine Species	20 species	Pipefish	L
	2 species	Seahorse	L
	2 species	Pipehorse	L
	2 species	Seadragon	L
	Arctocephalus pusillus	Australian Fur-seal	L
	Arctocephalus forsteri	New Zealand fur-seal	L

Key: T-threatened; M-migratory; E-endangered; V-vulnerable; CD-conservation dependent; L-listed; C-Cetacean

Marine Mammals

A number of marine mammals (whales, dolphins and seals) are known to occur in the Otway basin. Several of these species are discussed below based on their potential presence in the survey areas.

Whales. Blue whales (*Balaenoptera musculus*) are listed as an endangered migratory species under the EPBC Act. They have widespread migratory paths and although they can occur relatively close to the coast they are not known to follow coastlines or oceanographic features (Bannister et al., 1996). Sightings of blue whales in western Victoria have generally been between November/December and April/May. Most blue whales are sighted during the March/April period, on the continental shelf in water depths less than 200 m between longitudes 139°18'E - 143°03'E (Gill, 2002; APPEA 2005; DEH, 2007b). Observations suggest that western Victoria and southeast South Australia are used for feeding grounds at least in summer and early autumn (Gill, 2002). Aggregations of the krill species, *Nyctiphanes australis,* which are common along the Bonney Coast upwelling region, attract the blue whales to the area for feeding (Gill, 2002). Off Cape Bridgewater, blue whale sightings are concentrated along the shelf break but are more dispersed over a wider shelf and deepwater area to the northwest and southeast (Figure 1.1).

Southern right whales (*Eubalaena australis*) are listed as an endangered migratory species under the EPBC Act and occur along the Southern coast of Australia in winter and spring (Kemper et al., 1997). Calving females have a preference for shallow, northeast trending bays over sandy bottoms (Bannister et al., 1996). Warrnambool is recognised as a critical area for the recovery of this species (DEH, 2007c), as it is an important calving and nursery area. The majority of sightings near Warrnambool occur each year from May to November, just outside the break at approximately 5-6 m waters depth. The use of Warrnambool as a nursery area by the southern right whales could be associated with the high levels of natural sound from the surf, which would make it difficult for acoustically-sensitive predators such as the killer whales to detect the presence of calves (Bannister et al., 1996). Port Fairy and Portland have also been used intermittently as calving areas or by small numbers of mothers with very young calves (DEH, 2007c).

A discrete population of Humpback whales *(Megaptera novaeangliae)* (listed as vulnerable under the EPBC Act) migrate annually along the east coast of Australia between summer feeding grounds in the Antarctic and winter breeding and calving grounds in the tropics. Humpbacks observed along the western coast of Victoria are likely to be travelling north to the east coast of Australia via Tasmania's west coast and Bass Strait. Sightings are frequently made along the Victorian coastline from June to November (DEH, 2007d). In recent years, during the autumn period, there have been sightings from shore of humpback whales heading east off Portland and Warrnambool (Woodside, 2003).

There are other species that may also occur infrequently in the area, as described by Bannister et al., 1996. These include Bryde's whale (*Baleonopetra edeni*), pygmy right whale (*Caperea marginata*), killer whales (*Orcinus orca*) and minke whales (*Balaenoptera acutorostrata)*.

A summary of the timing of peak whale activities in and around the Otway Basin is provided in Table 3.5. The timing of these activities are peak only, and individuals of the species listed still have the possibility of occurring in the Otway Basin outside of the times indicated. In particular, southern right whales may remain until October and blue whales may appear in November.

Table 3.5 Summary of peak whale activities in the Otway Basin

Species	Activity	Month											
		J	F	M	A	M	J	J	A	S	O [1]	N [2]	D
Southern right whale	Migration, calving, nursing												
Blue whale	Feeding aggregation												
Humpback whale	Migration												

[1] Late-departing southern right whales. [2] Early arriving blue whales.
(Compiled from the above descriptions of the peak whale activities in the Otway Basin).

Other Cetaceans. Risso's dolphin (*Grampus griseus*) has been recorded in Victoria, generally found inshore as well as offshore. It is considered a pelagic and oceanic species also frequently seen over the continental slope (Bannister et al., 1996).

Dusky dolphins (*Lagenorhynchus obscurus*) predominantly occur in temperate inshore subantarctic zones and, at times, pelagic zones, but there are no key localities known in Australian waters (Bannister et al., 1996).

The common dolphin (*Delphinus delphis*) is found in Victorian waters, where their habitat is generally neritic, pelagic and oceanic. This species has been associated with high topographical relief of the ocean floor, escarpments and areas of upwelling (Bannister et al., 1996), but there are no key areas known in Australia.

The bottlenose dolphin (*Tursiops truncatus*) is generally found in coastal estuarine pelagic and oceanic habitats. In southern Australia, this species can occur close to shore as well as in waters beyond the continental slope all year round (Bannister et al., 1996). A key locality for the bottlenose dolphin is in Port Phillip Bay.

Pinnipeds. The preferred habitat of the Australian fur-seal (*Arctocephalus pusillus*) is on rocky islands in exposed places close to the sea, on open slopes, shore platforms and reefs, pebbled beaches and caves (Strahan, 1995). The Australian fur seal diet consists of fish, cephalopods and seabirds (Shaughnessy, 1999), diving up to 200 m in search of prey (Strahan, 1995). The Australian fur-seal has established four breeding areas in Victoria, with the largest breeding colonies found at Lady Julia Percy Island (29 km northwest of the proposed Otway 3D Seismic Survey and 71 km northwest of the extended survey) and Seal Rocks, much further to the east on Phillip Island (Shaughnessy, 1999). Births occur from late October to late December (Strahan, 1995; Shaughnessy, 1999). There are several small non-breeding colonies, one of which is at Little Henty Reef near Apollo Bay (Woodside, 2003). Australian fur-seal colonies can also be found on rock shelf sites on the eastern shores of Cape Bridgewater and Cape Nelson (Parks Victoria, 2004). Australian fur-seals are present in the region of the surveys all year round, however estimates of the numbers that utilise the area are lacking (Woodside, 2003).

The New Zealand fur-seal (*Arctocephalus forsteri*) prefers rocky parts of islands with jumbled terrain and boulders. There are no major New Zealand fur-seal breeding colonies in Victoria. The closest breeding colonies are located at Kangaroo Island, South Australia (Shaughnessy, 1999). New Zealand fur-seals from populations at Kangaroo Island may forage in western Victoria.

Sharks

There is a long-term decline in the abundance of white sharks (*Carcharodon carcharias)* in Australian waters (Environment Australia, 2002a), and while they are generally uncommon, they appear to be more frequent in some areas, such as around seal colonies. The white shark is primarily found in the coastal and offshore areas of the continental and insular shelves and offshore continental islands (Environment Australia, 2002a). It is suggested that the white shark population may segregate according to size and gender as well as for reproduction. Coastal areas off Portland appear to be seasonally important for juvenile white sharks between the months of December to June when pups may be born (Environment Australia, 2002a).

Marine Birds

Marine birds are not listed in Table 3.3 or Table 3.4 as they are mostly migratory, and may overfly the project area but are not likely to be impacted by the activity. The Bay of Islands (west of Peterborough) and the offshore limestone stacks are important roosting and breeding colonies for many bird species.

Of the Commonwealth-listed marine bird species, there are 12 species of albatross listed, all of which are migratory species whose status is threatened (three species are endangered and nine are vulnerable). There are two threatened species of petrel (one species is endangered and one is vulnerable) that may overfly the area.

Pipefish, Seahorses, Seadragons and Pipehorses

Pipefishes, seahorses and seadragons are associated with kelp forests in sheltered to moderately exposed reef areas at a range of depths 0-50 m depending on the species (Edgar, 1997). The spiny pipehorse, however, can be found in temperate marine water depths of up to 230 m (AMO, 2007). The weedy seadragons are only found in southern Australian waters (Parks Victoria, undated).

3.3 Heritage

3.3.1 Aboriginal

Sites of Aboriginal archaeological significance are likely to occur in the coastal and terrestrial areas adjacent to the survey areas. However, the survey areas are located offshore and are not areas known to be of high significance in terms of Aboriginal heritage.

3.3.2 Shipwrecks

Shipwrecks are most commonly associated with submerged shallow reefs. Shipwrecks represent significant archaeological, educational and recreational (i.e., diving) opportunities for the general public, historians, students, and tourists. No known shipwrecks occur in the survey areas (Larcombe et al., 2002), nor are any expected due to the surveys being located in open seas a significant distance from coastal waters.

The nearest shipwrecks to the survey areas occur all along the southwest coast, heading east from Port Fairy to Cape Otway, also referred to as the ‘Shipwreck Coast’ (Larcombe et al., 2002). Eighty known wrecks are currently found on the sea floor, with 29 of these lying on the bed of Warrnambool’s Lady Bay (Warrnambool City Council, 2007).

3.4 Socio-Economic Environment

The main activities in the survey areas include:

- Petroleum exploration and production.
- Commercial fishing.
- Commercial shipping.
- Marine conservation (parks and sanctuaries).
- Recreation and tourism.

3.4.1 Coastal Towns and Services

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 Western 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. Apollo Bay also services commercial fishing boats, while

Port Fairy has fish port and processing facilities (Department of Sustainability and Environment, 2003).

The Moyne, Corangamite and the Colac-Otway Shire Councils and Warrnambool City Council are responsible for the operation and maintenance of the coastal ports, including planning, issuing permits and licences, allocating moorings, maintaining wharves, jetties and navigation aids, dredging, operating facilities such as slipways, and the construction of new facilities (Department of Sustainability and Environment, 2003).

Warrnambool is the nearest coastal town to the Otway 3D Seismic Survey with a population of approximately 31,000 in 2007 (Warrnambool City Council, 2007). It lies approximately 263 km southwest of Melbourne. The coastal community of Warrnambool provides services to the commercial and recreational fishing industries of western Victoria and lies approximately 10 km north of the Otway 3D Seismic Survey area and 56 km north northwest of the extension to this survey.

3.4.2 Petroleum Exploration and Production

Petroleum exploration (onshore and offshore) has been undertaken within the Otway Basin of Victoria since the early 1960s. Hydrocarbons discovered by these exploration activities have been developed or are now undergoing assessment for development.

Offshore from western Victoria, several gas fields have been developed. All include offshore and onshore pipelines and connect to gas plants around the Port Campbell area. These include the:

- Minerva Gas Field (BHP Billiton), 10 km offshore from Port Campbell, in water deeper than 50 m. Production from this field commenced in 2004.
- Casino Gas Field (Santos), 30 km offshore from Port Campbell, in a water depth of 70 m. Production commenced in 2006 and there are prospects for expansion.
- Geographe and Thylacine Gas Fields (Woodside) are located further offshore, directly south of Port Campbell, in waters about 100 m in depth. Production is due to commence in 2007.

Petroleum exploration and production has regional benefits for southwest Victoria. Not only have the numerous onshore and offshore studies undertaken for these developments led to a greater understanding of the region's terrestrial, coastal and marine environments, but they have resulted in a boost to the regional economy through the provision of services to project personnel and through the creation of employment in construction and project support.

3.4.3 Marine Conservation

The closest marine conservation parks to the 3D Otway Seismic Survey area are listed below and illustrated in Figure 1.1.

- Discovery Bay Marine National Park (approximately 78 km northwest of the Otway 3D survey area and 118 km from the extended survey area).

- Lawrence Rocks Special Management Area (approximately 58 km northwest of the Otway survey area and 94 km from the extended survey area).
- Portland Bay Proposed Special Management Area (approximately 57 km northwest of the Otway 3D survey area and 100 km from the extended survey area).
- Deen Maar Proposed Special Management Area (approximately 25 km northwest of the Otway 3D survey area and 70 km from the extended survey area).
- Logans Beach Proposed Special Management Area (approximately 11 km north of the Otway 3D survey area and 50 km from the extended survey area).
- Bay of Islands Coastal Park (approximately 8 km north of the Otway 3D survey area and 39 km from the extended survey area).
- Merri Marine Sanctuary (approximately 13 km north northeast of the Otway 3D survey area and 54 km from the extended survey area).
- The Arches Marine Sanctuary (approximately 22 km east of the Otway 3D survey area and 39 km from the extended survey area).
- Twelve Apostles Marine National Park (approximately 25 km southeast of the Otway 3D survey area and 35 km from the extended survey area).

3.4.4 Commercial Fisheries

Australia's fishing zone is the fifth largest in the world, but has a comparatively low productivity due to nutrient-poor ocean currents. Fisheries production therefore relies heavily on the high unit value species such as prawns, tuna, rock lobster and abalone (Department of Agriculture, Fisheries and Forestry, 2003). About 10% of the known fish, crustacean and mollusc species are commercially fished, with commercial fishing being the fifth most valuable Australian rural industry (Department of Agriculture, Fisheries and Forestry, 2003).

A variety of marine species are commercially harvested in the Otway 3D and extended survey areas. These are discussed below and a summary of the fishers consulted is provided in Appendix 2.

Southern Rock Lobster Fishery

The southern rock lobster (*Jasus edwardsii*) occurs from the southwest of the Western Australian coast to southern New South Wales, including waters around Tasmania and New Zealand. The rock lobster fishery is the second most valuable Victorian fishery - in 2000/2001, it was worth $21.3 million to the Victorian economy (DPI, 2003a).

The fishery is now managed under the Rock Lobster Fishery Management Plan (DPI 2003a). There are a set number of access licences allocated between the eastern and western (west of Apollo Bay) sectors and a total allowable catch divided into individual transferable quota units. Commercial fishers use lobster pots while recreational fishers use SCUBA and hoop netting (DPI, 2003a). Pot numbers and dimensions are restricted (pot and escape gap size) to ensure sustainable harvests. With these management measures, the Rock Lobster Management Plan aims to re-build stocks and catches over time. Stock assessment research shows that the harvestable biomass of lobsters is now 25% of the 1951 levels in the western zone and spawning biomass is 50% of 1952 level (DPI, 2003a).

The survey areas lie within the Victorian Western Zone, which extends from Apollo Bay to the South Australian border. There are 85 Rock Lobster Fishery Access Licences (RLFAL) in the Western zone, (DPI, 2003a), out of a total of 139 licences for Victoria (2001/2002) (DPI, 2003a). The 2000/2001 commercial catch from the Western Zone was 507 tonnes, with an average of 0.59 kg/potlift (Hobday & Smith, 2001). Octopus and leatherjacket were the most common by-catch species in 2000/2001 (Hobday & Smith, 2001). The Southern Rock lobster has been the major fishery for Portland, Warrnambool and Port Campbell for decades and supports a fleet of approximately 30 vessels (SIV, 2006).

The life cycle of the rock lobster is complex. The fertilised eggs are carried under the tail of the female before being released, typically between September and November. The phyllosoma larvae spend from 1-2 years drifting in the plankton, during which time they develop through 11 larval stages. The final (puerulus) stage settles on shallow reefs and grow over a period of years into adult lobsters

There are fishing seasons in the rock lobster fishery; the taking of females is prohibited from 1 June to 15 November to protect females during spawning, and from 1 September to 15 November the taking of males is prohibited to protect the soft shells of males during moulting and growing (DPI, 2003a).

