WOODSIDE
AUSTRALIAN ENERGY
A.B.N. 63 005 482 986

CONTROLLED DOCUMENT

Title: Trim 3D Marine Seismic Survey Environment Plan

DOCUMENT INFORMATION			
DRIMS#: 2230293	**Rev: v4**	**DRIMS Classification** (if applicable):	
Prepared by: P. Farrell		**Date:** 17/11/05	**Signature:**
Supervised by (if applicable):		**Date:** 17/11/05	**Signature:**
Approved by: S. Rigby		**Date:** 17/11/05	**Signature:**
Custodian: S. Rigby		**Date:** 17/11/05	**Signature:**

CONCURRENCE			
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REVISION HISTORY				
Revision	**Description**	**Date**	**Prepared by**	**Approved by**
1	For client review	3/11/05	P. Farrell	S. Mahroogi
2/3	Edits after review	16/11/05	P. Farrell	S. Mahroogi
4	Final issue	17/11/05	P. Farrell	S. Mahroogi

RELEASE STATEMENT
(Check one box only)

- ☐ Unclassified (Shared without Restrictions)
- ☒ Restricted (Freely Shared within Woodside and Associated Companies)
- ☐ Confidential (Shared With Selected Personnel)
- ☐ Most Confidential (Strict Need-to-Know Basis)

REVIEW STATUS
(Check one box only)

- ☐ Review Period 1 Year
- ☐ Review Period 3 Years
- ☒ Review Not Required

PREPARED
(Check one box only)

- ☐ By WEL
- ☒ For WEL Under PO/Contract No:

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Table of Contents

1 INTRODUCTION

Woodside Energy Ltd proposes to undertake a 3 dimensional (3D) marine seismic survey in the Great Australian Bight (GAB), in permit EPP29. This survey, referred to hereafter as the Trim 3D Seismic Survey (Trim 3D MSS) will cover approximately 1,250km^2 in Commonwealth waters in the Great Australian Bight (GAB) within the area bounded by the coordinates presented in Table 1. The survey centre is approximately 340km south of the south western corner of the South Australian coast.

The survey, which is expected to take approximately 36 days to complete, will be conducted in the period 1st January 2006 to 1st May 2006. The exact timing of the survey within this period is subject to vessel availability and is not yet known.

1.1 PURPOSE AND STRUCTURE OF DOCUMENT

This Environment Plan for the Trim 3D MSS has been prepared in accordance with the Commonwealth regulatory requirements of the *Petroleum (Submerged Lands) (Management of Environment) Regulations 1999*.

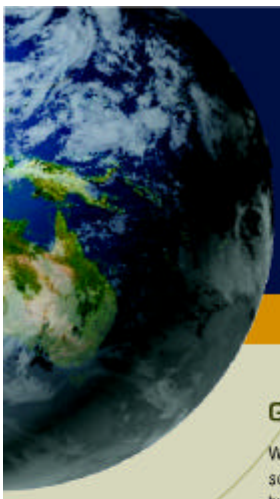
The overall purpose of this Environment Plan is not only to comply with statutory requirements but also to ensure that the seismic acquisition is planned and conducted in line with Woodside corporate Environmental Policy and Health, Safety and Environment (HSE) Management System. It includes:

- A description of the proposed activity
- A description of the existing environment in the area of proposed operations
- The identification and assessment of all environmental risks in advance of the seismic operations commencing
- The identification of environmental performance objectives, standards and criteria
- The development of appropriate environmental management and mitigation measures that will allow any environmental risks and effects to be avoided or reduced to as low as is reasonably practicable.

It will also serve as a practicable environmental management tool that can be used throughout the survey by operators to implement targeted environmental control measures.

1.2 CORPORATE ENVIRONMENTAL POLICY

Woodside is committed to protecting the environment and consequently has a written corporate Environment Policy (see overleaf) that provides a public statement of the corporate commitment to protecting the environment during offshore exploration operations such as seismic surveys.



WOODSIDE

The Woodside Group of Companies

Environmental Policy

General Policy Objectives

Woodside is an oil and gas exploration and production company. Our vision is to provide for society's energy needs in ways that make us proud. While recognising that the world's hydrocarbon reserves are finite, we share the desire of the community to develop these resources in ways that meet the needs of the present, without compromising the environment for future generations.

At all stages of our business, we plan and perform activities so that adverse effects on the environment are avoided or kept as low as reasonably practicable.

Strategies

To implement this Policy we will:

- Delay or stop activities where effective environmental controls are not in place.
- Comply with all applicable laws and regulations while aspiring to higher standards.
- Apply responsible standards where laws and regulations do not exist.
- Apply and demonstrate a systematic approach to environmental management to ensure compliance and achieve continuous performance improvement.
- Set and regularly review environmental objectives and targets.
- Strive to prevent pollution, and seek improvement with respect to emissions, discharges, wastes, energy use, resource consumption and ecological footprint.
- Monitor the effects of our activities on the environment and take action to address effects where necessary.
- Openly communicate our environmental performance with our workforce, Government and the wider community.
- Foster a culture that empowers and rewards everyone to act in accordance with this Policy.

Application

The Managing Director of Woodside Energy Ltd. is accountable to the Board of Directors for ensuring this Policy is implemented. This Policy will be reviewed every three years.

This Policy applies to all personnel, contractors and joint venturers engaged in activities under Woodside's operational control. Responsible Woodside managers will use their influence to promote this Policy in non-operated ventures.

Don Voelte
Managing Director & CEO
April 2004

1.3 ENVIRONMENTAL LEGISLATION

All activities conducted during the Trim 3D MSS will comply with legislative requirements established under the Australian Commonwealth Government regulatory framework[1].

The major relevant Commonwealth statutes and regulations are:

- *Petroleum (Submerged Lands) Act 1967*, and delegated legislation;
    - o *P(SL) Acts Schedule - Specific Requirements as to Offshore Petroleum Exploration and Production 1995*
    - o *Petroleum (Submerged Lands) (Management of Environment) Regulations (1999)*
- *Environmental Protection and Biodiversity Conservation Act 1999*; and the *Great Australian Bight Marine Park (Commonwealth Waters) Management Plan 2005-2012*
- *Australian Maritime Safety Authority Act 1990*;
- *Environment Protection (Sea Dumping) Act 1981*;
- *Historic Shipwrecks Act 1976*;
- *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*;

Under the *Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)*, the proponent must refer those proposals considered to have the potential for significant impacts on matters of 'National Environmental Significance' to the Department of the Environment and Heritage (DEH) or may choose to refer the proposal for determination by DEH. Written advice was received from DEH (18th July 2005) that the project remained 'not a controlled action'.

The seismic survey will be carried out in accordance with the '*Guidelines on the Application of the Environment Protection and Biodiversity Conservation Act to Interactions Between Offshore Seismic Operations and Larger Cetaceans*' (October 2001).

A proportion of the survey area will overlap the Benthic Protection Zone (BPZ) of the Great Australian Bight Marine Park (Commonwealth Waters). The BPZ of the Great Australian Bight Marine Park was established to preserve a representative sample of benthic flora/fauna and sediments, extending across the continental shelf and down the slope into deeper waters (Environment Australia 1999). The GAB Marine Park (Commonwealth Waters) Management Plan allows (at s.6.5) for seismic surveys to be conducted across the BPZ if permitted by the Governor General Permission to carry out the 3D MSS across portions of the BPZ was received from the Delegate to Director of National Parks, 27th October 2005.

1.4 INTERNATIONAL AGREEMENTS AND CONVENTIONS

A number of international agreements and conventions may have impacts on petroleum activities in Australian Commonwealth waters. The principal ones are:

- *International Convention for the Prevention of Pollution from Ships, London, 1973/78* (commonly known as MARPOL)
- *Protocol to International Convention on the Prevention of Marine Pollution by Dumping of Waste and Other Matter, 7 November 1996* (Previously known as the London Dumping Convention)
- *International Convention on Oil Pollution Preparedness, Response and Co-operation, 1990* (commonly known as OPRC 90)
- *Agreement Between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and Their Environment* (commonly referred to as the

[1] Note that if internet access is available the full text of the legislation can be found by clicking on the legislation name. The hyperlink provided was valid for links to legislation current at the time of document preparation.

China Australia Migratory Bird Agreement or CAMBA)

- *Agreement Between the Government of Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and Their Environment* (commonly referred to as the Japan Australia Migratory Bird Agreement or JAMBA)

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal

The ship operation aspects of MARPOL 73/78 are implemented in Australia under the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (C'th) which is administered by AMSA. Annexes I, II, III and V of MARPOL are given effect under different parts of the Act. Part II of the Act implements Annex I by making it an offence by the master and the owner if there is a discharge of oil or an oily mixture from an Australian ship into the sea, with the usual exceptions to the offence contained in the convention (accident, approved discharge, etc). Similar provisions are set out in the Act relating to Annexes II, III and V. Waste disposal record books are to be kept and inspectors have wide powers.

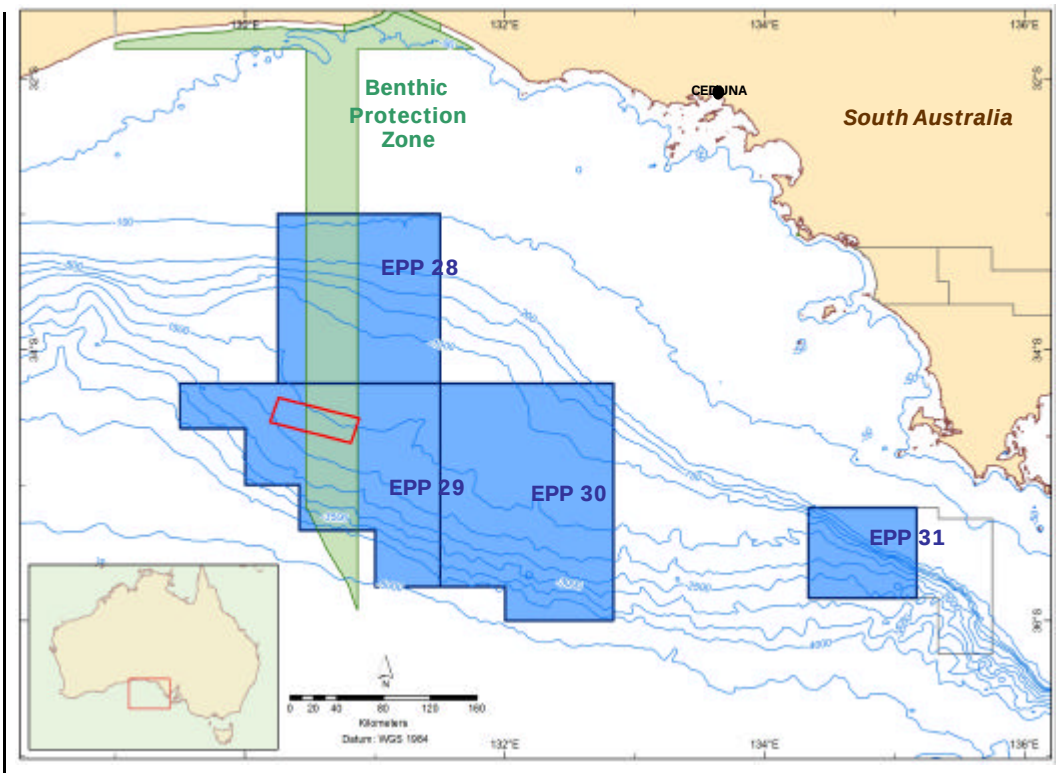
Many provisions under MARPOL 73/78 require ships to have certain construction configuration (especially tankers) and that ships carry particular equipment (such as oily water separators). These requirements are given force in Australian legislation by the Commonwealth *Navigation Act 1912* (C'th).

2 PROPOSED SEISMIC SURVEY

2.1 LOCATION

The survey area lies in Commonwealth waters approximately. The survey is centred about 370 km south-west of Ceduna in South Australia, and is 300 km south of the Marine Mammal Protection Area of the GAB Marine Park at the Head of the Bight. The survey will occur within the area shown by Figure 1. The survey area is beyond the break of the Continental Shelf in water depths of between 1,200m and 2,500m.

Figure 1: Location Diagram



2.2 DESCRIPTION OF THE SURVEY

The Trim 3D MSS is scheduled to start in January 2006 and take about 36 days to complete, depending on weather and ocean conditions.

The survey will be conducted by the Petroleum Geo Services (PGS) seismic survey vessel MV *Ramform Victory*. This vessel normally carries a complement of 45 to 50 crew. A second smaller support vessel will also be used for logistic, safety and gear management support. The support vessel will typically have a crew of 5 to 7 personnel.

The *Ramform Victory* will come to the GAB from the North West Shelf, stopping Fremantle for a crew induction. The vessel has been contracted for Woodside's Aragorn 3D MSS north-west of King Island

(permits T/30P and T/34P) immediately after the Trim survey. The vessel is likely to make a port call between surveys.

A marine seismic survey involves an acoustic pulse being sent out from a signal source (called an acoustic energy source array or airgun array) deployed behind the vessel. This pulse is reflected from the boundaries between geological layers in the sub-surface and the reflected signals are recorded by a series of hydrophone receivers towed in a number of cables ('streamers') behind the vessel.

For the Trim 3D MSS, two acoustic energy source arrays will alternately generate acoustic signals at intervals of approximately 7 to 10 seconds. Acoustic energy sources operate by releasing bursts of compressed air, which push the water away from the individual airguns and create a pressure wave that results in a seismic signal. The operating pressure for the acoustic energy source arrays will be approximately 13, 800 kilopascals (2000 psi). The acoustic energy source array will have a volume of 0.051 m^3 (3,090 cubic inches). The seismic signal produced will have an intensity in the order of 220-240 dB re 1µPa-m at frequencies extending up to approximately 110 Hz.

The pressure of a seismic pulse diminishes with increasing distance from the source. Most of the pressure loss is due to geometric spreading of the expanding wavefront. At distances from the source that are less than the depth of water below the source location, the pressure of the seismic pulse decreases in proportion to the square of the distance from the source (**Figure 2**).

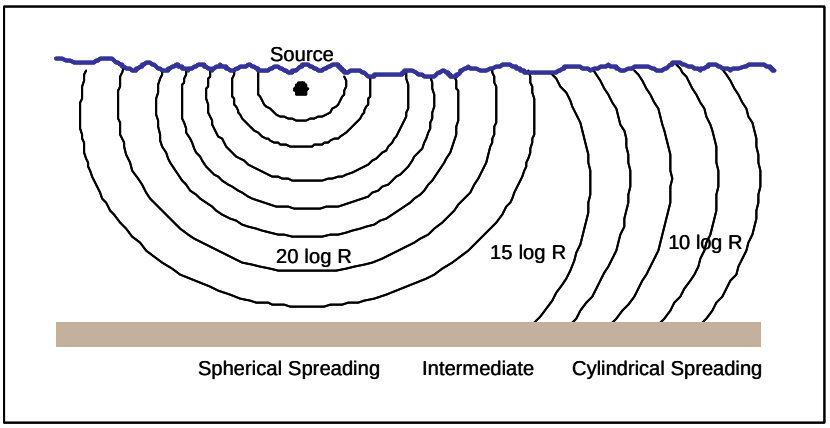


Figure 2: Schematic Representation of Spreading Loss

This is known as 'spherical spreading' and the pressure decrease with distance can be expressed as:

Received pressure = (Source pressure measured at 1 m) – (20 log R) dB

Where:
R = range to receiver (m)

This transmission loss is 6 dB with each doubling of the distance. That is to say, pressure decreases by three-quarters with each doubling of the distance.