Giant Crab Fishery

The giant crab (*Pseudocarcinus gigas*) fishery is a newly developed fishery that grew rapidly during the 1990s. It is only found in southern Australian waters from central NSW to southwestern Australia, including Tasmania. The giant crab was initially caught as by-catch of the rock lobster fishery, however now it is a targeted species caught using pots. Giant crabs occur at the continental shelf break and upper slope to depths greater than 400 m, however, they are most abundant at depths between 150 m to 350 m (DPI, 2003b), and primarily taken from depths between 140 and 270 m (DPI, 2003b). The giant crab season is the same as that for the southern rock lobster (i.e., closed season for female giant crab is from 1 June to 15 November, and is closed between September 1 and November 15 for male giant crab) (DPI, 2003b).

Abalone Fishery

The abalone fishery is the most valuable Victorian fishery, currently worth about $60 million (DPI, 2006). The fishery is divided into three zones; eastern, central and western. The Otway 3D Seismic survey is in the vicinity of the western zone abalone fishery. There are six abalone divers that operate from Portland (SIV, 2006).

Abalone fishing is only possible by hookah diving, (air supplied from compressor on a boat) and in Victoria, this is generally between the shoreline down to a depth of up to 30 m (McShane et al., 1986; DEH, 2003), but often at depths shallower than 15 m (Gorfine & Walker, 1997). Blacklip abalone (*Haliotus rubra*) are harvested all year round, while fishing for greenlip abalone (*Haliotus laevigata*) is banned.

South East Fishery

The South East Fishery (SEF) fishes more than 100 species, but 17 species or species groups provide the bulk (>80%) of trawl landings. Such species include the orange roughy, gemfish, flathead, blue grenadier, redfish, school whiting, warehou, jackass morwong and others (BRS, 1994; Department of Agriculture, Fisheries and Forestry, 2003). Trawling is concentrated along the edge of the continental shelf.

Gillnet, Hook and Trap Fishery

The Gillnet, Hook and Trap Fishery (formerly the Southern Shark Fishery and South East non-Trawl Fishery) extends from southeast Queensland to the South Australia/Western Australia border. Among the 21 species subject to quota arrangement include blue eye trevalla, blue grenadier, flathead, gemfish, john dory, orange roughy, royal red prawn and silver trevally (AFMA, 2003). Shark species caught include school and gummy shark, with school shark overfished (BRS, 2003). Methods of fishing include demersal longline, dropline, trotline and handline for scalefish, hook to target sharks, gillnets in waters deeper than 200 m and fish traps (AFMA, 2003). There are only one or two boats left in this fishery in the Portland area partly due to the pressure of deep sea trawling and the development of the crab and squid fisheries (SIV, 2006).

Southern Squid Jig Fishery

The Southern Squid Jig Fishery, which mainly targets the arrow squid (*Nototodarus gouldi*), is located in Commonwealth waters of southeast Australia in water depths ranging from 50 to 200 m. Squid jig catches are mainly taken between Queenscliff and Portland with peak catches being between January and June (AFMA, 2003). Squid jigging is a seasonal fishery with approximately 45 boats fishing from Portland during the squid season (March to July) (SIV, 2006). Squid have a short life cycle, allowing sustainable catches to be high, and with the increasing popularity of the product, it is a fishery that is expected to grow. The present value of this fishery is worth about AU$2.5 million a year (SIV, 2006).

Eastern Tuna and Billfish Fishery

The Eastern Tuna and Billfish Fishery extends from the northern coast of Australia south to the Victoria/South Australia border, encompassing Tasmania. Species targeted using longline and minor line includes yellowfin tuna (*Thunnus albacares*), bigeye tuna (*Thunnus abesus*) and broadbill swordfish (*Xiphias gladius*), while purse seine fishing (yielding low quantities) targets the skipjack tuna (*Katsuwonus pelamis*) (AFMA, 2003). The fishery has 311 fishing concessions, and its estimated value in 2001-2002 was $56 million (AFMA, 2003).

3.4.5 Commercial Shipping

The south east marine region is one of the busiest areas for shipping in Australia, with freight and passengers carried between the mainland and Tasmania and between Australian ports and New Zealand (BRS, 2002). Major shipping channels are located through the survey areas, with over 1,000 vessels travelling through each year (to and from west and east coast ports, as well as international shipping).

3.4.6 Recreation and Tourism

Recreation and tourism activities are extremely valuable foundations for the local and regional economy, and include:

- Sight-seeing.
- Surfing.
- Fishing (rock, beach and boat).
- Scuba diving and snorkelling.

Sight-seeing

The visual beauty of the rugged coastal cliffs and the surf beaches make up the primary attractions to the area. Interesting coastal features include Pickering Point, Thunder Point and Point Ritchie around the Merri and Hopkins rivers (Warrnambool City Council, 2007). This part of the Victorian coastline is promoted nationally as the 'Shipwreck Coast.' Internationally, the limestone formations of the Twelve Apostles and the sheer vertical coastal cliffs attract tourism, and are one of Australia's best known seascapes and one of Australia's most photographed natural features (next to Uluru).

Warrnambool is also known as Victoria's Southern Right Whale Nursery. Female Southern Right Whales often return to Warrnambool's Logans Beach to calve, and may swim as close as 100 m to shore (Warrnambool City Council, 2007).

The Great Ocean Road tourist drive facilitates most tourist visits to the region. Other coastal attractions of the area include the Port Campbell National Park, Loch Ard Gorge, the Grotto and the Blowhole. Numerous self-guided tours (e.g., the Historic Shipwreck Trail), picnic facilities and coastal lookouts are provided along the coast, with camping sites, caravan parks, guesthouses, motels and hotels encouraging tourism stays in the area. The Warrnambool and Port Campbell visitor information centres provide visitors to the area with information on all these local attractions.

Recreational Fishing

Recreational ocean fishing is popular along the coast of Warrnambool, Newfield Bay (east of Peterborough), Gibson Steps (east of Port Campbell), Curdies Inlet, the Port Campbell jetty and at Princetown. In Warrnambool there are a number of long established fishing locations ranging from freshwater fishing in our lakes and rivers to estuarine and saltwater fishing in the bays, inlets and oceans (Warrnambool City Council, 2007). A number of commercial boat tours are also available for charter to provide fishing activities. Fishing licences are required for inland and ocean fishing.

4. Environmental Effects and Mitigation Measures

The following section provides a description of potential environmental impacts and proposed mitigation during the seismic surveys.

4.1 Potential Environmental and Social Effects

The components (i.e., potential hazards) of the seismic surveys that could result in environmental effects include:

- Operation of the seismic vessel and towing of the airgun and streamer (hydrophone) arrays of transmitters and receivers through the survey areas.
- Interference with shipping, commercial fishing and recreational boating businesses.
- Discharge of the air source arrays in the survey areas.
- Seabed disturbance as a result of anchoring or grounding.
- Accidental damage to or loss of streamers and associated equipment.
- Routine waste discharges from the survey vessel.
- Accidental fuel and oil spills from the survey vessel.
- Collision with another vessel.

The environmental and social issues potentially resulting from these activities are:

- Disturbance to marine fauna – disruptions to populations of pinnipeds (seals), cetaceans (dolphins and whales), fish, benthic invertebrates and plankton from the discharge of the airgun arrays.
- Disturbance to benthic habitats – damage and/or destruction of seafloor habitats and palaeo-environments from anchoring, grounding and accidental loss of streamers and associated equipment.
- Interference with shipping and boating in the area – disruption to vessels.
- Interference with commercial and recreational fishing – disruption to fishing vessels, disruption to commercial/recreational catches, hazard to professional abalone divers.
- Waste disposal – sewage, putrescible waste, chemicals and solid and hazardous wastes.
- Fuel and oil spills – spillage from the survey vessel or from the streamer.
- Aesthetic impacts from any oil spills and waste discharges (if these were to occur).
- Interference with existing oil and gas production infrastructure (existing or under construction).

- Introduction of exotic marine species.
- Recreation – interference to boating, surfing, diving, snorkelling, swimming activities.
- Loss of tourism-related values from any oil spills and waste discharges, (if these were to occur).

4.2 Discharge of High Intensity Sound

The first major nation-wide scientific review of the environmental effects of offshore seismic survey in Australia was conducted in 1994 (Swan et al., 1994). It drew a general conclusion that the airguns now used in seismic surveys do not pose any significant hazard to marine life, unless they are very close to the source. While this may have generally explained the lack of *prima facie* evidence of adverse impacts from seismic airgun arrays, it also identified gaps in the understanding of impacts at the sub-lethal, behavioural and pathological levels highlighting uncertainties about such effects on the marine resources considered at highest risk, mainly the air-breathing marine mammals and fish with swim bladders. In 1995, Australian Petroleum Production and Exploration Association (APPEA) initiated a major program of research to address these concerns. The seismic research studies, based mainly in Western Australia, ran from 1996 to 1999 and were published in 2003 (APPEA, 2003) and included:

- Characterisation and measurement of airgun signals and modelling of their propagation.
- Development of a model to predict exposure through time for any given seismic survey configuration, linked to effect types and threshold response levels.
- Monitoring of the movement and behaviour of humpback whales through an area in which 3D seismic was operating.
- Conduct of approach trials with airguns to determine responses of humpback whales.
- Conduct of trials exposing caged fish to airgun noise approach, and to measure behavioural, physiological and pathological effects.
- Modelling of response of fish otoliths to applied airgun signals.
- Conduct of approach trials with single airgun to captive turtles.
- Conduct of approach trials with single airgun to cage-held squid.

Individual companies undertaking seismic surveys and APPEA have also sponsored many research investigations in their areas of operation. The discovery of significant blue whale summer feeding grounds in the Bonney Upwelling region off western Victoria/South Australia has become a major research focus for companies operating in the vicinity of the blue whales. APPEA (2005) has summarised the results and implications of 40 of its recent scientific studies (including those listed below), conducted primarily by independent scientific institutes:

- Review of the lobster lifecycles and larval movements in the Otway basin region, using conservative assumptions of zones of effect to predict numbers of lobster in larval stages that would potentially have been impacted during the Santos/Strike 2002 3D seismic survey in VIC/P44 (Santos).
- Review of the effect of seismic surveys on catch rates of rock lobsters in Western Victoria (Santos and PIRVic).
- Trialling of SEAMAP's passive acoustic monitoring (PAM) system on the Western Monarch's support vessel, Total Voyager, during the latter part of the Otway 3D survey in 2002/03 to trial its effectiveness in the detection of cetaceans. The system is optimum for detecting cetaceans that vocalise in the higher frequency ranges (e.g., sperm whales, killer whales, dolphins etc) but less so in the lower frequency ranges of blue whales (Santos).
- The large and diverse seismic program conducted in the Otway, Sorell and Gippsland Basins during late 2002/early 2003 provided an ideal opportunity to compare the frequency of cetacean sightings in different areas, different water depths and different types of activity (i.e., 2D/3D). Analysis of the numerous sightings has provided greater insights into cetacean distribution and behaviour (Santos).
- Underwater noise measurements and determination of sound attenuation and decay curves during seismic and drilling activities in the offshore Otway Basin in 2003 and 2004 and during seismic surveys off Port Nelson in 2003.
- Desk top study into the effect of drilling and seismic noise on blue whales (Woodside).
- Aerial surveys of blue whales and krill swarms to attempt to correlate presence of blue whales with presence of krill swarm (Woodside).
- Aerial survey of blue whales in the Otway basin region 1999/2000 (Woodside).
- Aerial survey of blue whales in the Otway basin region during seismic survey in October/November 2003 (Santos).
- 3-year funding of PhD studies examining the habitat preferences of southern right whales (Woodside).
- Satellite tagging of Australian fur seals (Woodside).
- Observations of the interaction between seismic operations and migrating humpback whales, during seismic surveys off the Western Australian coast in 2002 (Roc Oil).
- Genetic substructures of Western Australian humpback whales (Apache Energy, Chevron, Texaco and Edith Cowan University).
- Studies of whales and in particular, presence of the southern right whales in Southern Australia (numerous studies since 1990 by BHPBilliton).

- Studies of potential seismic impacts to scallops held in cages beneath seismic survey in Bass Strait (Esso).
- Tests of passive acoustic monitoring (Esso).
- Extensive records of cetacean observations in Bass Strait, undertaken to meet DEW guidelines (Esso, BHPBilliton, Bass Strait Oil, Santos, Woodside).

4.2.1 Sound Disturbance

Background Ocean Noise Levels

Marine seismic surveying involves the discharge of compressed air to create sound pulses that are reflected from layers under the sea floor and recorded back at the surface. Interpretation of these reflections is a key step in exploration for hydrocarbons. There is currently no other method that has sufficient resolution to identify rock structure beneath the surface.

Both physical and biological processes contribute to natural background noise. Physical processes include that of wind and waves whilst biological noise sources include vocalisations of marine mammals and other marine species (Simmonds et al., 2003). Waterborne noise levels are expressed in units of decibels referred to as 1 microPascal (dB re 1 μPa). Of the physical processes, wind is the major contributor to noise between 100 Hz and 30 kHz (Simmonds et al., 2003). The dominant source of naturally occurring noise across the frequencies from 1 Hz to 100 kHz is associated with ocean surface waves generated by the wind acting on the sea surface (National Research Council, 2003). Surf noise is however specific to coastal locations.

An overview of the nature of underwater seismic sound has been provided in McCauley (1994) and McCauley *et al.,* (2000). The predominant sound frequencies from seismic acoustic arrays are 10 to 300 Hz, although the main frequencies used in seismic surveying in Australian waters are generally in the 10 to 100 Hz range. The sound intensity, measured in decibels (dB), varies depending on the frequency. For frequencies of 10 to 100 Hz, which are the bulk of seismic frequencies, the sound intensity at one metre from a 2,678 cubic inch (cu in) acoustic array is quoted as 258 dB re 1 μPa peak-peak (McCauley et al., 1998), which is equivalent to approximately 243 dB re 1 μPa mean squared pressure, or root mean squared pressure. However most values are given as peak to peak and this is assumed in the following discussion unless stated otherwise.

The sounds produced during a seismic survey are not at an unusual level relative to some other sounds in the ocean. Table 4.1 presents a comparison of some sounds heard underwater.

The seismic survey airgun array will produce at source (i.e., within a few metres of the airguns) sound pulses in the order of 220-240 dB re 1μPa-m at frequencies extending up to approximately 110 Hz. These levels will decrease to levels in the order of 170–180 dB re 1μPa-m within 1 km of the source and approximately 150 dB re 1μPa-m within 10 km, dependent on the sound propagation characteristics of the area (McCauley, 1994).

Table 4.1 Sound Intensity and pressure (dB re 1 μPa one metre from the source)

Source	Sound Intensity (dB re 1 μPa)	Frequency (Hz)
Undersea earthquake	272	50
Seafloor volcanic eruption	255+	Varied
Lightning strike on sea surface	250	Varied
Seismic acoustic source	230-255	< 200
Sperm whale clicks	Up to 235	100-30,000
Bottlenose dolphin click	Up to 229	Up to 120,000
Ship sound (close to hull)	200	10-100
Breaching whale	200	20
Blue whale vocalisations	190	12-400
Ambient sea sound	80-120	Varied

Source: APPEA, 2004.

Marine mammals and other marine species use sound for social interaction and communication between individuals and pods as well as for echolocation (the ability by which animals can produce mid- or high-frequency sounds and detect echoes of these sounds that bounce back off distant objects to determine physical features of their surroundings), navigation purposes, reproduction, predator avoidance, feeding and in perception of their environment (McCauley, 1994; SCAR, 2002).

The frequencies used by marine species cover a broad frequency spectrum (National Research Council, 2003; McCauley, 1994). Table 4.2 is a summary showing the range of frequencies used by various groups of marine species for communication and echolocation purposes.

Baleen whales have calls that overlap the frequency range of seismic sources, therefore making them potentially more susceptible to interference from seismic array shots (McCauley, 1994). Dominant frequency of calls produced by the toothed whales is above 1 kHz which is above the range of most energy produced by seismic survey airgun arrays (McCauley, 1994). The effect of seismic sources on the behaviour of marine mammals is complex and depends on factors such as:

- Hearing capability of individual species.
- Level and nature of noise exposure experienced.
- Habituation to seismic noise.
- Background noise.

4.2.2 Impact on Whales

The survey will be conducted between May to June 2007, potentially coinciding with the end of the summer/autumn aggregation period of the blue whales in south-west Victoria and the arrival of southern right whales at Logans Beach. Blue whales are mainly concentrated during the summer months feeding on krill aggregations that are associated with the nutrient fluxes of the Bonney upwelling on the continental shelf-break around 100 m depth. (Gill 2002). The maximum water depth of the Otway 3D survey area is 90 m and away from the continental shelf-break. By June, the expected time of the commencement of the extended survey in VIC/RL7 in slightly deeper offshore waters, the blue whales will have left the area.

Calving southern right females have a preference for shallow, northeast trending bays over sandy bottoms. Logan's Beach, near Warrnambool is an important calving area and is approximately 13 km to the north of the Otway 3D Seismic Survey area and 55 km from the area of the extended survey in VIC/RL7.

Table 4.2 Summary of sound frequencies used by marine species for communication and echolocation

Species	Communication Frequency (kHz)	Echolocation Frequency (kHz	Estimated Source Level (dB re 1μPa.m)*
Airgun array			220-240#
Odontocetes (Toothed Whales)			
Common dolphin	0.2-150	23-67*	-
Bottlenose dolphin	0.05-150	110-130*	218-228
Risso's dolphin	0.1-23.7	65	-
Killer whale	0.1-35	12-25	180
Mysticetes (Baleen Whales)			
Southern right	0.03-2.2	-	172-187
Pygmy right	0.06-0.135*	-	165-179
Humpback	0.02-10	-	144-192
Fin	0.02,1.5-2.5*	-	155-186
Blue	0.012-0.4	-	130-188
Bryde's	0.124-0.900*	-	152-174
Sei	1.5-3.5*	-	-
Minke	0.06-6	-	151-175
Invertebrates			
Rock lobster	2-10#	-	-
Snapping shrimp	2-40#	-	-
Fish			
Fish (general)	0.1-5#	-	-
Pinnipeds			
Seals (Otarridae)	2-32#	-	-
Seabirds			
Penguins	No known underwater vocalisations#	-	-

Source: Richardson et al., 1995; * SCAR, 2002; #McCauley, 1994.

The majority of sightings at Logan's Beach are of whales situated just outside the surf break in water depths of approximately 5-6 m. These depths are considerably shallower than the survey water depths, thus impacts to these whales from the proposed surveys are considered highly unlikely. While the seismic airgun discharges may be audible to whales at this distance, recent research and underwater measurements of sound from seismic surveys provides more insight into likely behavioural responses.

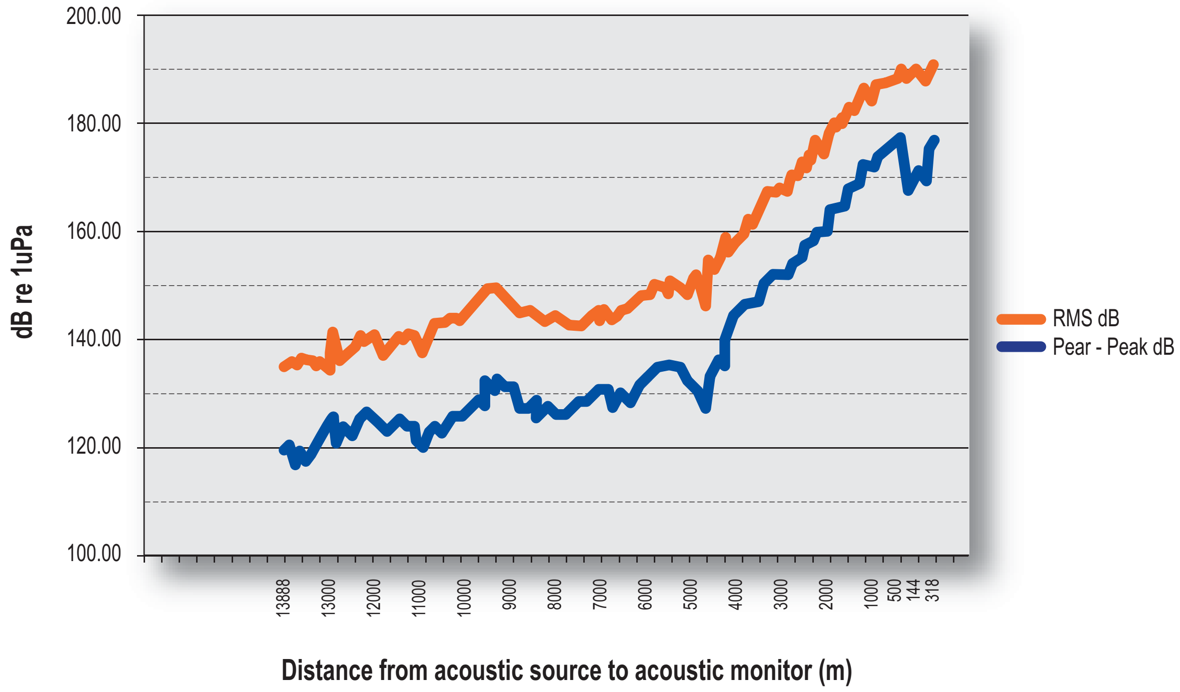
Information on propagation of seismic sound obtained from bottom recorders during seismic surveys conducted during 2003 and 2004 in the Otway Basin (McCauley, 2004) indicates that the sound levels build up very slowly as the vessel approaches and it is not until the separation distance is less than about 4 km that the sound level builds rapidly. Despite this rapid build-up the maximum narrowband (or spectral) signal level, which occurs at 25 Hz, does not exceed 140 dB until the source is less than 1 km from the recorder, and does not exceed 150 dB until at a distance of 100 m (McCauley, 2004), hence the 3 km distance applied in the DEW cetacean guidelines is likely to be conservative when considering actual threshold distances of behavioural change.

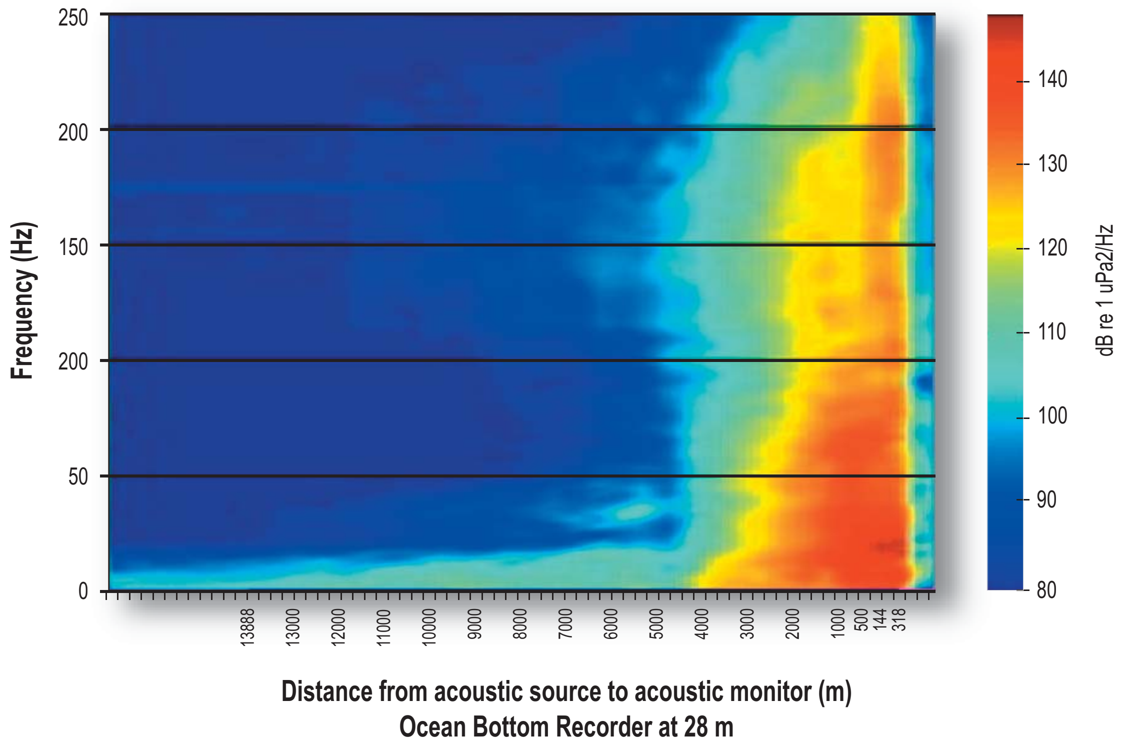
Baleen whales communicate by low frequency sounds and blue whales are considered acoustically sensitive to the frequency range of airgun sounds. The importance of the Bonney upwelling area to summer feeding of blue whales has given rise to concerns that an adequate avoidance distance may be in the range of 60 km or more (Gill and Morrice, 2003), which might hinder their access to the krill feeding grounds.

Over the past four years, seismic surveys conducted off Western Victoria and South Australia have been conducted under application of the guidelines on managing interactions between offshore seismic operations and larger cetaceans (the DEW Cetacean Guidelines). These surveys have indicated a progressive reduction in the separation distance of blue whales and seismic vessels from around 60 km in 2000 to 2.4 km in 2003 (APPEA 2005). Whether this implies habituation or obligatory tolerance while feeding cannot be determined, but it does suggest a radius of co-existence that has become relatively small in the offshore Otway area.

Less observational information exists on responses of southern right whales to seismic sound. The Logan's Beach exclusion zone near Warrnambool was established to protect the regular visiting southern right whales that use the area as a nursery during winter-spring following calving. Regulations were introduced to prohibit boating in the area during this time (DEH, 2007b). Logan's Beach is located approximately 55 km NNW of the nearest edge of the proposed survey area. Figure 4.1 shows a decay curve in 28m of water for a logger deployed off Port Nelson in 2003, the decay curve shows that the received signals are down to approx 140RMSdb at 4km. At 55 km, attenuation would be much greater and at the sandy coast of Logan's Beach would be even more absorptive to any residual sound from the survey. Dr Rob McCauley of Curtin University modeled the predicted decay curves to verify this and summarized that the signals along the shore will not be detectable via waterborne energy if the source is at, or more than 17km away. Received signals which can be considered high or which equal or exceed 140 dB re $1\mu Pa^2.s$ will only occur at < 4km from the array.

Physical damage to the auditory system of cetaceans is likely to occur at noise levels of about 230-240 dB at a distance of 1-2 m from the energy source (Gausland, 2000). Baleen whales appear quite tolerant of low and moderate level noise pulses from distant seismic surveys and usually continue normal activities when exposed to pulses with levels as high as 150 dB re $1\mu Pa$, and sometimes higher (Richardson et al., 1995). It is highly unlikely that marine mammals will be exposed to levels likely to cause pathological damage because of the ability for these species to avoid the vessel and the acoustic source array (McCauley, 1994). Application of the DEW Cetacean Guidelines and other adaptive measures will minimise the potential risks to whales should they approach within a potentially damaging close proximity to the vessel.





enesar people and place	Job No: 1305	Santos Ltd	Santos	Decay curve for acoustic logger in 28 m of water
	File No: 1305_02a_F04.01_FT	Environment Plan		Figure No: 4.1

Humpback whales may be encountered during the survey although the area lies outside the main migratory paths for this species. Behavioural responses of this species are relatively well researched through APPEA's humpback whale approach trials with a single operating airgun (McCauley et al., 2003a and APPEA, 2005) inside Exmouth Gulf in Western Australia have indicated response distances less than those of blue whales, and generally within the defining limits under the cetacean guidelines. The major conclusions were that whales actively engaged in their southerly migration were not disrupted by the 3-D seismic survey beyond minor alterations of course to avoid the vessel and that avoidance distances evident at ranges of 1-4 km. The mean airgun level was 140 dB re 1 μPa mean squared pressure for avoidance, 143 dB re 1 Pa for standoff, and 112 dB re 1μPa for startle response. A cow-calf pod showed some response at greater distance (11 km), but single large males often came within 100-400 m of the operating airgun, where they the estimated noise level received would have been 179 dB re 1 μPa.

Toothed cetaceans (sperm whales, beaked whales, dolphins) produce echolocation clicks which have the highest source levels of any recorded marine mammal sound ranging up to 220-230 dB re 1μPa-m (NRC, 2003). Most components of these sounds are well above the low frequency range where marine seismic survey noise is concentrated. Smaller toothed cetaceans have poor hearing in the low frequency range of airgun arrays and so are able to approach operating seismic vessels without adverse behavioural or pathological effects.

Physical damage to the auditory system of cetaceans is likely to occur at noise levels of about 230-240 dB at a distance of approximately 1-2 km from the energy source (Gausland, 2000). Baleen whales appear quite tolerant of low and moderate level noise pulses from distant seismic surveys and usually continue normal activities when exposed to pulses with levels as high as 150 dB re 1μPa, and sometimes higher (Richardson et al., 1995). It is highly unlikely that many marine mammals will be exposed to levels likely to cause pathological damage because of the good swimming abilities of marine mammals and their ability to avoid the vessel and the airgun array (McCauley, 1994).

Mitigation

Marine seismic surveys do not necessarily constitute a threat to marine mammals if care is taken to avoid situations that could potentially harm the animals (JNCC, 1998). The proposed Otway 3D Seismic Survey covers a relatively small area (725 km^2) and is of a short duration (approximately 5 weeks of data acquisition). The extension to this survey covers an even smaller area (185 km^2) and will occur for a maximum of 11 days, immediately after the completion of the Otway 3D Seismic Survey. It is intended that the surveys are completed during May-June 2007. The Otway 3D Seismic Survey will avoid the peak period of the presence of these three species of whale. While the extension to this survey will occur during or after the arrival of the southern right whale and the humpback whale, it is expected that impacts to these whales will be minimal as this survey is located much further offshore, more than 55 km from Logans Beach.

It is appropriate that mitigation measures are in place to manage any possible interactions between the seismic survey vessel and cetaceans in the survey areas. The DEW Cetacean Guidelines will be followed for both surveys to ensure that there is no significant risk of adverse effects to whales, in particular, blue, southern right or humpback whales during the surveys. The salient measures of these guidelines that will be followed are:

Aerial surveys

Deakin University Blue Whale Study (DUBWS) is preparing a project scope to undertake a program of aerial surveys prior to, during and immediately after the (preceding) seismic surveys to determine the level and location of whale activity in the survey areas. This will extend to cover the aerial survey requirements of both proposed surveys.

At least two aerial surveys will be undertaken within the survey areas prior to commencement of the seismic surveys. These surveys will detect the presence of southern right whales and establish likely migratory patterns to inform the conduct of the seismic surveys and intensity of spotter observations needed.