At distances from the source that are much greater than the water depth, sound propagates through a channel bounded by the sea surface and the sea floor and the pressure of the seismic pulse decreases in direct proportion to the distance from the source (ignoring some transmission of acoustic energy into the seafloor). This is known as 'cylindrical spreading' and the pressure decrease with distance can be expressed as:

Received pressure = (Source pressure measured at 1 m) – (10 log R) dB

When spreading is cylindrical, the spreading loss is 3 dB with each doubling of the distance. A simple model of spreading would use spherical spreading to distances equal to that of the water depth and then cylindrical spreading at greater distances. At ranges intermediate between spherical and cylindrical spreading, the transmission loss is often assumed to be 15 log R dB.

In many cases, observed and modelled spreading losses do not agree well with the simple spherical/cylindrical spreading model. The estimation of spreading is complicated by many factors. These include: reflections from the sea surface, sea floor and sub-bottom layers; transmission of energy into the seafloor; and differences in propagation for different frequencies. McCauley (2000) recorded the rate of decrease in broadband underwater noise energy using an acoustic energy source array of similar size to that proposed over a similar shelf break environment. He determined that the broadband underwater noise associated with seismic surveys decreased with range and that the received equivalent energy level can be predicted by the following equation:

$RL = -34.3536 \times \log_{10}(R) + 2.778 \times 10^{-5} R + 263.2064$

Where:
RL = received equivalent energy (dB re $1\mu Pa^{-2}s$) (at mean depth of 32 m)
R = Range to receiver (m)

The *Ramform Victory* will tow 10 hydrophone streamers each of which will be 4,595 m in length. These will be towed at a depth of approximately 9m beneath the sea surface. A tail buoy, that acts to both identify the end point of the streamer and keep the streamer at the desired depth, will mark the end of each streamer.

The vessel will traverse a series of pre-determined survey lines within the nominated area at a speed of approximately 9 km/hr. The survey lines will be defined to provide uniform data coverage over the survey area.

Seismic array details are summarised in the following table (Table 1):

Table 1: Seismic Array Details

Parameter	Value
No of streamers	10
Streamer length	4,595 m
Streamer depth	9 m
Number of source arrays	2
Source array total volume	0.051 m^3 (3,090 cui)
Operating pressure	13,789 kPa (2,000 psi)
Source array depth	7 m
Shotpoint interval	25m (~7.5 seconds)
Peak source sound pulse	220-240 dB re 1µPa-m
Frequency range	10 to 110 Hz

3 DESCRIPTION OF THE EXISTING ENVIRONMENT

3.1 CLIMATE

The climate of the coastal area of the GAB is typically semi-arid or Mediterranean and is characterised by hot, dry summers and cool, moist winters. It is largely influenced by mid-latitude anticyclones or high-pressure systems, which pass from west to east across the continent.

The seasonal atmospheric cycle maintains a high-pressure ridge over the South Australian Basin in summer so that the predominant winds are south-easterly winds, whereas in winter the anticyclonic centre lies over central Australia so that westerly winds occur. On a weekly scale, in winter the region is crossed by a series of cold fronts extending from low pressure systems in the Southern Ocean into continental Australia, and in summer the south-easterly winds are interrupted by meridional wind patterns during which hot air is advected southwards over the sea (Bye, 1998).

Most rain falls during winter, however it varies considerably with latitude, from approximately 500mm in the south of the GAB to less than 300mm in the north. Mean monthly maximum temperatures on the coast range from 26°C in January to 18° C in July at Eucla and from 28° C in January to 17° C in July at Ceduna (Edyvane, 1998).

3.2 OCEANOGRAPHY

The oceanography of the GAB is typified by a high energy, swell dominated wave regime and a coastline exposed to a persistent south-west swell (Environment Australia, 1996). The GAB experiences some of the world's highest and most persistent waves (Chelton *et al.*, 1981).

Tides along the western Eyre coast are microtidal in range and are predominantly semi-diurnal, with a mean tidal range of between 0.8m and 1.2m (Edyvane, 1998).

3.2.1 WAVE CLIMATE

The GAB is dominated by a high south-west swell, generated by the westerly moving low pressure systems south of the mainland. This south-west to westerly swell ranges from less than 2m for 50% of the year, to 2 to 4m for 30-45% of the year and exceeding 4m approximately 10% of the year. Wind generated sea conditions also provide an additional source of wave energy, with seas averaging 0.5 to 1.25m and may exceed 2m for 10-15% of the year (Edyvane, 1998).

3.2.2 WATER TEMPERATURE AND SALINITY

Open coast sea temperatures in the GAB vary from a mean summer sea-surface temperature of 18°C to a mean winter sea-surface temperature of 14°C. Generally high salinities is a feature of the GAB, with levels of 35.7% being recorded at 100m depths (Rochford, 1980).

3.2.3 CURRENTS

Four major water masses or currents influence the oceanography of the GAB (Edyvane, 1998). These are:

1. Leeuwin Current
2. Central Bight water mass
3. West Wind Drift cold water mass
4. Surface-flowing Flinders Current.

The West Wind Drift and the Leeuwin Current dominate water circulation on the continental shelf in the GAB. The former is a cool, circumpolar, eastward flowing current. The latter, the Leeuwin Current, is a fast, warm current of low salinity. Originating from the Indian Ocean, it passes from west to east

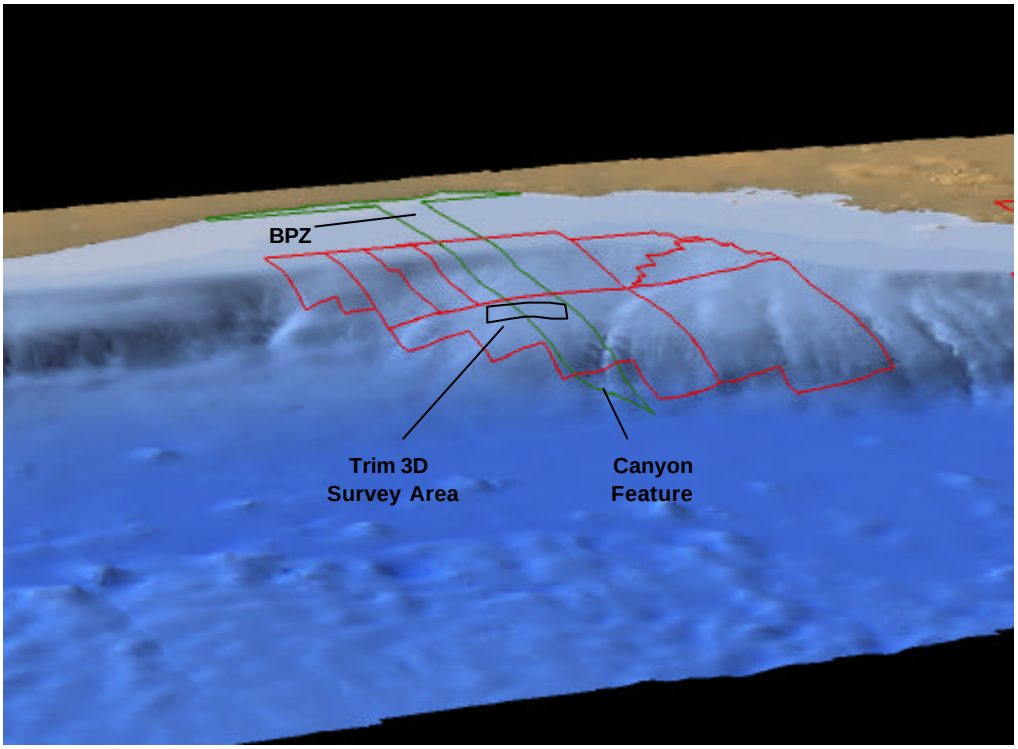
across the Bight mainly during the winter from May to September, ending in a slowly turning knot of whirlpools in the eastern Bight (Cresswell, 1991).

3.3 BATHYMETRY AND SEABED FEATURES

The Great Australian Bight forms part of the Southern Shelf of Australia, which is the northern boundary of the South Australian Basin of the South East Indian Ocean. The Southern Shelf has a maximum width of about 200km in the central Great Australian Bight and narrows to about 20km south of Western Australia and on the Bonney Coast of South Australia. The South Australian Basin has an abyssal plain of depth about 5,500m. Along the Southern Shelf of the Great Australian Bight and the Bonney Coast, in particular south of the Eyre Peninsula, about 25 very large (length 50km, width 5km) and steep (slope 1:10) canyons connect the continental slope and the abyssal plain over the depth range 1-5km. The continental shelf is almost featureless, forming a gentle sloping plain out to the shelf break at 125-165 m depth (Edyvane, 1998).

Water depth across the survey area ranges from approximately 1,200 to 2, 200m The nearest canyon feature is approximately 50km to the south and east of the survey area (refer to Figure 3).

Figure 3: 3D Representation of Bathymetry in the Great Australian Bight



3.4 BIOLOGICAL ENVIRONMENT

3.4.1 REGIONAL

The deep waters of the GAB extend for a length of 1,300km along the southwestern coastline of South Australia and the southern coast of Western Australia. The Bight has a broad continental shelf which is up to 200 km wide in places. The GAB region is an area of great conservation significance. It provides important calving habitat for the endangered southern right whale and colonies of Australia's only endemic pinniped (the Australian sea lion).

3.4.2 SEABED BIOTA

The benthic fauna of the abyssal plain are poorly known, largely due to limited opportunities for sampling, and to date very few areas of the southern Australian continental slope or abyssal plain have been biologically surveyed. Evidence available indicates that the macro-benthic communities are sparsely distributed, and rich in diversity (Commonwealth of Australia 1999). In a 1994 study of the south eastern continental shelf, a total of 359 species, belonging to 36 families were identified. These species were reported to be dominated by echinoderms, ascidians, molluscs, nudibranchs and polychaetes. The benthic fauna of the survey area is not well known.

3.4.3 PROTECTED SPECIES

Results of a search of the EPBC Act Protected Matters Interactive Search Tool indicated that a total of 43 Marine Listed Species, listed under the EPBC Act as Endangered, Vulnerable, Migratory or Cetacean may occur or the species habitat may occur within the survey area (refer to Table 2). This includes a total of 14 sea birds and 29 cetacean species.

Table 2: EPBC Act Protected Species Potentially in Survey Area

Species	Common Name	Category			
		Endangered	Migratory	Marine	Cetacean
Whales					
Balaenoptera acutorostrata	Minke Whale				✓
Balaenoptera bonaerensis	Antarctic Minke Whale		✓		✓
Balaenoptera edeni	Bryde's Whale		✓		✓
Balaenoptera musculus	Blue Whale	✓ (E)	✓		✓
Berardius arnuxii	Arnoux's Beaked Whale				✓
Caperea marginata	Pygmy Right Whale		✓		✓
Eubalaena australis	Southern Right Whale	✓ (E)	✓		✓
Feresa attenuata	Pygmy Killer Whale		✓		✓
Globicephala macrorhynchus	Short-finned Pilot Whale				✓
Globicephala melas	Long-finned Pilot Whale				✓
Kogia breviceps	Pygmy Sperm Whale				✓
Kogia simus	Dwarf Sperm Whale				✓
Megaptera novaeangliae	Humpback Whale	✓ (V)	✓		✓
Mesoplodon hectori	Hector's Beaked Whale				✓
Orcinus orca	Killer Whale		✓		✓
Pepanocephala electra	Melon-headed Whale				✓
Physeter macrocephalus	Sperm Whale		✓		✓
Pseudorca crassidens	False Killer Whale				✓
Ziphius cavirostris	Cuvier's Beaked Whale				✓
Mesoplodon bowdoini	Andrew's Beaked Whale				✓
Mesoplodon densirostris	Blainville's Beaked Whale				✓
Mesoplodon grayi	Gray's Beaked Whale				✓
Mesoplodon layardii	Strap-toothed Beaked Whale				✓
Mesoplodon mirus	True's Beaked Whale				✓

Species	Common Name	Category			
		Endangered	Migratory	Marine	Cetacean
Dolphins					
Delphinus delphis	Common Dolphin				✓
Grampus griseus	Risso's Dolphin				✓
Lagenodelphis peronii	Southern Right Whale Dolphin				✓
Lagenorhynchus obscurus	Dusky Dolphin				✓
Tursiops truncates.	Bottlenose Dolphin				✓
Sea Birds					
Catharcta skua	Great Skua				
Diomedea amsterdamensis	Amsterdam Albatross	✓ (E)	✓	✓	
Diomedea dabbenena	Tristan Albatross	✓ (E)	✓	✓	
Diomedea exulans	Wandering Albatross	✓ (V)	✓	✓	
Diomedea gibsoni	Gibson's Albatross	✓ (V)	✓	✓	
Halobaena caerulea	Blue Petrel	✓ (V)		✓	
Macronectes giganteus	Southern Giant-Petrel	✓ (E)	✓	✓	
Macronectes halli	Northern Giant-Petrel	✓ (V)	✓	✓	
Phoebetria fusca	Sooty Albatross	✓ (V)	✓	✓	
Pterodroma mollis	Soft-plumaged Petrel	✓ (V)		✓	
Thalassarche cauta	Shy Albatross	✓ (V)	✓	✓	
Thalassarche chlororhynchos	Yellow-nosed Albatross			✓	
Thalassarche chysosto ma	Grey Headed Albatross	✓ (V)	✓	✓	
Thalassarche melanophris	Black-browed Albatross		✓	✓	

(E): Endangered; (CE): Critically Endangered; (V): Vulnerable

3.4.4 CETACEANS

Of the 29 species of cetaceans (whales, dolphins and porpoises) that have been recorded in South Australian waters, at least 16 species have been recorded in the offshore waters of the GAB (129º to 135º30" E) (Kemper and Ling, 1991; Bannister *et al.,* 1996; C. Kemper, South Australian Museum, pers. comm..).

The most common animals stranding along the South Australian coastline are bottlenose and common dolphins. Other species frequently stranding along this coast are strap-toothed beaked whales, sperm, minke, long-finned pilot and pygmy sperm whales (C. Kemper, South Australian Museum, pers. comm.). Sightings of many live animals 'at sea' have been reported, especially of southern right whales along the coast and sperm whales and pilot whales further out to sea by aerial surveys conducted to detect tuna schools. The presence of some species appears to be seasonal (humpback whales are probably present during autumn, winter and spring but there are no good records for this) and there is a possibility that the GAB may have important feeding grounds for some species. Beaked whales may be preying on deep-water squid, which are thought to be diverse and abundant in the Ceduna Canyons and on the edge of the continental shelf. Sperm whales (also predators of deep-water squid and fish) may be using the continental slope as a hunting ground during their east-west movements (C. Kemper, South Australian Museum, pers. comm.). Killer whales have also been seen regularly but no seasonal patterns are apparent. Beaked whales may be more likely to occur in the summer months, but there is no hard evidence to confirm this (C. Kemper, South Australian Museum, pers. comm.).