An experienced MMO will be onboard the spotter aircraft to provide accurate locations of observed whales. The aircraft will be in radio contact with the seismic survey vessel to enable communications.

Marine mammal observer (MMO)

An experienced MMO will be on board the seismic vessel for the duration of the surveys. They will have equipment necessary to carry out their duties.

The MMO will conduct visual observations for at least 30 minutes prior to start of seismic acquisition.

The MMO will conduct visual observations throughout the surveys.

All cetacean sightings will be reported to the Department of Environment and Water Resources.

Pre start-up visual observation procedures.

Visual checks (using binoculars from a suitable, high observation platform on the survey vessel will be conducted before the commencement of operations to deterine the presence of whales.

Observations which ensure effective monitoring of a 3 km radius around the survey vessel (concentration of observations within the 210 degree forward arc) will begin at least 30 minutes prior to and continue during the use of any high-energy acoustic sources.

Soft start procedures

A sequential build-up of warning pulses will be carried out at the commencement of all surveys. The whole array will not be fired without a full soft start. Soft starts will be used even if no whales have been seen.

Discharge of the acoustic sources will not commence unless there are no whales within a minimum distance of 3 km from the survey vessel. If whales are detected within this zone the start up of acoustic sources will be delayed until they have been observed to move outside the 3 km radius or, if they are no longer observable, 30 minutes after the last sighting within 3 km.

Start-up delay procedures

If whales are sighted during this soft start procedure within the 3 km zone, the seismic source will be shut down or 'powered down' to the 200-300 cu in array. Re-commencement of soft start procedures will take place after 30 minutes has lapsed since the last whale sighting within the 3km zone whether the array has been shut down or 'powered down'.

Power-down (using the minimum audible source of 200-300 cu in array) and not shut-down may be used during line turns or changes for the surveys.

Following a power-down/shut-down, normal soft-start procedures would be followed.

Shut down procedures

Where a seismic vessel with an operating acoustic source approaches within 3 km of an individual whale or pod of whales, the acoustic source will be shut down or powered down to the 200-300 cu in array. The source operations will not recommence until the animal or pod has been seen to move outside of a 3 km range, or has not been seen for 20 minutes.

Night time/poor visibility surveys

In the event that a significant number (3-4) of whale-related power-downs of the seismic source was required during a particular day, night-time survey activity will be ceased for that night unless the Department of the Environment and Water Resources agrees otherwise (via communication on 24-hr number). If there are mitigating circumstances to consider, (e.g. repeat sighting of same individuals during the day in the same location, option to move to area where no whales have been sighted, etc), appropriate night time provisions will be applied.

By following all measures outlined above, the intent of the existing DEW Cetacean Guidelines will be met at all times during the surveys. This will ensure that there will be no adverse effects to whales as a result of this seismic surveys.

4.2.3 Impact on Seals

Information on seals' (pinnipeds) response to underwater sound is limited. McCauley, (1994) suggested that seals may tolerate seismic shots of high intensity and may be able to approach operating seismic vessels to a close range, because their hearing is poor in low frequencies. The seals commonly found in Australian waters belong to family Otariidae, which are thought to be less sensitive to low frequency sounds (<1 kHz) than to higher frequencies (>1 kHz). McCauley (1994) suggests that the sound frequency of seismic airgun arrays is below the greatest hearing sensitivity of Otariid pinnipeds, but data are lacking for Australian species. Shaughnessy (1999) states that seismic activity will only be a threat to seals if it takes place close to critical habitats.

The largest breeding colonies of fur seals occur at Seal Rocks, Phillip Island and Lady Julia Percy Island at Port Fairy (located approximately 29 km northwest of the Otway 3D

Seismic Survey and 71 km northwest of the extended survey). The closest known Australian fur seal non-breeding colony is at Little Henty Reef near Apollo Bay. This is however further east and not in the immediate vicinity of the seismic surveys.

Mitigation

The on-board observing and operation of a soft start is considered sufficient mitigation for potential impacts on seals. When combined with the short duration of surveys and their apparent tolerance, no adverse impact to seals or seal populations is expected. Potentially, seismic activities may affect seals' prey abundance or behaviour and seal breeding success may be affected by long surveys over feeding areas during the breeding season. Mating occurs in November to early December and pups are born in late November to early December. The proposed short duration of the surveys suggests impacts to seal colonies in the vicinity of the survey areas will be insignificant.

4.2.4 Impact on Fish

Sound in all fish species is detected by the paired otolith bones of the inner ear, located either side of the brain. The lateral line is also sensitive to low frequency sound, through particle motion rather than sound pressure. The most important factor determining 'hearing' sensitivity in fish is the presence of the swim bladder and its proximity to the inner ear. It acts as a pressure transducer, converting sound pressure to particle velocity. Damage can occur as a result of rapid change in volume of gas associated with airgun discharge. Thus fish without a swim bladder or ones in which it has no close connection with the inner ear are less sensitive to sound pressure. The elasmobranchs (sharks and rays), fast-swimming tunas and mackerels, and many of the flatfishes and flounders do not possess a swim bladder and so are not susceptible to swim bladder-induced trauma.

During the 1960s, ammonium nitrate explosive charges were used as a sound source for seismic surveys in Bass Strait, after which mortality of fish species was sometimes observed (Anon, 1966).

In contrast, airguns are seldom seen to cause lethal effects on fish and concern, particularly from commercial fishers, centres mostly on reduced catchability or dispersion from fishing grounds. There is some evidence of reduced commercial catches in areas subjected to seismic survey, although reef-dwelling species appear less easily scared away. Engas et al., (1996) found reduced catches of cod and haddock in Norwegian waters extended to an area 18 nautical miles beyond the area of data acquisition but catches showed recovery after 5 days. Pelagic fish responded to seismic sound by moving deeper rather than laterally in the water column (Slotte et al., 2004). In contrast, Wardle et al., (2001) found no evidence of fish or invertebrates moving away from reef areas exposed to seismic survey.

The Norwegian studies by Engas et al., (1996) were at depths of 280 m, hence spherical spreading of sound may have accounted for the 18 nautical mile radius of reduced catchability observed. Such results may apply differently in shallow water, because of different sound attenuation properties. Sound attenuation or decrease in intensity is the result of spreading, absorption, scattering, reflection and rarefaction. In shallow water, it is more rapid, owing to the interactions between the primary wave front and surface- and bed-reflected waves. The frequencies of surveying systems are also chosen to give maximum penetration into the seabed, and assist attenuation, as reflected waves are counter-productive to geophysical interpretation. Consequently, the area of effect in shallow water is up to ten thousand times reduced (Turnpenny and Nedwell, 1994) compared with deep water.

Underwater video recordings of the responses of caged fish (pink snapper) exposed to experimental acoustic source showed a startle response when start-up of the experimental gun occurred nearby and at high-level air gun signals above 156-161 dB re 1μPa mean squared pressure at an estimated 2–5 km from a seismic source (McCauley et al. 2003). Fish generally swam faster, swam to the bottom of the cage, and formed tighter school structure; suggesting avoidance of close exposure would have occurred had the fish not been caged. There was no evidence of physiological stress as measured by blood cortisol levels in the exposed fish. However, damaged hair cells in the hearing system were observed up to 58 days after exposure, but the behaviour of the fish in the cage indicated they would have fled had they been able to do so.

Mitigation

The soft start procedures and audible approach of the vessel means that fish cannot suddenly find themselves within close range of the seismic vessel without previously detecting and responding to the approach of the vessel. Response to the approaching seismic vessel is likely to include downward or lateral displacement, and avoidance of close proximity (a few metres) of the source where direct injuries could occur. Over reef areas, the most likely response of fish is to seek refuge in the reef, where they would be beyond the harmful exposure distance from the airgun source. During this time, catchability may be reduced but fish would not disperse away from the reef area. While this may be of temporary inconvenience for some fishermen, it is unlikely to be of lasting harm to fish populations.

4.2.5 Impact on Invertebrates

Marine invertebrates lack body cavity air spaces or sensory organs to perceive sound pressure, and largely for these reasons, are relatively robust to exposure to airgun discharge. Marine invertebrates do have organs or tactile hairs which are sensitive to hydrostatic disturbances and most invertebrates may only detect seismic survey sounds at close range; less than 15 m away from the source (McCauley, 1994). Any disturbance to benthic invertebrates immediately beneath an airgun array is likely to be short-lived as only a single ‘shot’ is fired before the array moves to the next firing location (~25 m further on).

Rock Lobsters

Most concerns about potential impacts to invertebrates relate to species of commercial value, as expressed for example by commercial rock lobster fishers, when seismic surveys take place over lobster habitat and during the fishing season. The Western Australian and southern rock lobsters form the basis of valuable and largely sustainably managed fisheries. As long ago as 1966, fishers expressed concern over possible damage to the rock lobsters and a test was conducted off Port Fairy, where three cray pots, each containing eight lobsters were placed in 8.5 fathoms (16 m) and a standard charge fired 5 feet below the surface above them (Anon, 1966). At that time, (prior to the use of airguns), the standard charge used in surveys consisted of 25 lb of ammonium nitrate explosive. When the pots were lifted after the disturbance, none of the rock lobsters showed any sign of damage and all behaved normally. The lobsters were then taken ashore, placed in a wet sack and 24 hours later were all in good condition (Anon, 1966).

While the 1966 studies are consistent with rock lobsters being highly resilient to forces being created by high explosives, temporary reduction in catch rates via startle responses cannot be discounted and concerns have also been raised by fishermen over the potential for seismic induced stress at spawning times to cause premature larval release and/or stress to larval survival during their 12-15 months development through several planktonic stages. However, designing trials to test and control such potential effects may be practically un-researchable, when the numerous factors such as long larval life, high natural larval mortality and widespread settlement is taken into account.

Parry and Gason (2006) investigated the effect of seismic surveys on catch rates of rock lobsters, by correlating catch records with 33 seismic surveys conducted in western Victoria since 1978. They found no evidence of any relationship between seismic survey and long term changes in catch rates. Their analyses also found that short term changes in catch rates in areas subject to intensive seismic survey did not differ from changes in adjacent areas not subject to seismic survey. While not in itself conclusive (historical surveys have been undertaken at various times of the year), some *prima facie* evidence would most likely be expected after 30 years if there was a significant effect. Parry and Gason's results are consistent with other findings (Swan et al., 1994, APPEA, 2005), and the overall improbability of detecting impacts given the extremely high natural mortality of the larval stages.

Squid

Squid held in cages show a startle response by firing their ink sacs when suddenly exposed to sound levels of 174 dB re 1μPa mean squared pressure but more progressive increases in alarm responses when ramping up exposure to 156-161 dB re 1μPa mean squared pressure. However, the conditioned response of the cage-held fish was maintained throughout the trials suggesting little threshold changes (McCauley et al., 2003a)

Plankton and Planktonic Larvae

The scientific reviews (McCauley, 1994 and Swan et al., 1994) concluded that for planktonic organisms, including fish eggs and larval stages, lethal impacts could occur to those organisms within about five metres of an airgun, and for a large seismic array, a pathological effect out to 10 m from source would be a conservative value. Laboratory and field studies generally support this view. Kostyuchenko (1973) exposed batches of fish eggs of marine species to airgun discharge (and other sources) at distances of 0.5, 1 and 10 m. Anchovies were most sensitive: with 7.8% and 3.6% impairment at 0.5 and 1 m but no effect at 10 m. Red mullet eggs were least sensitive with no effect at any of the tested distances. Turnpenny and Nedwell (1994) have reviewed the pathological effects resulting from exposure to high level sources in many species of fish and invertebrates (adults, larvae and eggs) and effects were observed only at extremely close proximity to the source (around 1 m). Even at this distance, effects were not always observed and crustacean larvae and adults appeared to be resilient to seismic airguns within very close distances to the noise source (range 0.5 to 3 m). The generally accepted 5 m impact zone described by McCauley (1994) is therefore likely to be the upper limit of the harmful impact distance. Field studies by Parry et al., (2002) also found no evidence of large changes to planktonic taxa in the surface waters to a depth of 20 m before and after seismic shooting.

In the case of the rock lobsters, each female spawns up to 680,000 eggs, depending on adult size (Hobday and Ryan, 1997). The larvae go through several stages in a protracted larval life lasting on average about 18 months, during which time mortality has been estimated at 97-98% (references cited by Levings, 2004). Levings (2004) conservatively estimated that approximately 0.005% of the combined SA, WA and Tasmanian hatching may have been affected by the 2002 Casino 3D seismic program, which indicates the minor scale of potential impact from seismic surveys when compared with natural mortalities associated with the larval lifecycle and the growth to mature lobster over a 5-7 year period. This is consistent with the findings of Parry and Gason (2006).

The larval strategy of the abalone is quite different, whereby their eggs contain enough food for the development of the larvae through to settlement stage, without the larvae needing to feed in the plankton. The planktonic phase is therefore very short and lasts only few days, during which the larvae primarily remain entrained in the kelp understorey, close to the parent reef, not in the water column. In this way, they are likely to remain well beyond the range of adverse effect from seismic source. Few are believed to migrate far because of the low probability of finding suitable habitat in such a short period of time (McShane et al., 1988; Prince et al., 1987, 1988). Furthermore, the most productive reefs lie predominantly in waters generally less than 15 m and too shallow for seismic survey in Victoria. The risk of exposure of abalone larvae to the 'impact zone' within a few metres of the airgun is consequently very low.

Overall, studies have failed to detect any impact from seismic surveys on catch rates and recruitment of adult and juvenile invertebrates such as rock lobsters. Adults are particularly resilient to sound pressure, even from chemical explosive and results of tests on larvae of analogue species such as Dungeness crabs indicate that impairment could only occur at very close proximity to sound source. Given the large numbers of larvae spawned and high natural mortality rates, effects would be too small to be detectable beyond the wide natural mortality variations, even when conservative assumptions of exposure are made (Swan et al., 1994; APPEA, 2005).

Mitigation

No specific mitigation measures are proposed, as impacts to invertebrates and planktonic organisms are considered minimal, and could not effectively apply to planktonic individuals within very close proximity to the source. Nevertheless, the timing of the surveys means that they will take place outside of the spawning season of rock lobsters and abalone.

4.2.6 Disturbance to Benthic Habitats

Disturbance to benthic habitat from the surveys is unlikely as the streamers are maintained at 6 m below the surface and the survey vessel will not be anchoring during the surveys. The only possible activity that could have impacts on benthic habitats would be engine failure or the accidental loss of equipment that could sink to the seabed as debris.

Mitigation

In principle, the vessel's distance from shore (in Commonwealth waters) and minimum operating depth of approximately 50 m will avoid possible disturbance to the seabed and benthic environment.

A support vessel will permanently be on station to ensure that in the event of loss of power (or other malfunction), streamers are recovered immediately and not allowed to sink or wash inshore.

4.3 Effects of Acoustic Discharge to Divers

The seismic surveys will operate in Commonwealth waters and the risk is considered low that the acoustic energy discharged during the surveys may be harmful to recreational and commercial (abalone) divers as well as those engaged in the unlawful diving for abalone. Risk is also very low for other water activities that have a lesser degree of submerged activity such as swimming and bathing, surfing and snorkelling.

Due to the location and depth of the surveys it is highly unlikely diving operations will be encountered.

4.4 Interference with Commercial and Recreational Fishing

The main issues will be the presence of the seismic vessel (navigation) and its requirements for towing and turning influencing operational areas of fishing vessels.

All vessel operations will be conducted in compliance with the Australian Maritime Safety Authority (AMSA) Offshore Support Vessel Code of Safe Working Practice (OSV Code), which includes standards for radar monitoring and vessel communications.

Operation of the seismic vessel conducting the surveys may cause some inconvenience to the planning of charter fishing, diving and tourism trips, which may need to change locations at short notice depending on vessel movements on any particular day.

The fisheries impacted by the presence of the seismic vessel as well as seismic related activities are discussed below.

4.4.1 Southern Rock Lobster Fishery

The proposed timing of the surveys after 1 April 2007 is likely to coincide with rock lobster fishing. However, during consultation, fishers have indicated that in comparison with the November - January period that has typically been proposed in the past, this is a preferred time when catch rates and prices are less favourable (see also Attachment 2). Procedures to minimise interference will be developed in consultation with fishers prior to and during the surveys, through the services of a locally employed liaison officer.

Commercial rock lobster fishing operations will be advised in advance of the likely dates of the seismic surveys. Via the scout vessel and arranged radio channel frequencies, Santos will maintain communications with the rock lobster fishing groups regarding progress of the surveys.

4.4.2 Giant Crab Fishery

The proposed timing of the surveys coincides with the open season for giant crab fishing. There is the potential for interference with fishing gear and temporarily reduced catch rates from the seismic survey areas.

As for the rock lobster fishers, commercial giant crab fishing operations will be advised in advance of the likely dates of the seismic surveys. Santos will maintain communications with the giant crab fishing groups regarding progress of the surveys.

4.4.3 Abalone Fishery

The seismic surveys will be undertaken in water depths ranging from 50 to 110 m, which is deeper than the commercially productive abalone reefs in the area.

Unlike the rock lobster fishery, no gear is left in the water for extended periods, and divers would have greater flexibility to dive for abalone when the survey vessel is in a different part of the survey area. It is expected that it would take the vessel at least seven hours to return to any particular location. Consultation with the VADA, and other divers in the association, will inform divers of the locations of day-to-day operations of the vessels.

4.4.4 South East Fishery

Trawling along the shelf edge in the seismic survey areas could potentially take place. Communication systems with the commercial trawl operators will advise of day-to-day activities to avoid interactions.

4.4.5 Gillnet, Hook and Trap Fishery

Shark gill netting and long lining may occur periodically along shelf edge depths in the survey areas. Communication systems with the shark fishers will advise of day-to-day activities to avoid interactions.

4.4.6 Southern Squid Jig Fishery

The Southern Squid Jig Fishery fishes mainly around Portland and Queenscliff in Victoria, close to the coast between March to July. The possible proximity of the seismic surveys to these areas will be managed by day-to-day communication through a locally employed fishery liaison officer in order to avoid impacting on this fishery.

4.4.7 Eastern Tuna and Billfish Fishery

The majority of the species targeted by this fishery are caught along the east coast of Australia and it is unlikely that impacts to the operations of this fishery will occur.

4.4.8 Recreational Fishing

The survey locations are offshore and deeper than most recreational fishing activities and the timing avoids the summer tourism peak. Santos understands that it may be necessary for some charter operators to schedule and locate activities to avoid the seismic vessel, and will provide day-to-day information to minimise inconvenience for charter operators.

4.5 Waste Disposal

All vessels must comply with State and Commonwealth legislation for the control of pollution and dumping at sea. MARPOL regulations will be followed for the disposal of all wastes in Commonwealth waters. A quantitative waste tracking log will be maintained in accordance with regulatory requirements for all relevant wastes.

4.5.1 Sewage and Putrescible Wastes

Sewage and putrescible wastes will be treated and disposed in Commonwealth waters in accordance with MARPOL regulations.

Procedures for the disposal of sewage and putrescible wastes will be detailed in the vessel's Health, Safety and Environment Plan.

4.5.2 Other Wastes

The survey vessel also produces other solid and liquid wastes, including packaging and domestic wastes, such as aluminium cans, bottles, paper and cardboard and hazardous materials such as lithium batteries, acids, solvents and toxic wastes. A variety of chemicals, such as lubricating oils and cleaning chemicals, are also stored and used on the survey vessel. Many of these items are consumed through use and are not accumulated in significant quantities as waste. All such materials will be returned to port for appropriate disposal.

Solid inert wastes will be returned to the mainland for disposal.

Hazardous wastes, generally of low quantity (mainly lithium batteries and small volumes of paints and solvents), will be segregated and stored in sealed storage areas and transferred to onshore licensed hazardous material handlers for disposal to a licensed depot.

4.6 Fuels and Oil Spills

Oil spills have the potential to cause adverse impacts to water quality, marine organisms and to the coastline. Many marine species have a larval stage, which is free-floating and potentially vulnerable to an oil spill. Shellfish can become tainted if oil is ingested, even at low concentrations. Seabirds may suffer from hypothermia that can result in death as oil reduces the insulation properties of feathers. Embryo chicks in eggs may be prevented from receiving oxygen if their shells become coated with oil. Seabirds may ingest the oil while feeding or preening and may be poisoned.

Oil may contaminate the skin and damage the digestive system of some cetacean species. Indirect effects may include the destruction of habitats and reductions in the population of staple prey. The risk of a fuel or oil spill from the survey vessel is related to the potential for leaking hydraulic hoses, leaking oil drums or puncturing of streamer sections. Procedures to address cable fluid spills will be specified in the vessel's Health, Safety and Environment Plan. The hydrophone cables are segmented into 12.5 metre segments each containing 32-34 litres of Isopar M, which is a light, kerosene-like fluid that rapidly evaporates. In addition, the high-energy wave environment would greatly assist the breakdown of spilled petroleum. Risks of rupture are low and bites from sharks have been the main cause. Because of the segmentation of the cable, loss of fluid is limited to the maximum within the ruptured section**.** A spill of cable fluid, and of this order, will not pose a threat to the marine or coastal environment and is not an incident that would lead to detrimental impacts at the community, population or species level.

Refuelling at sea is not anticipated given the short duration of the survey.

Mitigation

Risks of any significant spills from seismic activities are low, because no refuelling at sea will be undertaken. All oil products and oil wastes will be stored on board in properly constructed containers according to hazardous goods requirements, to avoid accidental spillage. Any spills shall be reported to Santos and to regulatory authorities advised in accordance with regulatory requirements and recorded in a wastes and emissions log.

In addition, petroleum legislation requires a safety and emergency response plan to be submitted to DPI for approval prior to any activities commencing. Operational measures to minimise the risk of mishap or accident include the following:

- Satellite navigation of vessel assisted by constant visual observation.
- Communications shall be constantly maintained with other vessels operating in the area to advise of the location of the survey vessel and avoid collision.
- The depth at which the hydrophone cables travel is controlled by 'birds' which ensure a constant depth of approximately 6 m, hence not likely to touch the seabed at the minimum of approximately 50 m depth of the surveys.
- Tail buoys maintain the transect line of each hydrophone cable.
- The hydrophone cables are tracked via GPS to monitor their location.
- The vessel will cease operating and seek safe harbour (or deep water) where adverse weather conditions make it unsafe, in the view of the Vessel Master, to continue survey operations.
- Santos will employ a scout vessel to warn other vessels in the area and maintain safety buffers.
- Santos will employ a support (e.g., tug) vessel as a precaution to assist the survey vessel in the event of engine failure or other emergency.

The survey parameters are well inside safe operational requirements. The mitigation measures listed will reduce any potential risk of incident to as low as reasonably practicable.

4.7 Introduction of Exotic Marine Species

The seismic vessel does not take on or discharge ballast water. The vessel may, however, potentially transport marine species on the hull, deck, anchor chains or seismic streamers. All contracted vessels undergo regular anti-fouling of the hull to prevent the build up of barnacles and other organisms that increase the drag on the vessel, leading to increased fuel consumption. The main chemical used in the anti-fouling agent, tributyltin (TBT), persists in the environment by attaching itself to muds (accumulating in sediments), and in high concentrations can have toxic effects on marine organisms through bioaccumulation. The impact of TBT leaching off a single vessel in open waters has been found not to be detrimental to marine life (Fabris et al., 1995) and remains under the ANZECC Guidelines for Fresh and Marine Water Quality (2000) TBT trigger value of 0.0004 μgL^{-1} for the protection of 99% of species in marine waters.

The contracted seismic vessel will be travelling from the offshore Gippsland Basin of Victoria. Details of the previous area of deployment of the vessel will be provided to Parks Victoria and the Department of Sustainability and Environment.

The following mitigation measures are proposed to minimise risks of introduction of exotic flora and fauna, and to comply with Parks Victoria conditions of consent 29-31.

Mitigation

The anti-fouling history details of all vessels to be used during the surveys and will be available for inspection by DSE and Parks Victoria personnel, as will the streamers and other potential sources of marine pest introductions.

Verification of anti-fouling of the hull will be provided by the survey contractor, who will advise when anti-fouling paint was last applied.

The trailing equipment of streamer lines and acoustic source arrays is usually all stowed on deck during the passage from the vessel's last deployment from outside Australian waters, rather than towed behind the vessel during non-survey periods. However, in this instance the vessel will be trailing streamers as it transits from Gippsland to the Otway for re-figuration. The risk of introducing exotic marine pests from the streamers is therefore very low.

4.8 Deck Drainage Discharge

Deck areas may require occasional washdown for housekeeping purposes. In this instance, 'Rigwash' (or equivalent), a fully biodegradable detergent will be used.

In the event of a chemical or oil spill, absorbent materials will used to remove spill material prior to any washing activities. The absorbent material will be placed in containers and sent to shore as hazardous waste. This will ensure that no contaminated waste streams are routinely discharged from the deck drainage system. However, on washdown events it is possible that minimal quantities of oil and grease, mud and chemicals may enter the deck drainage system and be discharged overboard.

No significant environmental impacts are expected from these occasional washdown events given the low level of contamination, low volumes, and large dilution effects when entering the marine environment.

4.9 Exhaust Emissions

The combustion of fossil fuels in vessel engines and onboard power generators will contribute to exhaust emissions including the greenhouse gas CO_2. Emissions will be minimised by ensuring that all engines and generators are serviced to manufacturers specifications. The short duration of the proposed surveys means that the low volumes of atmospheric emissions generated are unlikely to affect air quality on the area.

5. Environmental Hazard and Risk Analysis

An analysis of environmental hazard and risk has been conducted for both seismic surveys. Its purpose was to:

- Identify and assess environmental and social hazards during the seismic surveys.
- Undertake a scenario-based risk assessment, using the risk management method defined in Australian Standards Risk Assessment (AS/NZS 4360:1999).
- Identify and rank major hazards and determine appropriate risk reduction measures.

The following definitions are critical in the understanding of hazard and risk assessment.

Accident: an event capable of causing critical, major, moderate or minor damage to the environment, or negligible damage with no significant environmental effect.

Hazard: a physical situation with the potential for damage to the environment, human injury, damage to property or a combination of these.

Risk: the likelihood of a specified undesired event occurring within a specified period or in specified circumstances. It may either be a frequency (the number of specified events occurring in a time unit) or a probability (the probability of a specified event following a prior event), depending on circumstances.

5.1 Hazard Identification

The process of hazard identification and risk management are divided in three main sections (reproduced from AS/NZS 4360:1999):

- External and environmental hazards (global hazards):
  - Project-specific hazards (project implementation issues).
  - Personnel health hazards (a global hazard).
- Individual and special operations hazards during operations that are exceptional because of size, complexity or timing.
- General and routine work performed according to standard procedures.

5.2 Hazard Scenario

A scenario for realisation of each environmental and safety hazard was developed. Each scenario included:

- A description of the scenario and root cause of the hazard.
- Existing risk mitigation or prevention measures (that is, protection systems and management mechanisms) that are currently in place or are standard safety measures.

The likelihood and consequence of each hazard scenario was identified and assessed based on AS/NZS 4360:1999 (see Table 5.1 and Table 5.2).

Table 5.1 Qualitative measures of consequence or impact

Level	Descriptor	Example Detail Description (Safety/Financial/Environmental)
1	Insignificant	No injuries; low financial loss. Alteration/disturbance within the limits of natural variability; effects not transmitted or accumulating; resources not impaired.
2	Minor	First aid treatment; on site release immediately contained or medium financial loss. Temporary alteration/disturbance beyond natural variability effects confined to site and not accumulating resources temporarily affected.
3	Moderate	Medical treatment required; on site release contained with outside assistance; high financial loss. Alteration/disturbance of a component of an ecosystem; effects not transmitted or accumulating; potential resource loss, but sustainability unaffected.
4	Major	Single fatality, extensive injuries, and loss of production capability; off site release with no detrimental effects; major financial loss. Alteration to one or more ecosystems or component levels, but which are recoverable; effects can be transmitted/ accumulating.
5	Catastrophic	Multiple fatalities; toxic release off site with detrimental effect; huge financial loss. Irreversible alteration to one or more ecosystems or several components levels; effects can be transmitted/accumulating; lost sustainability of most resources.

Source: Based on AS/NZS 4360:1999.

Table 5.2 Qualitative measures of likelihood

Level	Descriptor	Description
A	Almost certain	Is expected to occur in most circumstances.
B	Likely	Will probably occur in most circumstances (one per year).
C	Possible	Might occur at some time.
D	Unlikely	May occur in exceptional circumstances.
E	Rare	Not known within industry.

Source: Based on AS/NZS 4360:1999.

5.3 Risk Matrix

Each scenario was then assessed using the risk matrix approach (Table 5.3). A risk estimate was made on the basis of the probability of the event occurring and the consequence. Matrix locations were chosen on the basis of operational and environmental judgement.

Table 5.3 Qualitative risk analysis matrix – level of risk

Likelihood	Consequences				
	Insignificant 1	**Minor 2**	**Medium 3**	**Major 4**	**Extreme 5**
	Level of Risk				
A (almost certain)	M	H	E	E	E
B (likely)	L	M	H	E	E
C (possible)	L	L	M	H	E
D (unlikely)	L	L	L	M	H
E (rare)	L	L	L	L	M

Legend

E	Extreme/intolerable risk; immediate action required.
H	High/undesirable risk; senior management attention needed.
M	Moderate/undesirable risk; management responsibility must be specified.
L	Low/tolerable risk; manage by routine procedures.

5.4 Risk Reduction Measures

Risk reduction measures were applied to risks deemed to be too high, that is, 'Extreme' or 'High' on the risk matrix.

The hazard scenario was then reassessed and so on. No risks unable to be reduced to an acceptable level were identified.

Philosophy of Risk Reduction

AS/NZS 9.180:1999 proposes a four-point scale of management action to be taken according to the risk classes of Table 5.4.

Table 5.4 Risk reduction philosophy

Level of Risk	Philosophy
Extreme/ intolerable risk	Unacceptable risk that will not be tolerated by Santos under any conditions and must be engineered down to a lower risk level. The amount by which such risks can be reduced will depend on the control that the project has over the factors involved in the hazardous event. For example, where a major risk-producing factor is the project's interface with the general public, fewer options are available to reduce that risk than in cases where the general public are not involved.
High/ undesirable risk	High/undesirable risks require that the engineering design or method should be altered to remove the hazardous event or to reduce the associated frequency or consequence severity so as to place the risk in a lower risk level.
Moderate/ undesirable risk	Moderate/undesirable risks require that a management plan be determined for the hazardous event to prevent its occurrence and to monitor changes that could place the risk in a higher level. The management responsibility must be specified.
Low/tolerable risk	Low/tolerable risks require no further treatment other than monitoring as the project progresses to ensure that there is no potential for the risk level to increase with time. These risks can be managed by routine procedures.