Bottlenose dolphins have been seen on many occasions playing amongst pods of southern right whales within the Marine Park. Humpback, sperm and blue whales calve and nurse their young in warm temperate and tropical waters. The presence of killer whales is possibly due to the abundance of pinnipeds (seals and sea lions) in the region, upon which they feed. The Leeuwin Current has been

suggested as a mechanism for bringing individuals of tropical species (such as Bryde's whale) into temperate southern waters (Kemper and Ling, 1991).

The density and temporal patterns of cetaceans at, and beyond, the shelf break of the GAB is not well understood. Data available suggests that the density of whales is relatively low. During dedicated blue whale sighting cruises in December 1995, undertaken by the IWC (International Whaling Commission) as part of SOWER (Southern Ocean Whale and Ecosystem Research), only three sei whales were observed, two of which were seen in the vicinity of 36°S and 133°E, close to the southern boundary of the EPP30 permit area. Various species of beaked whale (*Mesoplodon* spp. and *Ziphius* spp.) were also sighted during the transect across the GAB (Kato*et al.*, 1996).

A dedicated cetacean (whale, dolphin and porpoise) sighting program was in place for the majority of the Flinders 2D Marine Seismic Survey, which was conducted in 2000. This program involved the use of three dedicated observers each spending five weeks aboard the vessel. Very few marine mammals (13 sightings of 5 species totalling 165 individuals) were observed compared with other visual observation surveys conducted on seismic vessels in different locations. Only three sightings of large whales were recorded, one of a southern right whale well outside the survey area as the vessel transited into Port for crew change, and two other unidentified whales, one baleen and one unknown, within the survey area.

3.4.4.1 BLUE WHALES

Two subspecies of blue whales are recognised – the 'true' blue whale (*Balaenoptera musculus musculus*) and the pygmy blue whale (*Balaenoptera musculus brevicauda*). The Great Australian Bight is listed as a key locality for blue whales in the Action Plan for Australian Cetaceans (Bannister *et al.*, 1996). However, there is very limited information concerning distribution and abundance of both the 'true' blue and the pygmy blue whale in the GAB. Limited information is available on the migratory patterns and movements of both 'true' blues and pygmy blues, although each are known to undertake extensive migrations between warm water breeding areas in the low latitudes and cold water feeding areas in high latitudes (Bannister *et al.*, 1996).

It is recognised that the abundance of blue whales along the southern coastline of Australia increases during the summer period. Animals are observed from October to March along the south-west coast of Australia between Rottnest Island and Cape Leeuwin (McCauley and Duncan, 2001). Blue whales feed almost exclusively on a few species of krill (euphausiids). Given that their range extends across the southern Australian coastline, there is a possibility that blue whales occur in the offshore waters of the central GAB during the summer months.

3.4.4.2 SOUTHERN RIGHT WHALE

The southern right whale is listed as 'Endangered'. Southern right whales seasonally migrate to southern Australian coastal waters in the winter months between May and October to calve and mate, mainly on a three year cycle (Edyvane, 1998). This species of baleen whale feeds on mainly smaller plankton (e.g. pelagic larval crustaceans and copepods) in the open southern ocean during summer and moves to lower latitude breeding grounds during winter.

The breeding and calving aggregation or nursery area at the Head of the Bight is the largest in Australia and one of two major breeding areas in the world. Much of the present knowledge of southern right whale movements and behaviour in Australian waters stems from studies undertaken at the Head of the Bight, where the tall cliffs provide an excellent viewing platform for studying the whales (Burnell and Bryden, 1997), and from regular aerial surveys conducted along the southern Australian coastline (Bannister, 1998). Southern rights are generally observed within the Head of the Bight aggregation area from mid-May to late October (approximately 160 days) (Burnell, 1999). Whale numbers usually reach a peak in July and August, before declining in early October (Burnell and Bryden, 1997).

3.4.4.3 LONG-FINNED PILOT WHALE

Long-finned pilot whales occur in some temperate and sub-polar oceans, and are usually found in deep, offshore waters, although they may be seen in coastal waters (Bannister *et al.*, 1996). The long-finned pilot whales in the Southern Hemisphere are isolated from those in the Northern Hemisphere.

Long-finned pilot whales are often found along the edge of continental shelves, since they prefer deep water. Generally, the shelf edge is an area of increased bottom relief and this has been shown to influence the distribution of pilot whales indeed the largest sighting of whales during the Flinders 2D MSS (7 long-finned pilot whales) occurred near the head of the canyon feature to the south of the proposed survey area (Burton *et al.*, 2001).

3.4.4.4 SEI WHALE

The sei whale is a cosmopolitan species, with a patchy oceanic distribution. It favours temperate, deep offshore habitat more than other species of large whales and has only infrequently recorded in Australian waters (Bannister *et al.* 1996). The movements and distributions of sei whales are often unpredictable and are not well documented. The information suggests that sei whales have the same general pattern of migration as most other baleen whales, although it is timed a little later and they do not go to such high latitudes (Gambell 1985).

3.4.4.5 SPERM WHALE

The sperm whale is the largest of the toothed whales. There are marked differences in size between the sexes, males average 15 to 18m in length, while females average only 11 to 12m (Carwardine 1995). Sperm whales are found the world over, in patchy distributions and generally in deep water (beyond 200m), off the continental shelf. In the Southern Hemisphere, females and young males are generally restricted to warmer waters north of 45oS, while males travel to and from colder waters. Sperm whales are deep divers and have been recorded to dive for over 2 hours, although typical dive time is reported as being less than 45 minutes. Major food includes oceanic cephalapods, deep-sea angler fish and mysid shrimps (Bannister *et al.* 1996).

The distribution and abundance of sperm whales in Australian waters is not well known. Bannister *et al.* (1996) reports that populations are generally restricted to a narrow area only a few miles wide at the edge of the continental shelf. Key locations for sperm whales in Australian waters include the continental shelf edge between Cape Leeuwin and Esperance in WA, south west of Kangaroo Island in SA, off the Tasmanian southern and western coasts and off the coasts of NSW and Queensland.

3.4.4.6 OTHER MARINE MAMMALS

Other pelagic, oceanic cetacean species may occur in the survey area, including killer whales, Risso's dolphin and common dolphin.

Killer whales are likely to be found in oceanic, pelagic and neritic (shallow marine environments extending from mean low water down to 200m depths, generally corresponding to the continental shelf) habitats most commonly in cold deep waters. Off Australia, they are often seen along the continental slope and on the shelf as well as often being seen near seal colonies (Bannister *et al.*, 1996). Although not a migratory species, their movements vary seasonally and are related to food supply (Bannister *et al*, 1996).

Risso's dolphin is generally considered a pelagic and oceanic species and is frequently seen over the continental slope (Bannister *et al.*, 1996). The common dolphin generally frequents neritic, pelagic and oceanic habitats. This species has been associated with high topographical relief of the ocean floor and escarpments (Bannister *et al.,* 1996) and may occur in or around the survey area.

3.4.4.7 AUSTRALIAN SEA LION

The Australian sea lion is the only pinniped (seals and sea lions) endemic to Australia and is one of the rarest and most endangered marine mammals in Australia (Gales, 1990). The species is categorised as 'Rare' under South Australian legislation, as 'Lower Risk, Near Threatened' under the Action Plan for

Australian Seals (Shaughnessy, 1999) and 'Rare' by the IUCN. Australian sea lions are mostly found on the Western Australian and South Australian coasts. Sea lion populations in the GAB region of South Australia have been estimated at between 613 and 744, which represents approximately 9.3% of the South Australian population or 6.6% of the total world population for this species (Dennis and Shaughnessy, 1996).

3.4.4.8 New Zealand Fur Seal

The New Zealand fur seal, a common species widely distributed in New Zealand, also occurs across the GAB and southern Tasmania. Only small numbers of this species are found dispersed. throughout the GAB, indicating that they do not breed there (Dennis and Shaughnessy, 1996). A survey of fur seal sightings along the coastline of the GAB identified approximately 12 New Zealand fur seals (Dennis and Shaughnessy, 1996). There are small breeding colonies of New Zealand fur seals on some islands off the south-west corner of the Eyre Peninsula (Shaughnessy, 1994). New Zealand fur seals feed on squids and barracouta which live near the surface but also dive deep for octopus and spiny lobsters. Fur seals generally forage on the shelf break where they target vertically migrating species such as squid.

3.4.5 Fish

3.4.5.1 Grey Nurse Shark

The grey nurse shark (eastern population) (*Carcharius taurus*) is highly unlikely to occur in the survey area. While there are historical records of this shark from all around Australia there are no current records of this species occurring in Oceanic waters of the GAB

3.4.5.2 Great White Shark

The Great White Shark (*Carcharodon carcharias*), listed as 'vulnerable' has also been observed in the GAB. Great white sharks appear to range widely, remaining resident in one locality for periods of only days or (rarely) weeks according to observations by fishermen, divers and marine scientists. The breeding characteristics of great white sharks are not known. Great whites have been tagged with transmitters by CSIRO in recent years. The most recent shark (Neale) was tagged near Corner Inlet in eastern Bass Strait and travelled a total of 3,000km over a 4 month period. The track included two Bass Strait crossings – probably east of Flinders Island. Neale's track concluded at Coffs Harbour in New South Wales.

3.4.6 Seabirds

The 14 species of sea bird listed in Table 2 are mostly migratory and although all these species may fly over the survey area and possibly forage in the area, they are highly unlikely to be impacted by the activity. Very little information on seabirds has been collected in the GAB, particularly with regard to feeding and nesting aggregations. Non-breeding migratory seabirds such as albatross, petrels and prions are known to frequent the coastal and shelf regions of the GAB, but to an unknown degree (Copley, 1995). Many seabird species, such as short-tailed shearwaters and whitefaced storm petrels probably, feed in the area and/or breed wholly or largely on the offshore islands of the GAB (e.g. Nuyts Archipelago and Franklin Islands) (Copley, 1995). Pilchards are an important food item for a number of seabirds and calamari and cuttlefish are important prey for some albatross species.

3.4.7 Plankton

Distribution of plankton in the Southern Ocean and in the survey area is largely influenced by ocean currents and sea temperatures. Measures of phytoplankton and zooplankton densities in the GAB indicate unusually low productivity levels (e.g. phytoplankton standing crop average of ~12mg chlorophyll *a*/m^2 and zooplankton biomass of ~7mg wet weight /m^3, Motodo *et al.,* 1978). The low productivity values in the GAB have been attributed to lack of nutrient replenishment from the land and absence of upwelling of deep water (Motoda *et al.*, 1978, Herzfeld et al., 1998).

3.5 SOCIO-ECONOMIC ENVIRONMENT

3.5.1 PARKS AND RESERVES

A proportion of the survey area will overlap the Benthic Protection Zone (BPZ) of the Great Australian Bight Marine Park (Commonwealth Waters) as illustrated by Figures 1 and 4.

The Great Australian Bight Marine Park (Commonwealth Waters), which was declared in 1998, is a Commonwealth Reserve under the EPBC Act. It is made up of two overlapping areas, the Marine Mammal Protection Zone, and the Benthic Protection Zone (BPZ).

The Marine Mammal Protection Zone of the Park is for the purpose of complementing the South Australian Government's Great Australian Bight Marine National Park in the conservation of the southern right whale and the Australian sea lion. The Benthic Protection Zone is for the purpose of conserving a representative strip of the unique benthic environments in the Great Australian Bight as part of the Commonwealth Government's commitment to a National Representative System of Marine Protected Areas

The Management Plan for the GAB Marine Park (Commonwealth Waters) sets out a risk-based approach to setting levels of protection as information is gathered and assessed. The BPZ of the Great Australian Bight Marine Park (Commonwealth Waters), is a multiple use marine park, which extends in a 20 nautical wide strip north-south from the State Marine Park for 200 nautical miles south, to the edge of the Exclusive Economic Zone, comprising approximately 1.3 million hectares.

3.5.2 COMMERCIAL FISHERIES

The fish fauna of the Commonwealth waters from the Western Australian border to just west of Cape Adieu (between three nautical miles and the limit of the Australian Fishing Zone at 200 nautical miles) support several commercially significant fisheries. They are subject to management under the Commonwealth *Fisheries Management Act 1999*.

The area of fisheries are illustrated by Figure 4. The two most important in economic terms are the Southern Bluefin Tuna Fishery and the Southern Shark Fishery.

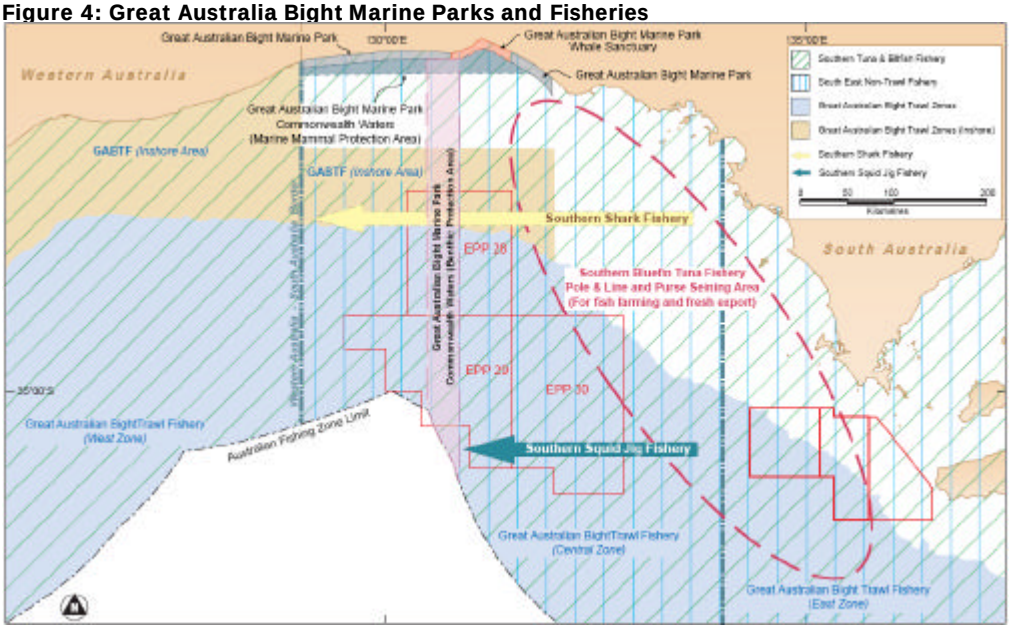
Southern Bluefin tuna are large (up to 200kg), long lived (up to 40 years or more) and highly migratory pelagic fish. Research of this species suggests that they are of single stock or population. The Bight appears to be an important feeding and nursery ground during the summer for this species (Cowling *et al.* 1996). The fishery is presently concentrated in the South Australian sector of the Bight, although previously was more evenly spread throughout the entire Bight (Jones: 1991).

The Southern Shark Fishery has operated for more than 60 years, and is located in Commonwealth waters adjacent to the States of Victoria, Tasmania and South Australia. Important temperate species of shark in Bight waters include the school shark (*Galeorhinus galeus*), the gummy shark (*Mustellus antarcticus*) and the bronze whaler (*Charcharinus brachyurus*). The Australian Fisheries Management Authority (AFMA) manages this fishery on behalf of the States and Commonwealth. The two main methods of capture are with demersal gill nets and long-lines.