5.5 Environmental Hazard and Risk Assessment

Table 5.5 presents the environmental hazard and risk assessment for the seismic surveys. The risk analysis impact and likelihood (columns 4 and 5) draw from the definition of risk in Table 5.1 and likelihood in Table 5.2. The risk evaluation draws from the matrix in Table 5.3.

Some of the mitigation measures presented in Table 5.5 are also addressed in Section 4. These mitigation measures have been developed from experience in offshore exploration environmental management in Australia and are based on Australian petroleum industry best practice environmental management guidelines, as defined by the Australian Petroleum Production and Exploration Association (APPEA) *Code of Environmental Practice* (1996).

There are no activities assessed as being of ‘high’ risk for the seismic surveys. This reflects the temporary and low impact nature of the activity, and the application of appropriate mitigation measures.

Table 5.5 Environmental risk assessment

Risk Identification			Risk Treatment	Risk Analysis		Risk Evaluation
Activity	**Hazard/Risk**	**Potential Environmental Consequence**	**Assessment/Safeguards/Mitigation Measures**	**Likelihood**	**Impact**	**Risk Ranking**
Acoustic airgun discharge	Impacts to cetaceans	Alteration of cetacean behaviour, interfering with normal activities such as breeding, feeding and migration.	• Surveys are located within the area and depth range of blue whale and southern right whale aggregation areas. • Surveys will be conducted after 1 April, potentially coinciding with the end of the blue whale summer migration period and prior to the main arrival of southern right whales. • Surveys are of short duration (33 days Otway 3D Seismic Survey; 11 days for the extension to this survey). • Survey areas nearest to shore to be completed first to reduce possible interactions with arriving southern right whales. • Likely to evoke avoidance response in whales only, but unlikely to displace species from key habitat or migration paths. • DEW cetacean guidelines employed (refer to section 4.2.2 and Appendix 1). Dedicated whale observer on board. Aerial surveys.	B	2	Mod
	Impacts to pinnipeds	No direct effects noted due to likely tolerance of high intensity seismic. May affect prey species (see fish).	• Not critical breeding or feeding habitat for species. • Operation of soft start-up procedures will enable avoidance response from pinnipeds. • Observers on survey vessel. • Surveys are of short duration.	C	2	Low
	Impacts to fishes	Potential pathological effects, behavioural changes, prey dependent species affected.	• No harmful pathological effects >1-5 m from seismic source. • Behavioural changes likely to be localised and temporary (alarm, avoidance, tighter schooling). • Smaller reef species less susceptible (reduced air cavities), outside harmful exposure distances and likely to seek shelter in reef and kelp. • Surveys are outside of marine parks. • Observers on survey vessel.	C	1	Low

Table 5.5 Environmental risk assessment (cont'd)

Risk Identification			Risk Treatment	Risk Analysis		Risk Evaluation
Activity	**Hazard/Risk**	**Potential Environmental Consequence**	**Assessment/Safeguards/Mitigation Measures**	**Likelihood**	**Impact**	**Risk Ranking**
Acoustic airgun discharge (cont'd)	Impacts to invertebrates (crustaceans, shellfish, squid, etc.)	Potential hydrostatic disturbance to organs or tactile hairs at very close range (<0.5m).	• No detectable harmful effects beyond 1-5 m therefore potential to impact on population is negligible. • Most invertebrates are believed unable to detect seismic airguns beyond 15 m from source. No body cavity/air space to be affected by the seismic activities.	B	1	Low
	Impacts to plankton or planktonic larvae (e.g., fish eggs, lobster and abalone larvae)	Potential lethal or pathological effects.	• Seismic sounds only detectable to most invertebrates at very close range (i.e. within <15 m). • No harmful effects to fish eggs or crustacean larvae beyond 1-5 m. • Negligible proportion of lobster larvae within impact distances of air guns. • Abalone non-synchronistic spawners and so short survey durations and distance from shore limits period for potential for impact. • Abalone larvae mainly remain close to the parent reef surface at depths well away from the impact distance of air guns. Major reefs inshore and shallower than the operating area.	B	1	Low
	Impacts to seabed	Impact from streamer grounding.	• Support vessel in attendance in case of loss of power to main vessel. • No anchoring. • System of streamer recovery by support vessel if required.	E	3	Low

Table 5.5 Environmental risk assessment (cont'd)

Risk Identification			Risk Treatment	Risk Analysis		Risk Evaluation
Activity	**Hazard/Risk**	**Potential Environmental Consequence**	**Assessment/Safeguards/Mitigation Measures**	**Likelihood**	**Impact**	**Risk Ranking**
Acoustic airgun discharge (cont'd)	Geological features (reef or terrestrial)	Potential damage to natural heritage features or habitat.	• Forces of seismic activities are negligible when compared to the wave energy sustained by the coastal and subsea geological features. • No anchoring.	D	1	Low
	Shipwrecks	Potential damage to heritage sites or features.	• No known wrecks within survey areas. All located closer inshore, within surf zone to shore zone. • Forces of seismic activities are negligible when compared to the wave energy sustained by any shipwrecks.	D	1	Low
	Impacts to recreational fishing, diving, tourism, surfing	Potential health effects for submerged aquatic activities (surfing, diving, snorkelling and swimming) within close proximity to acoustic source. Temporary displacement of aquatic recreation activities (including fishing, swimming, diving, snorkelling and surfing).	• Offshore distance and depths unlikely to pose health problems. • Period of any inconvenience limited to short survey durations. • Recommended operating buffer of 1,500 m advised for surfing, diving, snorkelling and swimming (DMAC, 1979).	C	2	Low
Vessel presence	Impacts to commercial fisheries	Reduction in fish catches or interference with fishing activities likely to be localised and short term.	• Industry and government guidelines available on avoidance of conflict with commercial fisheries. • Consultation with commercial fishing industry during planning phase to agree impact mitigation. • Liaison and communication with commercial fishing operators regarding daily schedules and work plans during operations.	B	1	Low

Table 5.5 Environmental risk assessment (cont'd)

Risk Identification			Risk Treatment	Risk Analysis		Risk Evaluation
Activity	**Hazard/Risk**	**Potential Environmental Consequence**	**Assessment/Safeguards/Mitigation Measures**	**Likelihood**	**Impact**	**Risk Ranking**
Vessel presence (cont'd)	Impacts to water based leisure craft recreational activities	Temporary displacement of aquatic recreation activities. Potential collision hazard.	• Offshore distance/depth/timing/duration will reduce the extent of inconvenience. • Potential for scout vessel to be used if required. • All vessel operations will be conducted in compliance with the AMSA OSV Code (e.g., radar monitoring, vessel communications). • Watch will be maintained on survey vessel for other craft.	C	2	Low

Table 5.5 Environmental risk assessment (cont'd)

Risk Identification			Risk Treatment	Risk Analysis		Risk Evaluation
Activity	**Hazard/Risk**	**Potential Environmental Consequence**	**Assessment/Safeguards/Mitigation Measures**	**Likelihood**	**Impact**	**Risk Ranking**
Vessel presence (cont'd)	Collision with large cetaceans	Death or injury of large cetaceans.	• Program potentially coincides start of southern right whale migration period. • Whales tend to display avoidance behaviour and so risk of collision is very low. • Seismic vessels move slowly permitting greater response time for evasive action by vessel and/or whale to avoid collision, i.e., risk is less than for normal commercial shipping. • DEW cetacean guidelines employed (refer Appendix 1). • On board dedicated whale observer.	D	3	Low
	Waste discharge to sea	Waste discharge may cause changes in planktonic or benthic communities due to reduced water quality and added nutrients. Wastes may wash up on shoreline, with impacts to coastal values.	• No waste discharges to the marine environment in State waters. • Wastes stored in properly constructed containers to prevent accidental spillage. • Solid wastes will be returned onshore for appropriate disposal. • Waste register will be maintained to record waste management practices and audited.	D	2	Low
	Small volume spill occurring (e.g., from streamer cable rupture)	Mortality of planktonic organisms due to reduced water quality or hydrocarbon toxicity. Oil may wash up on shore with impacts to coastal values.	• Risk of a spill due to streamer loss extremely low. Risk is significantly lower than risk posed by current boating activity in the areas (fisheries, recreation, and transportation). • Seismic programs shall be carried out in the shortest, safest time possible. • Carry out the seismic programs out of adverse weather conditions periods.	D	3	Low

Table 5.5 Environmental risk assessment (cont'd)

Risk Identification			Risk Treatment	Risk Analysis		Risk Evaluation
Activity	**Hazard/Risk**	**Potential Environmental Consequence**	**Assessment/Safeguards/Mitigation Measures**	**Likelihood**	**Impact**	**Risk Ranking**
Vessel presence (cont'd)	Small volume spill occurring (cont'd)		• Streamers are segmented limiting potential spill volume. • Streamers are filled with light kerosene type petroleum, 95% of which evaporates or degrades (from light exposure) within 24hours of spill. • Ensure that an Oil Spill Contingency Plan (OSCP) is in place for vessel and staff are appropriately trained in its execution. • Ensure that all necessary oil spill contingency plant and equipment is functional and accessible. • No at-sea refuelling is planned for the surveys. Return to port for refuelling. • Ensure that port refuelling operations are monitored by either the vessel's Master or First Officer. • Ensure that equipment and procedures used for transferring fuel (e.g., 'Dry-Break' hose couplings), conform to the AMSA Code for the safe working of support vessels. (Applies in port – no at-sea refuelling). • The depth at which the hydrophone cables travel is controlled by 'birds' which ensure a constant depth of approximately 6 m. • Tail buoys maintain the transect line of each hydrophone cable. • The hydrophone cables are tracked via GPS to monitor their location.			

Table 5.5 Environmental risk assessment (cont'd)

Risk Identification			Risk Treatment	Risk Analysis		Risk Evaluation
Activity	**Hazard/Risk**	**Potential Environmental Consequence**	**Assessment/Safeguards/Mitigation Measures**	**Likelihood**	**Impact**	**Risk Ranking**
Vessel presence (cont'd)	Small volume spill occurring (cont'd)		• The vessel will cease operating and seek safe harbour (or deep water) where conditions make it unsafe, in the view of the Vessel Master, to continue survey operations. • In the unlikely event of a spill during fuel transfer, ensure that the volume spilled is minimised by the automatic operation of shutdown pumps or safety valves and apply Emergency Response and OSCPs.			
	Moderate fuel spill - rupture of support vessel fuel tanks resulting from a collision with another vessel or offshore structure, resulting in a fuel spill	Mortality of planktonic organisms due to reduced water quality or hydrocarbon toxicity. Oil may wash up on shore with impacts to coastal values.	• Ensure that all vessel operations are conducted in compliance with the AMSA OSV Code (eg. radar monitoring, vessel communications). • Establish daily communication schedule with commercial fishing boats. • Possibly use local vessel for reconnaissance work capitalising on local knowledge of hazards to be avoided. • Installation of real time current metres to predict impact in path of vessel and trailing cables. • Apply seismic contractors Emergency Response Manual and Oil Spill Contingency Plan to the operation. • Satellite navigation of vessel assisted by constant visual observation. • Communications shall be constantly maintained with other vessels operating in the area to advise of the location of the survey vessel and avoid collision.	D	3	Low

Table 5.5 Environmental risk assessment (cont'd)

Risk Identification			Risk Treatment	Risk Analysis		Risk Evaluation
Activity	**Hazard/Risk**	**Potential Environmental Consequence**	**Assessment/Safeguards/Mitigation Measures**	**Likelihood**	**Impact**	**Risk Ranking**
Vessel presence (cont'd)	Moderate fuel spill (cont'd)		• The depth at which the hydrophone cables travel is controlled by 'birds' which ensure a constant depth of approximately 6 m. • Tail buoys maintain the transect line of each hydrophone cable. • The hydrophone cables are tracked via GPS to monitor their location. • The vessel will cease operating and seek safe harbour (or deep water) where conditions make it unsafe, in the view of the Vessel Master, to continue survey operations. • Ensure that senior personnel on vessels are familiar with the contents of the Emergency Response Manual and OSCP such that the initial response to an oil spill is carried out efficiently. • Ensure that all personnel are aware of the existence and location of the above-listed documents. • Ensure that the OSCP is up to date and staff are appropriately trained. • Ensure that all the necessary oil spill contingency plant and equipment is functional and accessible. • Rehabilitation and restoration will be undertaken in consultation with DPI and DSE.	D	3	Low
Streamer presence	Introduction of marine pests	Ecological consequences of introduction of marine pests	• Assess risks from previous location of vessel operation • Inspect streamers for exotic species - DSE may require streamers to be cleaned of pests if present. • Inspect hull anti-fouling management and vessel records.	D	3	Low

6. Environmental Performance Objectives and Standards

This section summarises the Santos environmental objectives, standards and criteria for the seismic surveys. The overall performance objectives are directly linked with the identified risks and effects discussed in Sections 4 and 5 (Tables 5.1 to 5.5). The roles and responsibilities of the key survey personnel are identified, including training requirements, in order to ensure that environmental performance objectives and all conditions of consent are met.

This section also identifies the standards (i.e., legislation, industry guidelines and codes of practice), and conditions (e.g., the consent conditions required by Commonwealth and Victorian Government Agencies) by which operations should be carried out to achieve each stated environmental objective, consistent with industry's best practice. Performance criteria by which Santos will measure its environmental performance are also presented. The performance criteria are measurable and relate directly to the environmental objectives. The criteria provide an overview to the commitments for environmental management detailed in the Implementation Strategy in Section 7.

6.1 Santos Environment, Health and Safety Management System

The seismic surveys will be conducted in accordance with the Santos Environment, Health and Safety Management System (EHSMS) and Santos Environmental Policy (see Section 2.6). Santos developed the EHSMS based on international standards and industry best practice for application to all Santos operations (Figure 6.1). The Santos EHSMS consists of two sets of standards; 'management' and 'hazard'.