The Great Australian Bight Trawl Fishery extends from Kangaroo Island, off South Australia, to Cape Leeuwin in Western Australia, encompassing an area of about 812,000km^2. This is primarily a demersal and developmental mid-water trawl fishery based around regular catches of inshore species and exploratory trawling for the deeper dwelling species. The fishery has two basic components: the continental shelf fishery, in depths of 100 to 150m and the deeper slope fishery, in depths between 200 and 1,000m. Although the southern boundary extends to the limit of the Australian Fishing Zone fishing is essentially confined to a narrow margin of the continental shelf and slope in depths of less than 1,200m (Bureau of Resource Sciences, 1994).

The Southern Jig Fishery extends from the northern New South Wales coast to the Southern Australian/Western Australian Border. Arrow Squid (*Nototodarus gouldi*) is the principle species of this fishery. Squid jig catches are concentrated during the period of January to June off the Victorian coastline (specifically from Queenscliff and Portland). In contrast, Arrow Squid in South Australia is more commonly taken as bycatch within the Great Australian Bight Trawl Fishery.

Figure 4: Great Australia Bight Marine Parks and Fisheries



3.5.3 SHIPPING

A major shipping lane passes to the south of the proposed survey area, although there is little shipping activity within the survey area.

3.5.4 RECREATIONAL USE

Due to the distance offshore there is very little recreational activity in the survey area.

4 DESCRIPTION AND ASSESSMENT OF ENVIRONMENTAL RISKS AND EFFECTS

4.1 POTENTIAL ENVIRONMENTAL EFFECTS

The components of the seismic survey that could result in significant environmental effects have been determined through an evaluation of the proposed activity, the surrounding environment and the legislative requirements. The activities with potential to cause significant environmental effect include:

- Operation of the seismic vessel and towing of the acoustic energy source and streamer (hydrophone) arrays through the survey area
- Discharge or 'firing' of theacoustic energy source arrays
- Routine waste discharges from the survey vessel
- Accidental fuel and oil spills from the survey vessel
- Accidental loss of streamers and associated equipment.
- Introduction of exotic species

Although the risk is considered to be remote, each of these activities has the potential to result in detrimental impacts on the physical, biological and socio-economic environment of the area. The key potential environmental aspects associated with the proposed Trim 3D MSS are discussed in the following sections.

4.2 DISTURBANCE TO MARINE FAUNA

McCauley (1994) provides a detailed review of the potential effects of seismic acquisition on marine animals. The review was undertaken by an Independent Scientific Review Committee (ISRC), chaired by Professor John Swan, and commissioned by the Australian Petroleum Exploration Association (APEA) and the Energy Research and Development Corporation (ERDC). The ISRC report examined all aspects of the possible effects of seismic surveys on marine life, from whales to plankton. Potential impacts on hearing, and behaviour at different stages of development were studied. The ISRC report concluded on this note:

> *"Given the relatively small scale of seismic activity, the often large scales over which biological events occur, and the low probability of encounter between seismic surveys and 'at risk' populations at an appropriate time and place, then the wider implications of disruption by seismic surveys appear to be small for most species …. However the risks increase dramatically when seismic surveys are conducted in or adjacent to aggregation areas for 'at risk' populations".*

4.2.1 SONIC DISTURBANCE

According to the ISRC report, environmental issues relating to seismic surveys have largely focused on the potential effects to fish stocks and marine mammals from the sound waves associated with the seismic energy source. Concerns have included:

- Pathological effects (lethal and sub-lethal injuries) – immediate and delayed mortality and physiological effects to nearby marine organisms
- Behavioural change to populations of marine organisms
- Disruptions to feeding, mating, breeding or nursery activities of marine organisms in such a way as to affect the vitality or abundance of populations
- Disruptions to the abundance and behaviour of prey species for marine mammals, seabirds and fish
- Changed behaviour or breeding patterns of commercially targeted marine species, either directly,

or indirectly, in such a way that commercial or recreational fishing activities are compromised.

4.2.2 PATHOLOGICAL EFFECTS

The response of marine fauna to marine seismic survey sounds will range from no effect to various behavioural changes. Immediate pathological effects are likely to be restricted to very short ranges and high sound intensities and are unlikely to occur for the majority of species, as most free-swimming animals will practice avoidance manoeuvres well before they get within the ranges at which pathological effects may occur. Table 6 lists pathological effects observed to occur as a result of exposure to seismic survey noise under controlled conditions.

Table 6: Observed Seismic Noise Pathological Effects

Species	Source	Level (dB re 1µPa @ 1m)	Distance From Source (m)	Exposure Level (dB re 1µPa)	Observed Effect	Reference
Fish and Plankton						
Cod (adults)	Single airguns and arrays, 1,000 – 20,000 cm3	220-240 (estimated)	0.5	226 – 246	Haemorrhaging and eye damage	Kosheleva, 1992
			1.0	220 - 240	No harmful effects	
Cod (adults)	Electrically generated signal in laboratory conditions	Not stated	Not stated	192 – 198	Transient stunning, no subsequent mortalities	Hastings, 1990
Cod (larvae 5 days)	Single airgun	250	1	250	Delamination of the retina	Matishov, 1992
Cod (larvae 2- 110 days)	Single airgun	222	1	222	No injuries detected	Dalen and Knutsen, 1987
			10	202	No injuries detected	
Fish eggs Anchovy	Single airgun	230 dB (estimated)	1	230	7.8% of eggs injured relative to control	Kostyvchenko, 1973
			10	210	No injuries detected	
Fish eggs Red Mullet			1	230	No injuries detected	
			10	210	No injuries detected	
Dungeness crab (larvae)	Seven airgun array	244 (estimated)	1	233.5	No significant difference in survival rate relative to controls	Pearson *et al*., 1994
			3	230.9		
			10	222.5		
Benthic Species						
Mussel Periwinkles	Single airgun	223 (estimated)	0.5	229	No detectable effect, all three groups continued to function normally after airgun exposure. Monitoring over next 30 days revealed no adverse effects.	Kosheleva, 1992

4.2.3 DISTURBANCE TO PLANKTONIC ORGANISMS

Except for larvae, fish eggs and other minute planktonic organisms within a few metres of an air-gun, no planktonic organisms are likely to significantly affected by air-gun array discharges (McCauley, 1994). Data presented in Table 6 indicates that the range of pathological effects on plankton is likely to be restricted to less than approximately 2m. Any effect of the seismic source on planktonic organisms is insignificant compared with the size of the planktonic population in a survey area or natural mortality rates for planktonic organisms.

4.2.4 DISTURBANCE TO INVERTEBRATES

4.2.4.1 SQUID

Little is known about the hearing ability of cephalopods. The few papers on cephalopod hearing suggest that their hearing is less sensitive than most fish and that the most sensitive frequencies are between 10 and 200 Hz. (Packard et al., 1990).

The results of experiments to measure lethal effects of seismic acoustic sources on squid were reported by Norris and Møhl (1983). They observed short-term tolerance of sound levels to 260 dB re 1 µPa by one species but lethal effects at levels of 246 to 252 dB re 1 µPa for another. This suggests that lethal effects to squid would only occur within very close proximity (i.e. less than a metre) of the airguns.

McCauley et al., (2000) reported on the reactions of caged squid to an airgun. They found alarm responses at 156-161 dB re 1 µPa. rms. and strong startle response at 174 dB re 1 µPa rms involving ink ejection and rapid swimming. The caged squid also moved to use the sound shadow near the surface to reduce the sound pressure levels. The observed alarm response suggest that squid would likely move outside the lethal range of a sound source. This level of received noise energy equates to a distance of about 2,000m from the airgun source. Any possible effects on squid mortality produced by extra swimming caused by the alarm response are unknown.

4.2.4.2 KRILL

Krill are important prey for protected whale species. Their distribution and abundance is also fundamental to many other animals. There have been no studies specifically on the effects of noise on krill. Crustaceans are thought to be insensitive to sound which they detect through mechanoreceptors. In separate reviews of available literature McCauley (1994) and Hirst and Rodhouse (2000) hypothesise that most invertebrates would only detect seismic shots within a range of about 15 to 20m . Hirst and Rodhouse (2000) found only two studies that observed catch levels of shrimp and lobster in areas surveyed with airguns. Both studies reported no change during surveys.

Assuming that krill will be affected in a similar way to fish eggs and juveniles (see Table 6 above), there will be very localised mortality within a few metres radius around an operating low frequency, high energy source. The effect on fish eggs and planktonic larvae is insignificant compared with the size of the planktonic population in a survey area or natural mortality rates for planktonic organisms.

4.2.5 DISTURBANCE TO FISH

There appears to be a wide range of susceptibility among fish; however, those with a swim bladder will be more susceptible than those without this organ. Many adult fishes, including the elasmobranchs (sharks and rays) do not possess a swim bladder and so are not susceptible to swim bladder-related trauma. Most pelagic fish are expected to swim away when seismic noise reaches levels at which it might cause pathological effects; however, the presence of many open sea fish near operating vessels suggest that some of these species are hardly affected by the sounds at all.

Studies with caged fish (Kosheleva, 1992 and McCauley et al., 2002b) have shown that some fish species that are caged, and therefore unable to swim away from the noise source, can suffer physiological damage to eyes and hearing. Conditions that could result in fish being trapped and unable to move more than a few metres from the noise source as the survey vessel traverses the area

do not exist in the proposed survey area (indeed it is difficult to conceive of any vessel-based seismic survey causing fish to be trapped within a few metres of the noise source). Therefore it is considered that the risk of physiological effects on fish is negligible.

For some fish, strong 'startle' responses have been observed at sound levels of 200 to 205 dB re 1µPa, indicating that sounds at or above this level may cause fish to flee. Sound levels of this level are likely to occur approximately 100 to 300m from an acoustic energy source array. Based on this an approximate range of 200m is given as the minimum distance at which fish may flee from an operating array and below which pathological effects may occur (McCauley, 1994). Based on existing information, significant impacts on fish populations resulting from seismic survey noise are likely to be restricted to:

- Short ranges and high sound intensities (ie <200m range from source)
- Populations that cannot move away from operating arrays (eg shallow water site-attached benthic species)
- Surveys that take place over protracted periods close to areas important for the purposes of feeding, spawning or breeding
- Surveys that take place over protracted periods close to areas that constitute narrow restricted migratory paths.

Fish may possibly be exposed to noise levels sufficient to cause startle response or pathological damage if air-gun arrays start suddenly. In circumstances where arrays are already operating (as a vessel moves along an acquisition line), individuals would be expected to implement avoidance measures before entering ranges at which pathological damage might take place. There are no narrow or restricted areas within the proposed survey areas that could 'trap' fish.

4.2.6 DISTURBANCE TO CETACEANS

Cetaceans employ an extremely acute acoustic sense to monitor their environment and are correspondingly sensitive to sounds below and, to a lesser extent, above the water surface (Richardson *et al.*, 1995). Sound waves created from seismic operations, if they are of high enough intensity, may interfere with the acoustic perception and communication of any cetaceans in the vicinity, and may have the potential to induce stress.

4.2.6.1 BALEEN WHALES

Baleen whales produce a rich and complex range of underwater sounds ranging from about 12 Hz to 8 kHz but with the most common frequencies below 1 kHz (McCauley, 1994). This, combined with studies of their hearing apparatus, suggests that their hearing is also best adapted for low frequency sound (McCauley, 1994; Richardson et al., 1995). Baleen whales make individual sounds that last for up to 16 seconds (Richardson et al., 1995) and can "sing" for long periods. These sounds are thought to be used in social interaction and communication between individuals and pods.

Richardson et al (1995) summarised published baleen whale sound characteristics. Table 7 lists the estimated source levels, frequency ranges and dominant frequencies of baleen whale calls for species that may be encountered during the proposed survey. The individual papers from which these figures are obtained are listed in Richardson et al (1995) [Table 7.1]. It can be seen that some species produce quite high sound levels. Likewise, McCauley et al (1998) report humpback and southern right whale song components reaching 192 db re 1 μPa^2 (p-p) as well as levels of 180 to 190 db re 1 μPa^2 (p-p) for humpback flipper slapping and breaching sounds.

Physical damage to the auditory system of cetaceans may occur at noise levels of about 230 to 240 dB re 1µPa (Gausland, 2000), which is equivalent to a distance of about 1 to 2m from the energy source. Because of the good swimming abilities of marine mammals and their avoidance of either the vessel or the acoustic energy source array, it is highly unlikely that any marine mammals will be exposed to levels likely to cause pathological damage (McCauley, 1994).

Table 7: Sounds Produced By Baleen Whales That May Be Encountered During Proposed Survey

Species	Frequency (Hz)	Dominant frequency (Hz)	Estimated Source Level (db re 1µPa.m)
Blue	12 - 31,000	16 - 25, 6,000 – 8,000	130 – 188
Fin	10 - 28,000	20, 1500 - 2500	155 – 186
Humpback	25 – 8,200	25 – 4,000	144 – 192
Minke Sei	60 - 20,000 1,500 – 3,500	60 - 12. 000	151 - 175
Southern right	30 – 2,200	50 - 500	172 -192

Noise associated with acoustic energy sources used during seismic surveys can cause significant behavioural changes in whales (McCauley 1994). Behavioural responses to acoustic energy source noise include swimming away from the source, rapid swimming on the surface and breaching (McCauley et al., 1998, 2000). The level of noise at which response is elicited varies between species and even between individuals within a species (Richardson et al., 1995). Stone (2003) suggests that different groups of cetaceans adopt different strategies for responding to acoustic disturbance from seismic surveys with baleen and killer whales displaying localised avoidance, pilot whales showing few effects and sperm whales showing no observed effects. Richardson et al (1995, at p. 300) notes that

'*Baleen whales seem quite tolerant of low and moderate level noise pulses from distant seismic surveys. They usually continue their normal activities when exposed to pulses with received levels as high as 150 dB re 1µPa, and sometimes even higher*'.

This noise level equates to a distance of about 2,000 m from the source of the size proposed for this survey.

A comprehensive study carried out by McCauley et al (1998) monitored the effects of seismic survey noise on humpback whales in the Exmouth Gulf region of Western Australia. The following conclusions were drawn from this research:

- Only localised avoidance was seen by migrating whales during the seismic operation, indicating that the 'risk factor' associated with the seismic survey was confined to a comparatively short period and small range displacement
- Coupled with the fact that humpback whales were seen to be actively utilising the 'sound shadow' near the surface, then it is unlikely that animals will be at any physiological risk unless at very short range from a large air-gun array, perhaps of the order of a few hundred metres
- Upper levels of noise at 1.5 km from the seismic survey array are in the order of 182 dB re 1µPa^2, which is still well below the source levels of the highest components of humpback whale song (192 dB re 1µPa^2). Thus at 1.5 km the received air-gun signal is still well within the range which humpback whales would be expected to cope with physiologically, since it would be difficult to argue that humpback whale song can cause physiological problems to the animals (McCauley, 1994).