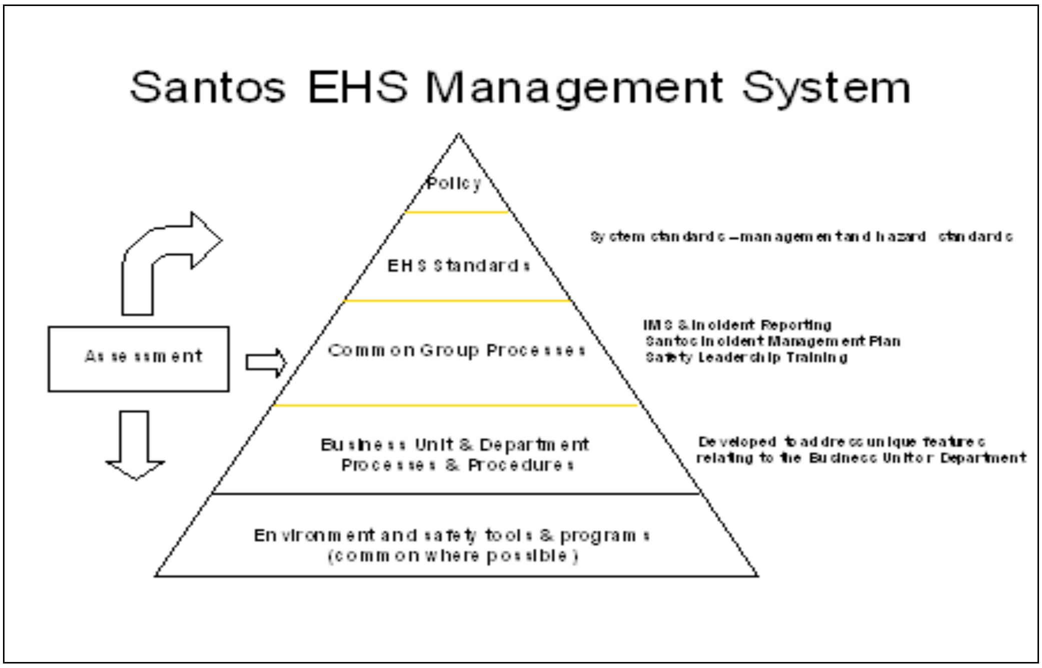


Figure 6.1 Santos EHS Management System

The framework has been developed to ensure that Santos' system is compliant with AS 4801: 2000 (Occupational Health and Safety Management Systems) and AS/NZS ISO 14001:1996 (Environmental Management Systems). Development of the Santos EHS Management Standards was completed and approved in July 2003. This has involved the drafting, management review, and approval of 18 Management Standards, which all sites are required to implement.

Management Standards are documents that define the requirements necessary to ensure that environmental, health and safety risks are systematically managed. Hazard Standards are documents which detail the specific controls required to manage the risks of specific hazards to acceptable levels.

For each standard, an assessment guide and auditor guide has been, or will be developed. The assessment guides are used to evaluate the status of implementation of the standard while auditor guides are used to determine the level of conformance to the standard. The auditor guides provide additional detail as to the requirements for practical implementation.

The contractor is required to implement and comply with the EHSMS procedures, or have equivalent procedures in place.

6.2 Environmental Objectives, Standards and Criteria

The environmental objectives, standards and measurement criteria are outlined in Table 6.1.

Table 6.1 Summary of environmental management objectives, standards and performance criteria

Aspect	Objectives	Standards	Criteria
Policy	Communicate Santos Environmental Policy.	Santos Environment Policy.	Audit shows environment policy in place and personnel awareness undertaken.
Seismic operation	Minimise effects of acoustic airgun discharge to marine fauna.	DEW Cetacean Guidelines on the application of the Environment Protection and Biodiversity Conservation Act to interactions between offshore seismic operations and larger cetaceans. Mitigation measures specified in sections 4 and 5 and Appendix 1 of this EP.	Documentation / verification of whale observing and impact mitigation procedures. Observations of observers on scout vessel.
	Minimise impact of seismic survey vessel on commercial fishing operations.	Mitigation measures specified in section 5 of this EP.	Verification of consultation/ daily radio schedules with commercial fishing operators.
	Minimise impacts to recreation and tourism activities.	Mitigation measures specified in sections 4 and 5 of this EP.	Verification of mitigation measures (notifications and consultation), through audit.

Table 6.1 Summary of environmental management objectives, standards and performance criteria (cont'd)

Aspect	Objectives	Standards	Criteria
Introduced Pests	Avoid introduction of pest species.	Hull antifouling. Streamer inspection.	Conduct risk assessment, based on vessel's previous area of operation. Verification of records. Verification of inspection. Cleaning and further verification (if necessary).
Waste Management	Manage/store wastes to avoid any marine discharge and therefore any environmental impacts.	Mitigation measures specified in sections 4 and 5 of this EP.	Verification through review of waste log.
Fuel and oil spills	Manage operations to avoid spills and minimise safety and environmental risks.	Santos Environment Policy. Seismic contractor operating procedures.	Verification through review of the spill record database.
Training	To ensure personnel are aware of their roles, responsibilities, obligations and management procedures.	Santos Environment Policy. Seismic contractor operating procedures.	Audit verification via training log.

6.3 Training

Seismic crews undergo continual training covering general operational procedures including waste management, spill and other emergency response. In addition, crews shall undergo project specific inductions designed to ensure each crew member is aware of their responsibilities and have the necessary skills to complete the required tasks and meet project objectives to avoid or minimise impacts to the marine environment.

Inductions will be conducted at the commencement of project operations and will detail the requirements of this Environment Plan, including:

- The Santos Environmental Policy and EHSMS, and requirements in this EP.
- Detail of significant environmental features of the survey areas and surrounds.
- Details of procedures to minimise introduction of exotic species.
- Detail of the function of the whale observer to call shut-downs and notification procedures in the event of detrimental effects to whales.
- Waste storage and management procedures within coastal waters.
- Nearshore operating requirements (distances offshore, minimum depths, daylight hours etc.) to minimise risk of collision or grounding.
- Emergency, spill procedures.
- Local emergency contact numbers.
- Section 7 environmental commitments.

All relevant personnel will undertake an environmental induction and completion will be recorded in the training database.

6.4 Environmental Roles and Responsibilities

All Santos and contractor personnel are required to comply with the Environment Plan and all relevant conditions of approval. Key environmental roles and responsibilities, and therefore chain-of-command, are identified in the following text, whilst specific duties assigned to key personnel are identified in Table 7.1.

6.4.1 Santos Chief Operations Geophysicist

- Responsible for ensuring the implementation of the Environment Plan at the system level.
- Responsible for notifying (in writing) DPI of names and contact details of all environmental contact persons listed and any changes in nominated persons during the course of the project.
- Responsible for maintaining communications with DPI at regular intervals during the period of the seismic program.
- Responsible for notifying the DPI and other appropriate regulatory authorities of all reportable incidents.

6.4.2 Santos Onboard Representative

- Client site representative during surveys.
- Responsible for conducting environmental inductions and training of survey vessel crew on relevant aspects of the Environment Plan, with assistance from specialist environmental advisers as appropriate.
- Responsible for monitoring the performance of the survey contractor with regard to requirements of the Environment Plan and all conditions of approval.
- Responsible for notifying the Santos Chief Operations Geophysicist of all incidents.

6.4.3 Vessel Master

- Responsible for safe operation of the survey vessel.
- Overall responsibility for HSE management onboard the vessel, and for ensuring environmental impact mitigation measures relevant to vessel operation are implemented, as specified in the Environment Plan and all conditions of approval.
- Responsible for notifying the Santos Onboard Representative of any incidents/activities arising from vessel operations that may have a negative impact on the environment.

6.4.4 Party Chief

- Responsible for safe execution of all data acquisition operations of the survey program.

- Responsible for ensuring that environmental impact mitigation measures relevant to data acquisition are implemented, as specified in the Environment Plan and all conditions of approval (e.g., soft start).
- Responsible for ensuring compliance with all aspects of HSE reporting and incident/near miss investigations.
- Responsible for notifying the Santos Onboard Representative of any incidents/activities arising from seismic data acquisition that may have a negative impact on the environment.

6.4.5 Environmental Adviser

- Responsible for ensuring induction training to ensure all exploration and associated crew personnel are aware of, and can discharge their responsibilities to meet the requirements of the EP and the objectives, standards and conditions to minimise impacts to the marine environment. Liaison with stakeholders on environmental matters as required.

6.4.6 Whale Observer

Santos will provide a trained and experienced whale observer on board the seismic source vessel throughout the surveys, with the following responsibilities:

- Responsible for conducting whale observations according to requirements of the Department of Environment and Water Resources (as communicated to Santos – see Appendix 1)
- Responsible for conducting and recording onboard environmental observations according to requirements of DPI.

7. Implementation Strategy for the Environment Plan

This section describes the implementation strategy for the Environment Plan, specifically detailing the measures to ensure that the environmental performance objectives, standards and all conditions of approval are met.

The implementation strategy identifies:

- Systems, practices and procedures.
- Specific roles and responsibilities.
- Employee training.
- Monitoring, auditing and recording requirements.
- Emergency response planning.
- Consultation with government and stakeholders.

The implementation strategy is summarised in Table 7.1.

Table 7.1 Implementation strategy

ID	Subject	Responsibility	Commitment	Evidence of Action
1	Approval to commence/continue operations	Santos Chief Operations Geophysicist	Obtain written approval from DPI.	Letters of approval from DPI.
2	Auditing and Reporting	Santos Chief Operations Geophysicist	Ensure that one compliance audit per year against the commitments proposed in this Environment Plan takes place during exploration operations.	Results of a compliance audit.
3		Santos Onboard Representative	Ensure that the results of the compliance audit are forwarded to the Santos Project Manager who signs off the closeout report to DPI. The report will include statements describing environmental performance.	Results of a compliance audit.
4		Santos Onboard Representative	Report to DPI any spills of petroleum of greater than 80L as required under the Section 26 PSLME Reg.	Results of a compliance audit.
5		Vessel Master or Party Chief (see Section 6.4)	Report internally any oil or other chemical spill regardless of volume.	Results of a compliance audit.
6	Provision of standards and procedures	Santos Onboard Representative	Provide as required, major Contractor(s) Person-In-Charge with access to all relevant operating standards and procedures such as the Emergency Response Plan, and Environment Plan.	Included in HSE Plan documentation. Compliance audit.
7	Communication of standards and procedures	Santos Onboard Representative	Conduct as required, pre-site mobilisation induction for employees and contractors to ensure general environmental expectations and desired outcomes outlined in the Environment Plan are understood.	Results of a compliance audit.
8	Oil spill response	Survey contractor	Ensure that relevant staff involved in emergency response are AMOSC trained in the use of oil spill response equipment.	Results of a compliance audit.
9		Survey contractor	Ensure that all personnel are made aware of the existence and location of Emergency Response and Oil Spill Contingency documents on the seismic vessel.	Results of a compliance audit.
10	Oil spill response	Survey contractor	Ensure that senior personnel on seismic vessel are familiar with the contents of the Emergency Response and Oil Spill Contingency documents such that the initial response to an oil spill could be carried out effectively.	Results of a compliance audit.
11		Survey contractor	Ensure that oil spill response equipment is available on the vessel. Further resources will be obtained via the AMOSC Plan (through AMOSC) as required.	Results of a compliance audit.
13	Disposal of wastes	Survey contractor	Styrofoam cups will not be used on board the survey vessel.	Results of a compliance audit.

Table 7.1 Implementation strategy (cont'd)

ID	Subject	Responsibility	Task	Evidence of Action
14	Handling of hazardous substances	Vessel Master or Party Chief	All substances shall be handled in accordance with their respective material safety data sheets (MSDS). Material Safety Data Sheets must be held on the vessel by the seismic contractor for all chemicals used.	Results of a compliance audit.
15	Supply of equipment and supplies	Vessel Master or Party Chief	Ensure that storage on supply vessels and survey vessels is in accordance with various legislative requirements including the AMSA OSV Code and AMSA Marine Orders: Dangerous Cargoes, Cargo Stowage and Securing, Marine Pollution Prevention - Noxious Liquid Substances, and Marine Pollution Prevention - Packaged Harmful Substances. Ensure stocks of oil spill response equipment are regularly checked and replenished to ensure appropriate supply quantities are on hand at all times.	Results of a compliance audit.
16	Cetacean Mitigation Management Plan	Santos Onboard Representative Whale observer	Ensure that seismic vessel, helicopter (or fixed wing aircraft hired for purpose), and support vessel operators are familiar with whale monitoring program and data logging procedures.	Results of a compliance audit. Observation records to DEW
17	Cetacean Mitigation Management Plan	Santos Onboard Representative Whale observer	Ensure that aspects of the cetacean monitoring program relevant to season and location are activated on seismic vessels, helicopters (or fixed wing aircraft hired for the purpose).	Results of a compliance audit. Observation records to DEW
18	Fauna and flora impact mitigation observation	Santos Onboard Representative Whale observer	Ensure that the survey vessel and support vessel crews are aware of their responsibility for implementing a program of observation for adverse effects to cetaceans and subsequent shutdown in accordance with the procedure outlined in Section 8.1 of this Environment Plan.	Records and results of compliance audit to Parks Victoria
19	Fishing interaction	Vessel Master	Establish routine communication times /frequencies to inform fishing operators / cooperatives of daily areas of seismic survey.	Maintain log of communication record.
20	Recreational vessel interaction	Vessel Master	Establish vessel contact with recreational vessel at least 3 km (approximately 30 minutes) prior to interaction with seismic vessel, and inform the recreational vessel of the path of the seismic vessel. Ensure that no recreational vessel remains in the path of the seismic vessel.	No incidents between seismic vessel and recreational vessels. Maintain log of communication record.

Table 7.1 Implementation strategy (cont'd)

ID	Subject	Responsibility	Task	Evidence of Action
21	Disposal of wastes	Vessel Master or Party Chief	Ensure sewage and putrescible waste are treated in accordance with MARPOL requirements and all other wastes are packaged and transported to shore for disposal. Ensure waste log is implemented. Solid inert waste will be returned to shore for disposal. Hazardous wastes, generally of low quantity and mainly includes lithium batteries, paints, will be segregated and stored in sealed storage areas and transferred to onshore licensed hazardous material handlers for disposal to a licensed depot.	Documentation of compliance.
22	Loss of material	Vessel Master or Party Chief	Any spillage during loading, unloading, supply vessel transportation, storage or at the seismic location shall be reported immediately to Santos.	Written documentation and reporting of incidents.
23		Vessel Master or Party Chief	Any loss to the sea of liquid hydrocarbon or other hazardous substance that requires an operational response to contain or recover is to be managed in accordance with the Oil Spill Contingency Plan. Ensure stocks of oil spill response equipment are regularly checked and replenished to ensure appropriate supply quantities are on hand at all times.	Written documentation, reporting of incidents, incident investigation report.
24	Refuelling	Vessel Master	Ensure that refuelling operations for the seismic and supply vessels will be conducted in accordance with refuelling procedures, including continuous visual monitoring and the use of Santos approved fittings. Refuelling is to be conducted at port only.	Results of a compliance audit.
25	Government and stakeholder management liaison	Santos Environmental Adviser	Advise DPI of project execution progress on a regular basis.	Documentation of compliance (email, phone records).

8. Monitoring, Auditing & Reporting

8.1 Environmental Monitoring

Santos is proposing to undertake an aerial survey across the proposed seismic program areas prior to the commencement of seismic data acquisition, the occurrence and timing of which will be dependent upon appropriate weather conditions in the survey areas. A decision on the need to undertake repeat surveys will be made based on the results of the initial survey. The aerial surveys are likely to be undertaken in conjunction with, but in addition to, surveys being undertaken by the Deakin University Blue Whale Study (Victoria).

Santos will develop an appropriate whale monitoring strategy, which will assess compliance with mitigation measures, provide impact assessment verification feedback and also enable an operational response to any significant environmental threat that may arise during the surveys.

8.2 Auditing

Santos will report on seismic operations to demonstrate that the environmental performance objectives and standards outlined in this EP have been met. Santos will undertake internal compliance checks as appropriate to show that the actions detailed in this EP have been undertaken. The audit protocol will include an assessment against the following:

- Otway 3D Seismic Survey EP and the extension to this survey.
- Otway 3D Seismic Survey EPBC Act referral (Referral 2007/3367) and the EPBC Act referral which details the extension to this survey (submitted on 4 May 2007).
- EPBC Act referral determination – manner specified conditions.
- APPEA Code of Environmental Practice (1996).
- DEW cetacean observation and seismic operations guidelines (2001).

8.3 Reporting on Routine Operations

8.3.1 Internal Reporting

Under EHSMS sections 14 (Monitoring, measurement and reporting) and 15 (Incident and non-conformance investigation, corrective and preventative action), Santos requires all environmental incidents to be internally reported, no matter how small, using the Incident Management System (IMS). Formal processes for environmental improvement and rectification include:

- Non-compliance reports (NCR) – issued when potential policy breaches are noted and investigation is required.

- Corrective action requests (CAR) – specifies the required rectification action.

The following list summarises the internal environmental reporting required for the proposed seismic surveys:

- Environmental induction register.

- Audit reports of conformance with environmental performance objectives and requirements of this EP.
- Non-conformance with Environmental Performance Objectives.
- Cetacean surveillance and sighting forms.
- Waste emissions log - in accordance with P(SL)A environmental requirements.
- Records of consultation/communication with stakeholders.
- Incident Reports.
- Emergency response reporting according to Contractor Emergency Response Plan and Santos Emergency Management Plan.

8.3.2 External Reporting on Routine Operations

Reporting to DPI will be undertaken within 3 months of closeout of the seismic survey programs. All cetacean sightings will be reported to the Commonwealth DEW and the Victorian DSE at the completion of the program.

8.4 Reporting on Non-routine Operations

Santos will report any reportable incidents (e.g., oil spill) to DPI as required under Sections 26, 26A and 26B of the PSLME Regulations 1999.

Any incident that is outside the environmental performance conditions for this activity, as agreed by Santos and the regulatory authorities, will be reported in the annual report to these authorities in accordance with requirements of the PSLME Regulations 1999.

Reportable Incidents

A reportable incident is defined by the P(SL)A MoE Regulations as 'an incident mentioned in the Environment Plan for the activity that has caused, or has the potential to result in, moderate to catastrophic environmental consequences as categorised by the risk assessment process undertaken as part of the preparation of the environment plan'.

The DPI will be notified of all reportable incidents as soon as practicable, and not later than 2 hours following the first occurrence of the reportable incident or the time that the operator becomes aware of the reportable incident, in accordance with regulation 26 of the P(SL)A MoE Regulations. A written report will be provided to the DPI within 3 days of the first occurrence of the reportable incident.

Recordable Incidents

A recordable incident is defined by the P(SL)A MoE Regulations as an incident arising from the activity that:

a) breaches a performance objective for the environment plan that applies to the activity; and

b) is not a reportable incident.

In accordance with regulation 26B of the P(SL)A MoE Regulations, a monthly written report of all recordable incidents will be submitted to the DPI as soon as practicable after the end of a calendar month (and not later than 15 days after the end of the calendar month), and contain a record of all recordable incidents that occurred during the calendar month.

Escape of Petroleum

Mandatory reporting requirements (in accordance with Section 285 of the Petroleum (Submerged Lands) Regulation Schedule – Specific Requirements as to Offshore Petroleum Exploration and Production 1995) for the escape or ignition and other material include:

- An escape or discharge into the sea of a mixture of petroleum and water in which the petroleum concentration was greater than 50 mg/L.
- An escape or discharge into the sea of more than 80 L of petroleum, not being the above.
- An uncontrollable escape or ignition of petroleum or any other flammable or combustible material causing a potentially hazardous situation.

Additional Regulatory Reporting

Additional regulatory reporting requirements for the surveys include:

- All oil pollution incidents in Commonwealth waters must be reported to AMSA under Marine Notice 1/1996.
- Any spills greater than 10 tonnes in Commonwealth waters must be reported to AMSA within 1 hour.
- Any incident that is outside the environmental performance conditions for this activity, as agreed by Santos and DPI, will be reported in the annual report to DPI in accordance with requirements of the P(SL) MoE Regulations.

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Appendix 1

Attachment A of the DEH Guidelines for managing interactions between offshore seismic operations and larger cetaceans

ATTACHMENT A

Standard Procedures for all Seismic Actions

Pre Start-up Visual Observation Procedures

- Visual checks (using graticule binoculars from a suitable, high observation platform on the survey vessel) for the presence of whales will be undertaken before the commencement of operations.
- Observations which ensure effective monitoring of a 3 kilometres radius around the survey vessel (see attached diagram) will begin at least 90 minutes prior to and continue during the use of any high-energy acoustic sources.

For information, indicators of whale activity may be in the form of blows and surface activity resulting in large splashes.

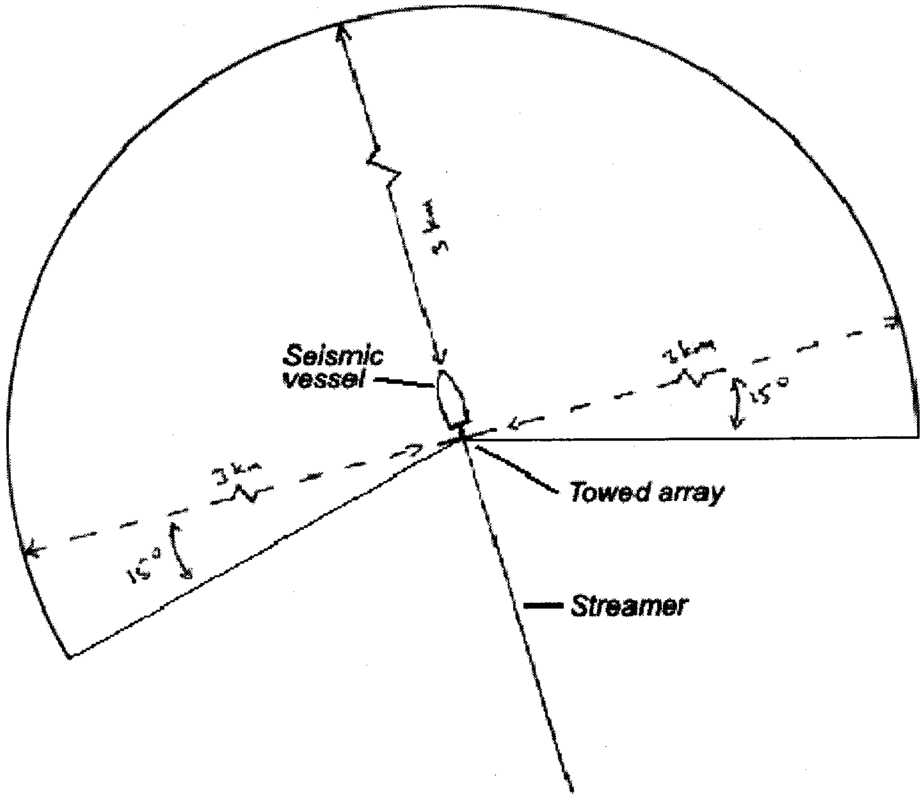

Diagram of area surrounding a seismic vessel that must be monitored for the presence of whales.

Start-up Delay Procedures

- Discharge of the acoustic sources will not commence unless there are no whales within a minimum distance of 3 km from the survey vessel.
- If whales are detected within this zone the start up of acoustic sources will be delayed until they have been observed to move outside the 3km radius or, if they are no longer observable, 30 minutes after the last sighting within 3km.

Soft Start Procedures

- A sequential build-up of warning pulses will be carried out at the commencement of all surveys. The whole array will not be fired without a full soft start. Soft starts will be used even if no whales have been seen. (Soft starts involve commencing with the least powerful source, the smallest gun available, and adding additional sources in sequence.)

- Visual observation will be maintained continuously during soft starts to establish the presence or absence of whales within 3 km of the vessel.

- If whales are sighted during this soft start procedure within the 3km zone, the seismic source will be shut down or powered down to the minimum audible source (the smallest gun available). Re-commencement of soft start procedures will take place after 30 minutes has lapsed since the last whale sighting within the 3km zone.

- There may be continued discharge of the acoustic source during line turns or changes. Discharge of only a limited number of air-guns in the acoustic array would be sufficient in this case.

- Alternatively the array may be completely shut down between the lines of a survey. In the event that the array is completely shut down between the lines of a survey, the full start-up delay and soft start procedures will be undertaken prior to the whole array being fired.

For information, the soft start procedure involves a gradual increase in the number of air-guns fired over a 20 minute period prior to commencement of a line, and serves to send out a series of warning pulses to whales and give them adequate time to leave the vicinity.

Visual Observation Procedures During Survey Line

- Continuous visual observations will be carried out during seismic operations. The area to be monitored for the presence of whales is the same as that applying for pre-start surveys.

- Where whales are seen as part of the observation procedures, continual observations should occur until 2 hours have passed since the last observation has occurred.

- All cetacean observations, whether within 3km or not, should be documented and reported.

Stop Work Procedures

- Where a seismic vessel with an operating acoustic source approaches within 3km of an individual whale or pod of whales, the acoustic source will be shut down or powered down to the minimum audible source.

- Where an individual whale or pod of whales approaches within 3 km of a seismic vessel, the acoustic source will be shut down or powered down to the minimum audible source unless the animal or animals are seen to be skirting the edge of the 3km limit.

- Seismic source operations will not recommence until the animal or pod has been seen to move outside of a 3 km range, or has not been seen for 30 minutes.

Recording and Reporting Procedures

- Any whale sightings will be recorded on the Department of Environment and Heritage's *Whale and Dolphin Sighting Report Summary* spreadsheet available on the Department's website.

- At completion of the seismic survey, copies of all report forms will be submitted to:
  Department of Environment and Heritage
  Ports & Marine Section
  GPO Box 787
  Canberra ACT 2601

Appendix 2

Summary of fishers consultation

Summary of Fishers Consultation:

NB: This information is correct as of 26 April 2007. Santos engaged the services of a fisheries consultant in February 2007 (Andrew Levings) who has undertaken consultation with the relevant fishers on an ongoing basis since then and will continue to do so until the survey is complete.

Fisher/Fishing Industry Body	**Consultation Summary**	**Feedback Received**
Australian Fisheries Management Authority	**23 February 2007** – Email to AFMA from Santos to provide details on the proposed survey and requesting details of relevant fishery organisations to contact. **23 February 2007** – Email response from AFMA detailing organisation to consult with.	**YES**
Adrian Rogers	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Allan Moncreiff	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Andrew Gilmore	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Brian OConnor	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including	**NO**

	bathymetry maps, timing, contact details for key Santos and vessel.	
Brian O'Connor	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Craig Saltmarsh	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
David Barker	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
David Sharp	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Doug McDougall	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Gary Edwards	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Gary Radford	**15 February –** Correspondence provided detailing proposed survey (including map) as	**NO**

	well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	
Gary Roberts	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Gary Robinson	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Gary Ryan	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Gavin Wicks	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Howard Sharp	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Ion McEachern,	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February.	**NO**

	23 April – Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	
John Edgar	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
John Pell	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
John/Graham Cull	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Lenny Lucas	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Lyle Elleway	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Mick Astbury	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**

Paul Armstrong	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Peter Ryan	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Peter Sandow	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Peter Threlfull	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Peter Trewartha	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Ross Ferrier	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Shane Gibb	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February.	**NO**

	23 April – Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	
Wayne Towers	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Lou Green	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Rod McDonald	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Stuart Richie	**15 February –** Correspondence provided detailing proposed survey (including map) as well as proposing meeting of 27 February. **23 April –** Correspondence forwarded updating details of proposed survey, including bathymetry maps, timing, contact details for key Santos and vessel.	**NO**
Commonwealth Fisheries Association	**23 February –** Correspondence forwarded detailing the proposed survey and approximate timing. Included Bathymetry map and vessel contact details **23 April –** Correspondence providing updated survey timing and location information. Included Bathymetry maps and key vessel and Santos contacts.	**NO**
Tuna Boat Owners Association of Australia	**23 February –** Correspondence forwarded detailing the proposed survey and approximate timing. Included Bathymetry map and vessel contact details **23 April –** Correspondence providing updated survey timing and location information.	**NO**

	Included Bathymetry maps and key vessel and Santos contacts.	
OceanWatch Australia	**23 February –** Correspondence forwarded detailing the proposed survey and approximate timing. Included Bathymetry map and vessel contact details **23 April –** Correspondence providing updated survey timing and location information. Included Bathymetry maps and key vessel and Santos contacts.	**NO**
Tasmanian Fishing Industry Council	**23 February –** Correspondence forwarded detailing the proposed survey and approximate timing. Included Bathymetry map and vessel contact details **23 April –** Correspondence providing updated survey timing and location information. Included Bathymetry maps and key vessel and Santos contacts.	**NO**
Seafood Industry Victoria	**23 February –** Correspondence forwarded detailing the proposed survey and approximate timing. Included Bathymetry map and vessel contact details **2 March –** Phone conversation with Ross McGowan – No concerns highlighted. Ensuring relevant parties contacted. **23 April –** Correspondence providing updated survey timing and location information. Included Bathymetry maps and key vessel and Santos contacts.	**YES**
Scallop Fishermans Association Inc.	**23 February –** Correspondence forwarded detailing the proposed survey and approximate timing. Included Bathymetry map and vessel contact details **23 April –** Correspondence providing updated survey timing and location information. Included Bathymetry maps and key vessel and Santos contacts.	**NO**
Great Australian Bight Fishing Industry Association	**23 February –** Correspondence forwarded detailing the proposed survey and approximate timing. Included Bathymetry map and vessel contact details **23 April –** Correspondence providing updated survey timing and location information. Included Bathymetry maps and key vessel and Santos contacts.	**NO**
South East Trawl Fishing Industry Association	**23 February –** Correspondence forwarded detailing the proposed survey and approximate timing. Included Bathymetry map and vessel contact details	**NO**

	23 April – Correspondence providing updated survey timing and location information. Included Bathymetry maps and key vessel and Santos contacts.	
Lakes Entrance Fishermen's Co-operative	**23 February –** Correspondence forwarded detailing the proposed survey and approximate timing. Included Bathymetry map and vessel contact details **23 April –** Correspondence providing updated survey timing and location information. Included Bathymetry maps and key vessel and Santos contacts.	**NO**
South East Fishery Association	**23 February –** Correspondence forwarded detailing the proposed survey and approximate timing. Included Bathymetry map and vessel contact details **23 April –** Correspondence providing updated survey timing and location information. Included Bathymetry maps and key vessel and Santos contacts.	**NO**
Port Campbell Fishermen's Association	**28 February –** Met with representative in Pt Campbell. No concerns highlighted due to area of operation. Would provide the details to members including Apollo Bay Fishermen's Association and provide any feedback. No feedback received to date. **24 February** – Updated map of area of operations forwarded through for information	**YES**

Fishers where invited to meetings on the 27th of February in Warrnambool or Portland and the 28th of February in Port Campbell.

Warrnambool Consultation 27th February 2007,
Warrnambool Fishermen's Club
Santos; Nick Fox, Andrew Levings.
Fishermen; Peter Sandow, Mick Astbury, Peter Ryan, David Barker, Gary Edwards, John Pell, Adrian Rodgers, Lenny Lucas, Paul Armstrong, Ashley Virgona, Bruce Carrison.

Portland Consultation 27th February 2007,
Macs Hotel
Santos; Nick Fox, Andrew Levings.
Fishermen; None.

Port Campbell Consultation 28th February 2007,
Waves Cafe

Santos;	Nick Fox.
Fishermen;	Antoinette Hannah.