Blue whales 'call' in the frequency range 10 to 20 hz at noise levels of up to 183 dB re 1µPa. It is probable that they can hear over a much wider range that encompasses, at least in part, the frequency at which the acoustic energy sources will operate. McCauley has summarised reported observations of blue whales and seismic made by McDonald et al (1995) as follows:
'*They used a grid of sea floor recorders, put down to monitor natural seismic noise from a seafloor spreading ridge, to record and localise blue and fin whale vocalisations. As part of their work program they used a small air-gun array to obtain geophysical data. They were thus able to follow several calling blue and fin whale movements, with respect to their air-gun array, and to the passage of merchant shipping. They did not observe any detectable changes in the movement or calling patterns of blue whales subjected to air-gun noise estimated to be 143 dB re 1µPa p-p at the whale, or to*

merchant shipping noise estimated to be up to 106 dB re 1µPa msp at the whale. The peak-peak levels are approximately 16 dB above the msp value. Thus the received air-gun level at which no detectable responses were observed, was around 127 dB re 1µPa msp.'

Based on this it would be expected that blue whales would show no detectable response beyond a range of 3 to 5km from the source, depending on heading of the source and seabed conditions. This is supported by recent aerial observations (John Hughes, Santos, *pers comm*, 7 April 2004) made from aircraft during seismic survey operations off Kangaroo Island, South Australia in December 2003, where a blue whale cow/calf pair were observed at a range of 7km from a seismic vessel which was discharging its normal (full) acoustic energy source array. The pair were then seen to approach to within 3km of the vessel, at which point the vessel ceased acoustic energy source discharges.

With regard to avoidance behaviour by baleen whales, it is known that baleen whales will avoid operating seismic vessels and the distance over which the avoidance occurs seems to be highly variable between species and even within species. It is considered that this avoidance behaviour represents only a minor effect on either the individual or the species unless avoidance results in displacement of whales from nursery, resting or feeding areas, at an important period for the species. The Trim survey area is not a known critical habitat for any cetacean species. The timing of the survey avoids the peak migratory periods for southern right, humpback and blue whales. The survey area is not a recognised aggregation area for blue whales.

It is considered that the potential adverse effect on baleen whales is likely to be minor. This conclusion is supported by the Environment Australia *Guidelines on the Application of the Environment Protection and Biodiversity Conservation Act to Interactions Between Offshore Seismic Operations and Larger Cetaceans* and implicitly by the Department of Environment and Heritage's decision that the proposed survey is not a controlled action under the *EPBC Act*.

4.2.6.2 TOOTHED WHALES

Toothed whales produce a wide range of whistles, clicks, pulsed sounds and echolocation clicks. Table 8 summarises the frequency and source levels reported in Richardson et al (1995) for species that may be encountered during the proposed survey. The frequency range of toothed whale sounds excluding echo location clicks are mostly <20 kHz with most of the energy typically around 10 kHz, although some calls may be as low as 100 to 900 Hz. Source levels range from 100 to 180 dB re 1 µPa (Richardson et al, 1995). The sounds produced other than echo location clicks are very complex in many species and appear to be used for communication between members of a pod in socialising and coordinating feeding activities.

There is little systematic data on the response of toothed whales to seismic surveys. Richardson et al (1995) reports that sperm whales appeared to react by moving away from surveys and ceasing to call even at great distances from a survey. However in a recent study supported by the US Minerals Management Service (Jochens and Biggs, 2003) two controlled exposure experiments were carried out (including one with three simultaneously tagged whales) to monitor the response of sperm whales to seismic source. The whales were exposed to a maximum received level of 148 dB re 1µPa. There was no indication that the whales showed horizontal avoidance of the seismic vessel nor was any there any detected change in feeding rates of the tagged sperm whales.

Smaller toothed cetaceans have poor hearing in the low frequency range of air-gun array noise (10-300 Hz), so may be able to approach operating seismic vessels closely without adverse behavioural or pathological effects (McCauley, 1994).

Goold (1996) studied the effects of 2D seismic surveys on common dolphins (*Delphinus delphis*) in the Irish Sea. The results indicated that there was a local displacement of dolphins around the seismic operation. However, observations indicated that the animals were tolerant of the sounds at distances outside a 1km radius from the guns.

The hearing capability of larger toothed whales (such as the killer whale) is unknown, but it is possible that they can hear better in the lower frequencies than the smaller toothed cetaceans. If this is the case, in lieu of any other information, their reactions to seismic survey vessels may be akin to those of the baleen whales.

Table 8: Frequency and Source Range For Toothed Whale Species That May Be Encountered During Survey

Species	Call frequency (kHz)	Dominant Frequency (kHz)	Source level (dB re µPa.m)	Echo location frequency (kHz)	Echo location source level (db re 1µPa.m)
Bottlenose dolphin	0.8-24	3.5 - 14.5	125 - 173	110 - 130	218 - 228
Common dolphin		2 - 18		23 - 67	
False killer		4 - 9.5		25-30, 95-130	220 - 228
Killer	0.5 - 25	1 - 12	160	12 - 25	191.1
Long-finned pilot	1 - 18	1.6 - 6.7		6-117	
Pygmy sperm	60 - 200	120			
Sperm	0.1 - 30	2-4, 10-16	160-180		

4.2.7 DISTURBANCE TO SEALS

The hearing capacity of seals is not well understood and only a small amount of data is available from captive seals from the northern hemisphere. Otariid seals (fur seals and sea lions) seem to have poorer hearing than phocids below 1 kHz and their high frequency cut off is at 36 to 40 kHz (Richardson et al., 1995).

The acoustic energy source array proposed will produce noise pulses at frequencies predominantly in the range of 10 to 100 Hz. This frequency is below the predicted sensitivity of seals. Anecdotal stories of seals approaching working seismic vessels support the prediction that seals would be unaffected by the proposed seismic survey. Richardson et al (1995) [p. 291] concludes '*Thus we might expect seals to be rather tolerant of, or habituate to underwater sounds from distant seismic sources*'.

4.3 INTERFERENCE WITH COMMERCIAL FISHING

Only limited commercial fishing activity takes place in the survey area. It is not expected that the survey will cause any significant disruption to commercial fisheries.

4.4 INTERFERENCE WITH SHIPPING

Shipping in the area is not significant and it is unlikely that the survey will cause any disruption to shipping activity in the region.

4.5 WASTE DISPOSAL

Routine discharges from seismic survey vessels are restricted to treated sewage and putrescible wastes (food scraps).

4.5.1 SEWERAGE AND PUTRESCIBLE WASTES

All discharge of untreated sewage is prohibited. There is a gradation of the level of treatment required for discharge of treated sewage effluent from ships depending on the distance from the coastline:

- Within less than three nautical miles of the coastline sewage must not be discharged unless it has been treated via a sewage treatment plant certified as meeting requirements of Regulation 3 of the Annex IV of the MARPOL Convention, and the discharge must not produce visible floating solids or cause discoloration of the waters.
- Between three and 12 nautical miles sewage must not be discharged unless it has been treated from a sewage treatment plant certified as meeting requirements of Regulation 3 of the Annex IV of the MARPOL Convention or comminuted and disinfected. If the discharge has only been treated by comminution and disinfection then the discharge can only occur when the vessel is under way at speed of greater than four knots.
- Beyond 12 nautical miles the discharge must as a minimum be ground such that it can pass through a 25 mm mesh and can only be discharged when the vessel is under way at speed of greater than four knots.

The discharge of sewage and putrescible wastes overboard may cause a slight increase in the nutrient content in the water column although the total nutrient loading from the survey vessel is insignificant in comparison to the natural daily nutrient flux that would occur in the region.

4.5.2 OTHER WASTES

The survey vessel produces a variety of other solid and liquid wastes including packaging and domestic wastes (such as aluminium cans, bottles, paper and cardboard) and hazardous materials such as 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. All of these materials could potentially impact the marine environment if discharged in significant quantities; however, routine procedure will be for all wastes (other than sewage and putrescible food scraps) to be returned for recycling/disposal onshore.

4.6 FUEL AND OIL SPILLS

The potential for spillage of oil or fuel (separate to loss of streamer which is discussed below) is similar to the risk associated with normal maritime activities in the area, such as fishing fleet and general transport activities. Due to the short duration of the project it is not expected that refuelling will be necessary. In the event that offshore refuelling is necessary the refuelling operation will be carried out in accordance with AMSA regulations, following notification to the Woodside Project Manager.

In the event of damage to or loss of a streamer, potential environmental effects will be limited to:

- Effects on water quality resulting from the release of streamer fluid (ISOPAR M: a mixture of light, hydrotreated petroleum distillates, predominantly C_{12}-C_{15} isoparaffinic hydrocarbons, very similar to kerosene) to the marine environment.
- Physical impacts on benthic communities arising from the cable and associated equipment sinking to the seafloor. Streamers have automatic flotation devices that activate at a depth of approximately 50 m; therefore, it is unlikely that any physical impacts would occur.
- Potential chemical/biological impacts on demersal and pelagic communities arising from slow leakage of ISOPAR M, as individual sections of the cable are punctured.

Because of the nature of the streamer fluid, expected weather and sea-state conditions, and the relatively small volumes likely to be released (typical release volume on the event of a rupture is in the order of 20 litres), spillages of ISOPARm are likely to disperse and weather rapidly. As a result of this, there will be minimal opportunity for any adverse effects on water quality or biota in the area.

4.7 INTRODUCTION OF MARINE PESTS

Marine pests are species that have been introduced to an area outside of their normal range and have survived, become established and become a threat to ecological and/or other concerns. Successful invasion of a natural community requires both a source of introduction and for the species to survive. Not all species that are introduced to an area outside of their range survive to become an invasive species. Most introduced species fail to establish (Williamson and Fitter, 1996). The invasiveness of a species can be considered to be a function of the frequency of introductions and the ability of the species to survive and flourish (Lonsdale 1999).

Marine pests are generally introduced to an area in one of two ways. Firstly, marine organisms may be taken up with ballast water loaded at one site and then transported and discharged at another site, these organisms include plankton, algae, invertebrates and fish. Secondly, ships may carry marine organisms from place to place attached to their hulls. Fouling communities can be complex with a multitude of species present.

4.7.1 BALLAST WATER

Translocation of marine organisms in ballast water has received considerable attention in recent years. The Australian government has placed a high priority on preventing the introduction and spread of marine pests. The Australian Ballast Water Management Advisory Council (ABWMAC) was appointed by the Minister for Primary Industries and Energy in May 1996.

The Australian Quarantine Inspection Service (AQIS) is the lead agency for management of international vessels ballast water. Australia was the first country in the world to introduce voluntary ballast water management guidelines for shipping. AQIS has recently (1st July 2001) introduced mandatory ballast water management requirement for international shipping. These requirements have legislative force under the *Quarantine Act 1908* (C'th).

In essence the mandatory '*Australian Ballast Water Management Requirements*' mean that all international vessels are prohibited from discharging 'high risk' ballast water in Australian ports. AQIS provide a Decision Support System which provides masters of vessels with a risk assessment of the likelihood of introducing exotic species into Australian ports or waters. Ballast water assessed as being 'high risk' must not be discharged into Australian ports or waters. Vessel masters are given flexibility in the manner by which this requirement is to be met.

The seismic survey vessel will be contractually obliged to comply with the AQIS ballast water management requirements.

4.7.2 HULL FOULING

There are no regulatory requirements in place within Australia that deal specifically with the controlling the translocation of marine organisms as hull fouling. Commercial seismic survey vessels have their hulls cleaned regularly and are treated with antifouling paints to prevent the establishment and growth of fouling communities. This means that the presence of fouling communities is usually much less on commercial seismic survey vessels than on smaller or non-commercial vessels.

5 RISK ASSESSMENT

The environmental risks associated with the proposed seismic operations have been assessed by a methodology that:

1. Identifies the activity and the environmental aspects associated with it
2. Identifies the values/attributes at risk within and adjacent to the survey area
3. Defines the potential environmental effects of the activity
4. Identifies the likelihood of occurrence
5. Identifies the consequences of potential environmental aspects
6. Determines overall environmental risk levels using a likelihood and consequence matrix

The overall method applied is consistent with that described within AS/NZS 4360 however the terminology used for ranking of likelihood and consequence differ slightly in accordance with emerging industry standards. The terminology used in the assessment of likelihood and consequence are defined in the following Sections.

5.1 ASSESSMENT OF LIKELIHOOD OF OCCURRENCE

The likelihood of occurrence for the key potential environmental impacts from the survey (see Section 4) have been estimated based on industry incident reporting. Quantitative probabilities have been determined as the number of occurrences per year based on the methods described by Stoklosa, 1998.

Likelihood of Occurrence	Quantitative Probability
Virtually certain	More than once per year
Likely	Once every 1 to 100 years
Unlikely	Once in every 100-10,000 years
Rare	Once every 10,000-1,000,000 years
Virtually impossible	Once in more than 1,000,000 years

5.2 CATEGORISATION OF ENVIRONMENTAL CONSEQUENCES

Environmental consequences arising from potential environmental aspects of the survey have been categorised from Negligible to Disastrous, using the qualitative methodology described by Stoklosa (1998) shown below.

Category of Effect	Qualitative Description of Environmental Effects
Negligible	Possible incidental impacts to flora and fauna in a locally affected environmental setting. No ecological consequences.
Minor	Reduction of the abundance/biomass of flora and fauna in the affected environmental setting. No changes to biodiversity or ecological system.
Major	Reduction of abundance/biomass in the affected environmental setting. Limited impact to local biodiversity without loss of pre-incident conditions.
Severe	Substantial reduction of abundance/biomass in the affected environmental setting. Significant impact to biodiversity and ecological functioning. Eventual recovery of ecological systems possible, but not necessarily to the same pre-incident conditions.
Disastrous	Irreversible and irrecoverable changes to abundance/biomass in the affected environmental setting. Loss of biodiversity on a regional scale. Loss of ecological functioning with little prospect of recovery to pre-incident conditions.

5.3 OVERALL ENVIRONMENTAL RISK ASSESSMENT

The Table below shows the overall environmental risk assessment matrix (also referred to as an event potential matrix) that compares the likelihood and consequences of key environmental aspects arising from the survey and assigns a level of risk.

Table 9: Generic Environmental Event Potential Matrix

CONSEQUENCE	LIKELIHOOD				
	Virtually Impossible ($<10^{-6}$/year)	Rare (10^{-6}-10^{-4}/year)	Unlikely (10^{-4}-10^{-2}/year)	Likely (10^{-2}-10^{-1}/year)	Virtually Certain (>1-10^{-1}/year
Negligible	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE
Minor	NEGLIGIBLE	NEGLIGIBLE	TOLERABLE	TOLERABLE	TOLERABLE
Major	TOLERABLE	TOLERABLE	TOLERABLE	TOLERABLE	TOLERABLE
Severe	TOLERABLE	TOLERABLE	TOLERABLE	INTOLERABLE	INTOLERABLE
Disastrous	INTOLERABLE	INTOLERABLE	INTOLERABLE	INTOLERABLE	INTOLERABLE

Table 10 shows a summary of the overall environmental risk assessment matrix that compares the likelihood and consequences of key environmental aspects arising from the survey and assigns a level of risk. The level of risk has been determined from a generic environmental event potential matrix (Refer to Table 9 above).

The risk assessment process demonstrates that a tolerable level of risk is presented to the environmental values/attributes in the survey area and surrounding from acoustic disturbance and potential fuel and oil spills. Performance objectives, standards and criteria and risk reduction and management actions for these tolerable level risks are identified in the Sections 6 (Performance Objectives, Standards and Criteria) and Section 7 (Implementation Strategy).

Table 10: Summary of Overall Environmental Risk Assessment

Aspect / Source of Risk	Potential Environmental Effects	Likelihood	Consequence	Comparative Ranking
Interference with shipping	Disruption to vessels in the main shipping route	Unlikely	Negligible	Negligible
Disturbance to marine fauna	Disturbance from discharge of the acoustic energy source arrays to:			
	Baleen Whales	Likely	Minor	Tolerable
	Toothed Whales and Dolphins	Unlikely	Minor	Negligible
	Seals	Likely	Negligible	Tolerable
	Fish	Virtually certain	Negligible	Minor
	Benthic invertebrates	Unlikely	Negligible	Negligible
	Plankton	Virtually certain	Negligible	Negligible

Aspect / Source of Risk	Potential Environmental Effects	Likelihood	Consequence	Comparative Ranking
Disturbance to benthic habitats	Damage and/or destruction of seafloor habitats from anchoring and vessel grounding	Unlikely	Negligible	Tolerable
Interference with commercial fishing	Disruption to fishing vessels	Likely	Minor	Tolerable
Waste disposal	Damage to sensitive resources from discharge of sewage, putrescible waste	Unlikely	Negligible	Negligible
	Impact to marine environment from disposal of chemicals and solid and hazardous wastes	Unlikely	Minor	Tolerable
Fuel and oil spills	Damage to or loss of streamer resulting in loss of fluid	Likely	Minor	Tolerable
Fuel and oil spills	Leak from survey vessels fuel tanks	Unlikely	Major	Tolerable

6 PERFORMANCE OBJECTIVES, STANDARDS AND CRITERIA

Table 11 presents the results of an assessment of the residual environmental risk remaining after implementation of the mitigation measures based on a generic risk assessment matrix (Table 9) that compares the likelihood and consequences of any particular environmental aspects associated with the survey. The risk assessment process demonstrates that a level of risk to the environmental values/attributes in the survey area and surrounding area have been reduced to as low as reasonably practicable.

Performance objectives, standards and criteria for each significant aspect of the Trim 3D MSS are also presented in Table 11. The objectives and standards proposed are consistent with all legislative requirements. The criteria listed provide a means for quantitatively determining whether the environmental standards and objectives have been met.

Table 11: Summary of Overall Environmental Risk Assessment

Aspect / Source of Risk	Potential Environmental Effects	Objective	Standard	Mitigation Measures / Criteria	Likelihood	Consequence	Risk
Vessel Presence	Disruption or interference to vessels in the main shipping route	Minimise interference with shipping traffic	• AMSA requirements • *P(SL)A 1967* (Cth)	• Functional navigational lighting in place and in use. • Operations carried out in a manner that does not interfere with navigation to a greater extent than is necessary • Marine notices broadcast according to requirements. Rescue Co-ordination Centre (RCC) notified of survey. Radio monitoring undertaken.	Unlikely	Negligible	Negligible
Vessel Presence	Disruption to fishing vessels or interference with catch	Minimise interference with commercial fishing	• *P(SL)A 1967* (Cth), Section 124; Woodside *Environment Policy* • Woodside *Environmental Standards and Aspirations* [ref, 2.2]	• Operations carried out in a manner that does not interfere with fishing to a greater extent than is necessary • Specific communications program to inform fishermen of survey vessel whereabouts to be developed and implemented in consultation with fishermen and fishing associations	Unlikely	Negligible	Negligible
Vessel Presence	Collision with large cetaceans	Minimise disruption to cetaceans	• Woodside *Environment Policy* • Woodside *Environmental Standards and Aspirations* [ref, 2.6] • DEH *Guidelines on Interactions Between Offshore Seismic Operations and Larger Cetaceans* • DEH *Whale and Dolphin Sighting Report* • Survey Vessel Environmental Management Procedures • EPBC Act Regulations 2000, Part 8	• Temporal avoidance of peak whale migrations by timing of survey to occur outsideof main migratory period • Work procedures if whales within 3km • Responsibilities for monitoring and recording whale sightings clearly identified and conveyed to vessel personnel • Sighting reports completed and returned to Woodside and DEH • Support vessel to maintain distance of 300m from sighted whales, if less than 300m then vessel reduce speed to 'no wake' and move outside 300m	Unlikely	Minor	Tolerable

Aspect / Source of Risk	Potential Environmental Effects	Objective	Standard	Mitigation Measures / Criteria	Likelihood	Consequence	Risk
	Introduction of marine pests	Avoid introduction of exotic species	• Woodside *Environment Policy* • Woodside *Environmental Standards and Aspirations* [ref, 2.7] • AQIS Ballast Water Management Requirements	• Ensure vessel complies with, and records compliance with, AQIS Ballast Water Management Requirements	Unlikely	Major	Tolerable
Operation of acoustic source	Disturbance from discharge of the acoustic energy source arrays to Baleen Whales or Odontid Whales and Dolphins	Minimise disruption to cetaceans	• Woodside *Environment Policy* • Woodside *Environmental Standards and Aspirations* [ref, 2.6] • DEH *Guidelines on Interactions Between Offshore Seismic Operations and Larger Cetaceans* • DEH *Whale and Dolphin Sighting Report* • Survey Vessel Environmental Management Procedures	• Temporal avoidance of peak whale migrations by timing of survey to occur between December and January • DEH Guidelines in place and adhered to • MMO onboard vessel • 'Soft start' procedures • 10 minute continuous whale watch every hour • Stop work procedures if whales within 3km • Responsibilities for monitoring and recording whale sightings clearly identified and conveyed to vessel personnel • Sighting reports completed and returned to Woodside and DEH	Likely	Minor	Tolerable
	Disturbance from discharge of the acoustic energy source arrays to seals	Minimise disturbance to seals	• Woodside *Environment Policy* • Woodside *Environmental Standards and Aspirations* [ref, 2.6]	• Presence of seals in the vicinity of survey vessel to be noted	Unlikely	Minor	Tolerable
Anchoring	Damage and/or destruction of seafloor habitats from anchoring and vessel grounding	Minimise disturbance to benthic habitats	• Woodside *Environment Policy* • Woodside *Environmental Standards and Aspirations* [ref, 2.5]	• No anchoring of the vessel will takeplace during the survey (except for emergencies) • Recording and reporting of all items lost overboard	Unlikely	Negligible	Negligible

Aspect / Source of Risk	Potential Environmental Effects	Objective	Standard	Mitigation Measures / Criteria	Likelihood	Consequence	Risk
Waste disposal	Damage to sensitive resources from discharge of sewage, putrescible waste,	Minimise effects of sewage discharge	• Woodside *Environment Policy* • Woodside *Environmental Standards and Aspirations* [ref, 4.2] • *'Protection of the Sea (Prevention of Pollution From Ships) Act 1983'* (Cth); 'MARPOL 73/78 Annex IV • Survey Vessel Environmental Management Procedures • Survey Vessel Garbage Management Plan	• Sewage not discharged within 3 nautical miles of the coastline unless vessel has a certified approved sewage treatment plant in place under Regulation 8 (1) (b) of MARPOL 73/78 Annex IV. Between 3 and 12 nautical miles of coast sewage must, as a minimum, be comminuted and disinfected • Ensure procedures for treatment and disposal of sewage are in place • Ensure that sewage treatment system is operational and includes maceration and disinfection • Relevant discharge requirements are adhered to • Waste log will be maintained to record waste management practises	Unlikely	Negligible	Negligible
Waste disposal	Impact to marine environmen t from disposal of chemicals and solid and hazardous wastes	Minimise potential impacts of solid and hazardous wastes	• Woodside *Environment Policy* • Woodside *Environmental Standards and Aspirations* [ref, 5.2] • MARPOL 73/78 Annex V • Survey Vessel Environmental Management Procedures • Survey Vessel Garbage Management Plan	• Correct segregation of solid and hazardous wastes in all areas of the vessel • A vessel *Waste Log Form* is kept detailing quantities of wastes transported ashore • Procedures comply with MARPOL requir ements	Unlikely	Minor	Tolerable

Aspect / Source of Risk	Potential Environmental Effects	Objective	Standard	Mitigation Measures / Criteria	Likelihood	Consequence	Risk
Fuel and oil spills	Damage to or loss of streamer resulting in loss of fluid	Minimise occurrence of fuel and oil spills	• Woodside *Environment Policy* • Woodside *Environmental Standards and Aspirations* [ref, 4.3] • MARPOL 73/78 Annex I • AMSA *Marine Notice 6/1995* • P(SL)A Schedule 1995, Clause 220 • P(SL)A Schedule 1995, Clause 285 • Vessel *Oil Spill Contingency Plan* • Vessel SOPEP (*Shipboard Oil Pollution Emergency Plan*)	• Procedures comply with MARPOL 73/78 requirements • MARPOL *Oil Record Book* kept up to date • Fuel spill contingency procedures are in place and operational • Designated containment areas onboard the vessel for storage of oils, greases and streamer fluid • Sufficient spill response equipment on board to respond to foreseeable spill events • Appropriate actions are taken to minimise pollution • Any spills >80 litres are reported to the Designated Authority • Personnel responsibilities are clearly identified • Streamers are segmented limiting potential spill volume	Likely	Minor	Tolerable

Aspect / Source of Risk	Potential Environmental Effects	Objective	Standard	Mitigation Measures / Criteria	Likelihood	Consequence	Risk
Fuel and oil spills	Leak from survey vessels fuel tanks	Minimise occurrence of fuel and oil spills	• Woodside *Environment Policy* • Woodside *Environmental Standards and Aspirations* [ref, 4.3] • MARPOL 73/78 Annex I • AMSA *Marine Notice 6/1995* • P(SL)A Schedule 1995, C lause 220 • P(SL)A Schedule 1995, Clause 285 • Vessel *Oil Spill Contingency Plan* • Vessel SOPEP (*Shipboard Oil Pollution Emergency Plan*)	• Procedures comply with MARPOL 73/78 requirements • MARPOL *Oil Record Book* kept up to date • Fuel spill contingency procedures are in place and operational • Designated containment areas onboard the vessel for storage of oils, greases and streamer fluid • Sufficient spill response equipment on board to respond to foreseeable spill events • Appropriate actions are taken to minimise pollution • Any spills >80 litres are reported to the Designated Authority • Personnel responsibilities are clearly identified • No refuelling at sea expected due to endurance of vessel	Unlikely	Major	Tolerable

7 IMPLEMENTATION STRATEGY FOR MANAGING ENVIRONMENTAL IMPACTS AND RISKS

7.1 MANAGEMENT OF ENVIRONMENTAL RISK

To either eliminate potential environmental risks or to reduce them to as low as reasonably practicable, a number of key control and mitigation measures must be implemented. The management actions and strategies for control of the significant environmental risks associated with the proposed survey are described in the following sections.

7.1.1 MANAGEMENT OF DISTURBANCE TO MARINE FAUNA

The proposed survey largely avoids potential disruption to sensitive ecological values in the area by both spatial and temporal separation. **Table 12** summarises the control and mitigation measures that eliminate or reduce any significant environmental impacts on marine life to ALARP levels. The management actions and implementation strategy are discussed further in the following sections.

Table 12: Control and Mitigation Measures to Minimise Marine Fauna Impacts

Sensitive Ecological Values	Control and Mitigation Measures
Cetaceans	Temporal avoidance of periods of peak whale migrations. Specific DEH-endorsed procedures must operate if any whales are encountered. Other cetaceans (non-whale) are unlikely to be significantly affected by the survey.
Fish	The survey will not be operating over critical habitat for feeding, spawning, breeding or migrating fish populations. 'Soft start' of acoustic energy sources at the start of each line.
Epibenthic Communities	The survey is unlikely to have any significant effects on benthic communities due to the water depth.

The main control measures to minimise the survey's potential impacts on cetaceans are temporal and spatial avoidance and the implementation of specific whale encounter procedures.

The survey has been timed to avoid peak periods of southern right and humpback whale migrations. The survey area is located several hundred kilometres to the west of the recognised blue aggregation area along the Bonney upwelling.

In addition to the control measures identified above, Department of Environment and Heritage's '*Guidelines on the Application of the EPBC Act to Interactions Between Offshore Seismic Operations and Larger Cetaceans, 2001*' procedures shall be applied. These procedures have the following key elements:

- ✓ ***Visual observations:*** A visual check for the presence of whales must be made before the commencement of each acquisition line;
- ✓ ***Delay procedures:*** Acoustic energy source discharge must not begin unless whales are a minimum distance of 3km from the survey vessel;
- ✓ ***Soft start procedures:*** A sequential build-up of warning pulses (over a period of 20 minutes) must be made at the start of each acquisition line ('soft start') to warn and deter whales from approaching the survey vessel. 'Soft starts' over a 20 minute period at the start of each new line will also serve to warn and scatter any other free-swimming fauna (ie dolphins, pelagic and demersal fish) in the area, thereby minimising the likelihood of animals being within pathological effects range;

- ✓ ***Whale watch:*** A continuous watch for whales must be maintained during 'soft start' sequences and during operations to determine the presence or absence of whales within 3km of the vessel; and
- ✓ ***Stop work procedures:*** Acoustic energy source array discharge must cease if whales approach within 3km, and are moving towards, the vessel. Operations must not recommence until the animals have moved outside a range of 3km or have not been seen for twenty minutes.

Any cetacean sightings during proposed survey will be recorded on Department of Environment and Heritage's *Whale and Dolphin Sighting Report* sheets and reported to the Commonwealth Department of the Environment and Heritage. Copies of these sheets will be sent to the Woodside Project Manager during the survey.

7.1.2 MANAGEMENT OF DISTURBANCE TO BENTHIC HABITAT

The survey is unlikely to have any significant effects on benthic communities due to the water depth. The survey vessel and support vessels will not anchor during the duration of the survey, except in an emergency situation. As a result of the water depths (approximately 100m to 2,000m) there are unlikely to be any significant effects from discharge of the acoustic energy source arrays on the benthic environment. In the event of loss of a streamer or associated equipment (eg paravanes, tail buoys) there is the potential for some limited disturbance of benthic habitats to occur. Wherever possible, streamers and associated equipment are recovered when lost during survey activities.

7.1.3 MANAGEMENT OF WASTE

Risks to the marine environmental resources in the proposed survey area and adjacent areas from disposal of wastes are considered to be negligible given that wastes other than routine sewage and putrescible material discharge will be returned to shore for recycling or disposal.

The survey vessel will have a 'Garbage Management Plan' in place. This plan will be consistent with the requirements of MARPOL 73/78 (Annexe V) and include a list of ship's equipment and detail the arrangements for handling of garbage.

7.1.3.1 SEWAGE AND PUTRESCIBLE WASTES

Sewage and foodscraps disposal must conform to the requirements of MARPOL 73/78 Annex IV and must be macerated to a diameter of less than 25 mm, prior to disposal. No sewage or putrescible wastes (ground or unground) is to be discharged within 12 nautical miles of any land unless vessel has a certified approved sewage treatment plant in place under Regulation 8 (1) (b) of MARPOL 73/78 Annex IV. No significant environmental impacts are expected because of the biodegradability of the waste, short period of seismic activities and large dilution factor. Total nutrient (nitrogen and phosphorus) input levels will be insignificant compared with natural nutrient flux in the area.

Risks to the marine environmental resources in the proposed survey area and adjacent areas from disposal of wastes are considered to be negligible given that wastes other than routine sewage and putrescible material discharge will be returned to shore for recycling or disposal.

The survey vessel will have a 'Garbage Management Plan' in place. This plan will be consistent with the requirements of MARPOL 73/78 (Annexe V) and include a list of ship's equipment and will detail arrangements for the handling of garbage.

7.1.3.2 SOLID WASTES

No significant environmental impacts are expected as solid wastes will not be discharged to the ocean. All solid wastes, such as packaging and domestic wastes must be segregated into clearly marked containers prior to onshore disposal. In accordance with MARPOL 73/78 regulations, no plastics or plastic products of any kind are to be disposed of overboard. No domestic waste (ie cans, glass, paper or other waste from living areas) is to be discharged overboard. No maintenance

wastes (e.g. paint sweepings, rags, deck sweepings, oil soaks, machinery deposits etc.) are to be disposed of overboard.

7.1.3.3 Chemical and Hazardous Wastes

All chemical and hazardous wastes, such as cleaning products, acids, solvents, toxic waste and medical waste, will be segregated into clearly marked containers prior to onshore disposal. No significant environmental impacts are expected as chemical and hazardous wastes will not be discharged to the ocean.

All storage facilities and handling equipment must be segregated in good order and designed in such a way as to prevent and contain any spillages as far as practicable.

No significant environmental impacts are expected as solid wastes will not be discharged to the ocean. All solid wastes, such as packaging and domestic wastes, must be segregated into clearly marked containers prior to onshore disposal. In accordance with MARPOL 73/78 regulations, no plastics or plastic products of any kind are to be disposed of overboard. No domestic waste (ie. cans, glass, paper or other waste from living areas) is to be discharged overboard. No maintenance wastes (e.g. paint sweepings, rags, deck sweepings, oil soaks, machinery deposits etc.) are to be disposed of overboard.

7.1.4 Chemical and Hazardous Wastes

All chemical and hazardous wastes, such as cleaning products, acids, solvents, toxic waste and medical waste, will be segregated into clearly marked containers prior to onshore disposal. No significant environmental impacts are expected as chemical and hazardous wastes will not be discharged to the ocean.

All storage facilities and handling equipment must be segregated in good order and designed in such a way as to prevent and contain any spillages as far as practicable.

7.1.5 Management of Potential Fuel and Oil Spills

The survey vessel will have a specific fuel spill contingency procedures in the unlikely event of a fuel spill and a *Shipboard Oil Pollution Emergency Plan* (SOPEP). Minor spillages will be managed through housekeeping cleanliness and the use of sorbent materials to clean up any spilled fuel or oils.

Any fuel or oil spills must be reported to Woodside, all spills of greater than 80 L will be reported by Woodside to the Designated Authority within 2 hours.

Incineration of any oil sludges onboard, or disposal of any oil sludges/slops in port, must be recorded in the vessel *Oil Record Book* (a requirement under MARPOL 73/78).

Stocks of absorbent materials onboard the survey vessel must be checked for their adequacy and replenished as necessary prior to the commencement of activities.

7.2 Roles and Responsibilities

The organisation and structure of the seismic survey to be undertaken, including roles and responsibilities for all key personnel onboard the survey vessel, are described in the Project Plan for the Trim 3D MSS. With regard to the implementation and management of this Environment Plan, the key responsibilities are:

- Vessel Master
    1. Responsible for the safe execution of all operations of the survey vessel.
    2. Overall responsibility for HSE management onboard the vessel, and for ensuring that appropriate control and mitigation measures are implemented to minimise potential environmental effects resulting from vessel operations (eg waste

management/disposal, and fuel/oil spill response).
3. Responsible for immediately notifying the Client Site Representative of any incidents/activities arising from vessel operations that are likely to have a negative impact on the performance objectives detailed in this Environment Plan.

- Party Chief
  1. Responsible for safe execution of all operations carried out by the seismic crew onboard the survey vessel.
  2. Responsible for ensuring that appropriate control and mitigation measures are implemented to minimise potential environmental impacts resulting from seismic acquisition (eg 'soft start' procedures, whale watch and stop work procedures, cetacean recording).
  3. Responsible for ensuring compliance with all aspects of HSE reporting and for investigations of all incidents and near misses.
  4. Responsible for immediately notifying the Client Site Representative of any incidents/activities arising from seismic operations that are likely to have a negative impact on the performance objectives detailed in this Environment Plan.

- Client Site Representative
  1. Responsible for ensuring that, during the Trim 3D MSS all sub-contractors perform operations in a manner consistent with the performance objectives and environmental management procedures detailed in this Environment Plan.
  2. Responsible for ensuring that the Vessel Master and Party Chief are adhering to the requirements of this Environment Plan and the approved Survey vessel HSE Management Plan.
  3. Responsible for keeping himself fully appraised of ongoing operations, particularly for environmentally critical activities.
  4. Responsible for immediately alerting the Woodside Acquisition Project Manager of any changes in operations that could have a negative impact on environmental performance.
  5. Responsible for immediately reporting any reportable incidents to the Woodside Acquisition Project Manager.

- Woodside Acquisition Project Manager
  1. Responsible for ensuring that the Designated Authority is notified of all reportable incidents in a timely fashion.
  2. Responsible for ensuring full briefing all project personnel of the environmental sensitivities of the survey area and environmental management procedures and commitments detailed in this Environment Plan.
  3. Responsible for communicating details of the survey programme to relevant Government agencies in advance of operations commencing.

All Woodside personnel and contractors in all areas of the Company's activities are responsible for applying the Corporate Environmental Policy.

7.3 AWARENESS

All staff and contractors taking part in the survey will be advised of their responsibilities prior to commencement of survey activities. This will occur through meetings with key contractor personnel and an induction and awareness presentation that will be given to all crew (including support vessels).

7.4 MONITORING, AUDIT AND REVIEW

The monitoring, audit and review programme for the Trim 3D MSS will consist of the following actions:

- ✓ The project 'kick off' meeting will include a presentation to review the environmental sensitivities of the survey location, key environmental performance objectives and commitments, as detailed in this Environment Plan.
- ✓ An environmental management review will be carried out aboard the survey vessel during the survey. This review will include a vessel inspection and an assessment of the environmental components of the contractor's HSE Management System. This review will particularly focus on aspects of applied environmental management aboard the vessel, including waste management, effluent and emission control, transport and materials supply, project management, contingency planning and preparedness and operations effects and control. The Client Site Representative will carry out this review.
- ✓ Recording of interactions with commercial fishing vessels/equipment
- ✓ Recording of all cetacean sightings on Environment Australia *Whale and Dolphin Sighting Report* sheets. Copies of these sheets will be provided to Woodside Project Manager and to the Commonwealth Department of Environment and Heritage.
- ✓ Total number of environmental incidents (minor spills, streamer loss etc.) and reportable environmental incidents (spills >80 litres) will be recorded. Reporting requirements for these incidents are detailed in section 7.5.
- ✓ A *Waste Log* will be maintained, detailing the quantities of wastes produced and returned to shore for disposal.

7.5 REPORTING

All incidents that have the potential to cause significant effects on the environment must be reported and investigated according to legislative requirements, survey vessel procedures and the Woodside Environmental Policy.

The Designated Authority will be notified of all reportable incidents, according to the requirements of Regulation 26 of the *Petroleum (Submerged Lands)(Management of Environment) Regulations 1999.* Under these regulations, a reportable incident is defined as *"for the operator of an activity, means an incident arising out of operations for the activity that is not within the parameters of the environmental performance standards in the environment plan in force for the activity*". As operator of the survey, Woodside has to provide written reports on any reportable incidents to the Designated Authority, and it is the responsibility of the Acquisition Project Manager to comply with this requirement.

All environmental incidents and interference with commercial fishery vessels or equipment will be reported to the Client Site Representative and the Woodside Manager, Marine Acquisitions within 24 hrs of the incident occurring. The following is a summation of reporting requirements:

- ✓ Woodside must be informed within 24 hrs of any incidents involving fuel/oil spill, the loss of streamers/individual streamer sections and spillage of ISOPAR M.
- ✓ Any spills greater than 80 litres must be reported to Woodside **within two hours**.
- ✓ Woodside is responsible for reporting all spills >80 litres to the Designated Authority **within two hours**.
- ✓ Any spills greater than 10 tonnes must be reported to Woodside **within one hour** via the WEL internal Emergency Response No. (ph +61 8 9158 8333)
- ✓ 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 one hour**, via the national 24 hour emergency notification contacts:

  Phone: (02) 6230 6811 Freecall: 1800 641 792, Fax: (02) 6230 6868

  Telex: +7162349 (computer connected), Email: mdo@amsa.gov.au

7.6 CONSULTATION

Woodside has initiated a significant, ongoing stakeholder consultation program as part of its planning for the Trim 3D MSS. This program initially commenced in 2003 and, due to delay of the survey, has continued into 2005. Further stakeholder engagement and consultation is planned. This will include Commonwealth Government and South Australian Government departments and agencies, local government, NGOs – including environment groups – fishing interests, community groups and media.

Initial contact already has been made with key government departments and fishing interests. The first round of consultation will be completed by the third week in November, two months before the survey is scheduled to start.

Public information material will be prepared for distribution through government, local government and NGOs; a newsletter will be distributed by email; and, newspaper advertisements will advise the community about the drilling program.

Comment: I suggest that this whole section be removed as it is now out of date

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APPENDIX A - Cetacean Reporting Forms & DEH Cetacean Interaction Procedures

Management Guidelines for Seismic Vessels Operating in Australian Waters so as to Avoid or Minimise Interference with Whales and Certain Other Larger Cetaceans

The following procedures should be followed by all seismic vessels operating in Australian waters during all seismic surveys so as to avoid interference with whales and other larger cetaceans as set out in the attached list.

Pre Start-up Visual Observation Procedures

For all seismic surveys in all waters the following checks should be made:

During daylight hours, visual checks (using binoculars from a suitable, high observation platform on the survey vessel) for the presence of whales will be undertaken before the commencement of operations.

During night time operations, Infra-Red (IR) or night-vision binoculars will be used to undertake visual checks before the commencement of operations.

Observations will begin at least 90 minutes prior to use of any high-energy acoustic sources, with particular focus on a 3 kilometres radius around the survey vessel. (See attached diagram).

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

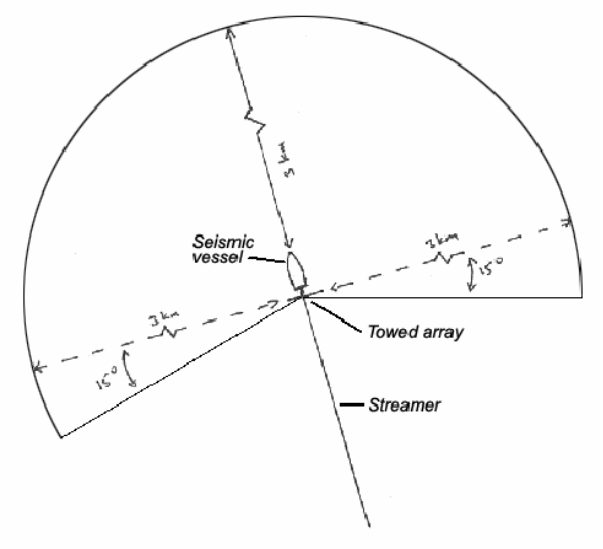


Diagram of area surrounding a seismic vessel that must be monitored for the presence of whales

For information, a practical and reliable method to accurately determine the range of a marine mammal from a ship's bridge is to measure the angle of the whale below the horizon. By then using standard formula which take into account the earth's curvature and refraction, and using the known height of eye of the observer, a reasonable estimate of the whale range can be calculated. The Norie's Nautical Almanac has standard tables and formula for calculating range from angles below the horizon. There are two methods of measuring angles below the horizon:

Range finding binoculars which have a graticule of set angle increments fixed in one eyepiece. The number and fraction of graticule units from the whale to horizon gives the angle below the horizon;

Sextant angles below the horizon. These provide the most accurate measure, and although require some experience at using and reading a sextant, are relatively easy to measure, although care needs to be taken whether reading the angle off or on the arc.

For information, acoustic monitoring, either ship based using signals taken from the streamer, or externally based from sonar buoys, is becoming an increasingly practical method of monitoring the presence of many whales species. There is merit in the continued exploration of this method of monitoring the presence of cetaceans. Where acoustic monitoring is used on a vessel, the signal should be continuously monitored on the bridge. The use of acoustic monitoring should be used to assist visual monitoring rather than replace it.

Start-up Delay Procedures

For all seismic surveys in all waters the following procedures should be followed:

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 away outside the 3km radius or, if they are no longer observable, 30 minutes after the last sighting within 3km.

Soft Start Procedures

For all seismic surveys in all waters the following procedures should be followed:

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.

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. 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

For all seismic surveys in all waters where a permit under Part 13 Division 3 of the *Environment Protection and Biodiversity Conservation Act 1999* (the Act), or approval under Part 3 of the Act, is not required the following procedures should be followed at a minimum:

Visual observations of 10 minute duration per hour will be carried out during seismic operations.

During night time operations, Infra-Red (IR) or night-vision binoculars will be used for the hourly observations. Night time visual observations will also be of 10 minute duration per hour.

Where a whale of a species included in Attachment 1 is seen as part of the observation procedures, continual observations should occur until 2 hours have passed since the last observation of a cetacean of a species included in Attachment 1.

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

For information, the area to be monitored for the presence of whales is the same as that applying for pre-start surveys.

For information, wherever practicable a trained, independent observer should be used for the task of undertaking visual monitoring both to ensure that the required observations are undertaken and to ensure that the best information is obtained from these opportunities to monitor cetaceans.

For information, aerial surveys can increase the amount of information available on the presence of cetaceans in an area and assist in monitoring these animals. Where planning and safety considerations permit aerial surveys of the area to be surveyed could be undertaken to supplement shipboard observation.

For all seismic surveys in circumstances where a permit or approval is required (feeding, breeding and resting areas and migratory routes, as identified in the accompanying maps) the following procedures will form the basis for the consideration of conditions. The exact conditions will be assessed on a case-by-case basis to ascertain if the requirements should be varied.

In or near migratory paths, other than non-peak Humpback migration paths, 30mins per hour observation by a trained and dedicated cetacean observer will normally be required.

In feeding, breeding or resting areas, continuous observation by a trained and dedicated cetacean observer will normally be required.

In addition, an independent observer may be required to ensure that the best information is obtained from these opportunities to monitor cetaceans.

For information, the area to be monitored for the presence of whales is the same as that applying for pre-start surveys.

For information, the nominated observer is additional to standard bridge crew members and will have some experience with whale observations. Note: Whale observations become increasingly difficult as sea state increase. An upper limit for practical whale observation is sea state 5. This coincides with the operational weather limits for most seismic vessels.

For information, aerial or stand-off vessel observation is likely to be required as part of any permit or approval.

Stop Work Procedures

For all seismic surveys in all waters the following procedures should be followed:

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.

Where an individual whale or pod of whales approaches within 3 km of a seismic vessel, the acoustic source will be shut down 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 20 minutes.

For information, the area to be monitored for the presence of whales is the same as that applying for pre-start surveys.

For information, it is important to monitor the behaviour of any whales that may be approaching the stop-work distance. Ascertain what the whale is doing and the direction it is travelling. If it is seen to be heading away from the seismic vessel and is outside the 3km zone, a shut down may not be necessary.

For information, particular care should be exercised in the monitoring for cetaceans under conditions of reduced visibility.

Aerial Survey and Stand-off Vessel Procedures

For all seismic surveys in waters where a permit or approval is required (feeding, breeding and resting areas and migratory routes, as identified in the accompanying maps), additional surveys are likely to be required as permit conditions or as part of the approval, if granted. These surveys will in most cases be aerial surveys except where vessel based surveys are required to collect special information or where aerial surveys are impractical. Two types of surveys are envisaged and the requirement for either or both will be assessed on a case-by-case basis.

- Surveys to identify where cetaceans are in relation to seismic activity and to identify when seismic vessels should be especially vigilant. These surveys would be run between the areas to be surveyed by the seismic vessel and the likely approach direction of cetaceans, or in the area in advance of the survey vessel.
- Scientific surveys to identify which areas are important to cetaceans eg to identify feeding, breeding and resting areas and times of peak migration. In particular these surveys may be required in areas of potential increased sensitivity (areas C or D on the attached maps) where insufficient information currently exists to determine timing and appropriate management arrangements.

Recording and Reporting Procedures

Any whale sightings will be recorded on the Environment Australia *Whale and Dolphin Sighting Report* form (attached below).

At completion of the seismic survey, copies of all report forms will be submitted to:

Department of Environment and Heritage
Marine Species Section
GPO Box 787
Canberra ACT 2601

Environment Australia
Marine and Water Division

Whale and Dolphin Sighting Report

National Cetacean Sighting Program

Marine Species Section
Environment Australia
GPO Box 787
CANBERRA ACT 2601 AUSTRALIA

DO NOT approach whales/dolphins closer than 100 metres

Please return to:

Date | Time (local) | Sighting from land / vessel / air / oil platform | Location | Latitude ° ' S | Longitude ° ' E

SPECIES DETAILS

Species (as close as possible eg long-finned pilot whale/pilot whale/toothed whale/whale)

How sure are you? (please circle)
very sure -- sure -- not sure

Animal/s length biggest/smallest

How did you estimate length?

Your distance (min/max) from animal

Total number of whales/dolphins

Number of calves

Behaviour of whales/dolphins (eg swimming-north, breaching, resting)

Please draw the shape and features you observed
(eg. flipper, tail, back and head. Mark in the colour/s and draw colour patterns and any unusual markings injuries, scars etc)

WEATHER/SEA CONDITIONS

Beaufort Sea State (please circle)
0------1------2------3------4------5------6------7+
mirror calm | moderate white caps | very rough

Weather (eg sunny, clear, light rain)

Cloud cover /8

Wind direction

Wind speed

Sea temperature (°c)

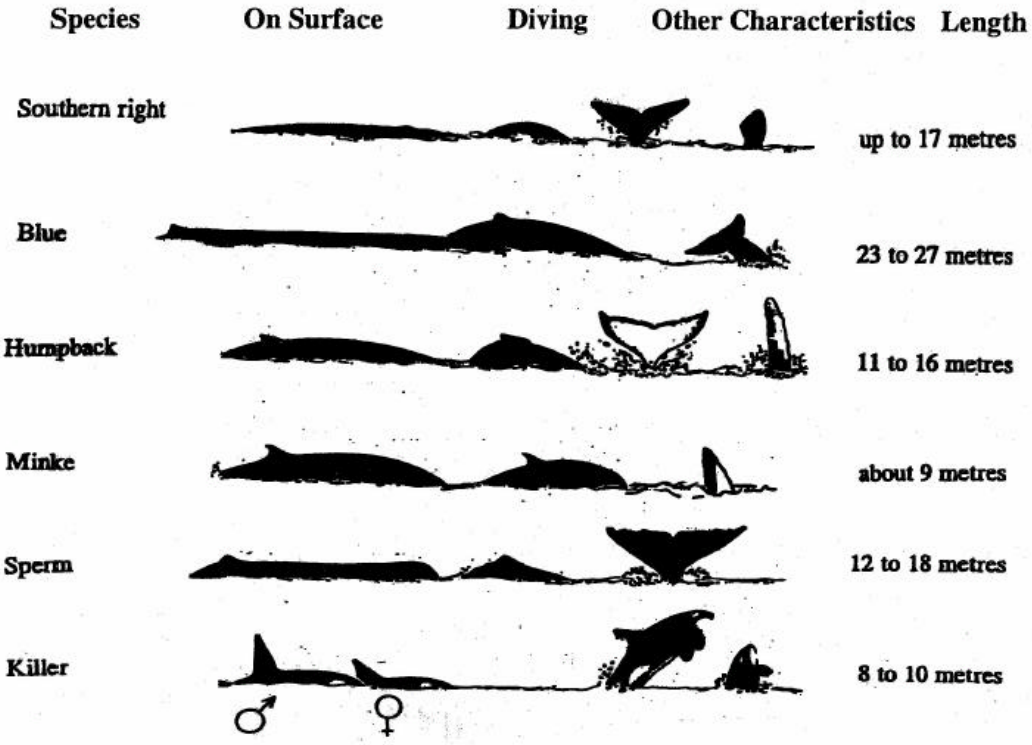
Other animals present (including fish, birds, etc...)

Other notes / sketches
(eg. what did you use to identify the whale/dolphin)

Were there any photographs taken Y/N

Your Name and Address

Species guide

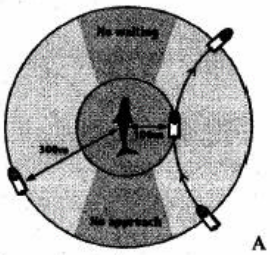


NB: for guidance only, not all species are shown here

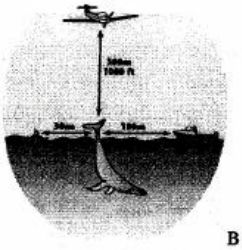
Whale watching guidelines

- Vessels should approach whales or dolphins as in A .
- Within 300 metres of a whale move at a constant slow speed no faster than the slowest whale or at idle, 'no wake' speed.
- Avoid sudden or repeated changes in speed or direction
- Do not approach closer than 100 metres in a boat (B)
- Stopping? allow the motor to idle (1 minute) before turning off
- No more than three vessels should attempt to watch a whale orgroup of whales at one time
- Do not allow the whales to become boxed in, cut of their path or prevent them from leaving.
- Do not approach mothers with young calves.

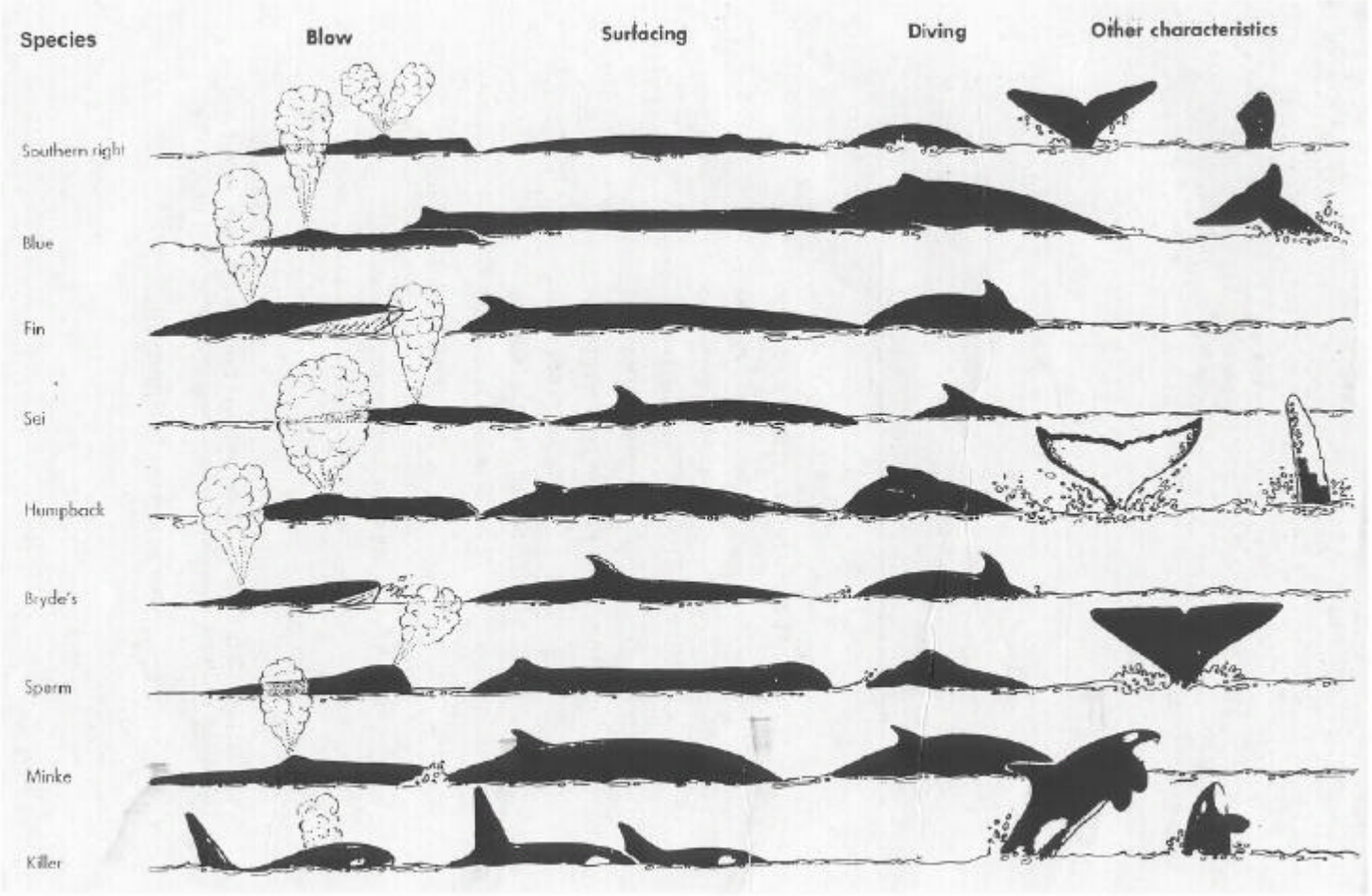
Move away slowly at idle, 'no wake' speed to at least 300 metres from the closest whale



A



B


Species
Blow
Surfacing
Diving
Other characteristics
Southern right
Blue
Fin
Sei
Humpback
Bryde's
Sperm
Minke
Killer

Identifying Whales at sea

Some of the large whales can be identified by their blow, surfacing and diving characteristics. Use this chart as a quick reference guide to identify the large whales you see.

What you should note when identifying a whale

- body length
- presence of a dorsal fin
- size and position of the dorsal fin
- shape and size of flippers
- shape of the head and general body shape
- presence of a beak
- shape of the blow
- body colour and patterns
- swimming characteristics
- presence of teeth or baleen (stranded whale)
- number of teeth (stranded whale)

Whales and Dolphins

IDENTIFICATION GUIDE

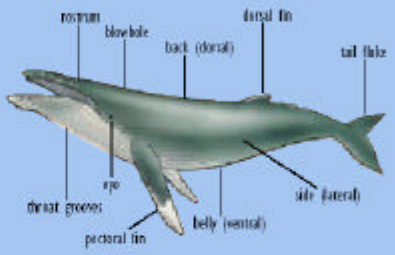
Forty-three species of cetaceans (whales, dolphins and porpoises) are known to occur in Australian waters. Sightings reports provide important information for the conservation and management of these animals. National Cetacean Sightings and Strandings Databases are maintained by Wildlife Australia. You can provide valuable assistance by recording sightings, strandings and entanglements of cetaceans and reporting them as soon as possible to Marine Species Section, GPO Box 787, CANBERRA, ACT, 2601. Telephone 1800 803 772.

Cetaceans are divided into two groups - those with teeth (Odontocetes), and those with baleen (Mysticetes). Baleen is a fibrous, bristle like substance used to sieve small prey from the water.

Odontocete (Tooth)

Mysticete (Baleen)

The blow hole is another distinguishing feature. Baleen whales have a double blow hole, while toothed whales have a single blow hole.



This diagram shows the external features of a cetacean used for identification. These features are referred to in the descriptions below.

BALEEN WHALES (MYSTICETES)

HUMPBACK WHALE

Megaptera novaeangliae

- medium/large (to 16m)
- back dark grey; underside of body, fins and flukes white
- dorsal fin extremely variable in size and shape but usually distinctive
- very long pectoral fins (1/3 body length)
- may raise flukes on diving; serrated trailing edge; white and black patterned undersurface; body arched strongly when diving
- tubercules (bumps) on rostrum; throat grooves present
- bushy blow to 3m - sometimes V shaped, sometimes tall & slender
- Australian distribution:
  Inshore along length of east & west coasts between about April and December

Other baleen whales found in Australian waters:

- Blue whale (to 30.5m);
- Fin whale (to 27m);
- Sei whale (to 21m); and
- Bryde's whale (to 15.5m).

SOUTHERN RIGHT WHALE

Eubalaena australis

- large (to 17m) stocky whale
- bushy V-shaped blow
- black body with white callosities (bumps) on head
- no dorsal fin; broad paddle like pectoral fins
- may raise flukes on diving; trailing edge smooth; dark underneath
- Australian distribution: Inshore waters south of around Sydney in the east and Perth in the west between about May and October.

MINKE WHALE

Balaenoptera bonaerensis

- medium (to 10.7m)
- dorsal fin tall and hooked
- don't raise flukes when diving
- sharply V-shaped head; throat grooves present
- blow and dorsal fin often appear simultaneously
- blow often indistinct, but maybe columnar
- black/dark grey back; wavy boundary to white underside
- may "ship-seek" or be erratic and evasive in movements
- Australian distribution:
  Generally offshore in Australian waters during winter migration.

TOOTHED WHALES (ODONTOCETES)

SPERM WHALE
Physeter macrocephalus


- large (to 18m); huge head and bluff
- body dark grey-brown to brown; white around mouth
- head may be heavily scarred; body wrinkled behind head
- dorsal 'hump' (fin) followed by knuckles along spine
- single blow angled forward 45° and slightly left
- flukes raised high on diving; trailing edge may be scalloped/serrated
- may dive for long periods and surface nearby
- may lie quietly at the surface and blow repeatedly after deep dive
- Australian distribution:
  All states in deep water (>200m) off continental shelf.
  All seasons with generalised movement south in summer.

KILLER WHALE
Orcinus orca


- medium (to 9.8m)
- distinctive black and white colour pattern
- male dorsal is taller than female, more-or-less straight; female dorsal is curved, more erect than a minke whale's
- low bushy blow, usually distinct
- highly social, form lifelong family groups; occasionally seen singly or in small groups.
- Australian distribution:
  All waters from polar to tropical. All seasons.

BOTTLENOSE DOLPHIN
Tursiops truncatus


- small (to 3.1m); distinct rostrum
- dark grey to light grey above fading to whitish underside
- distinct, curved dorsal; relatively small, pointed pectoral fins & flukes
- highly social, can occur in very large groups
- Australian distribution:
  All waters from tropical to temperate regions.
  All seasons.

LONG-FINNED PILOT WHALE
Globicephala melas


- small/medium (to 6.2m); bulbous forehead
- slate grey to black; grey post-dorsal saddle; post-ocular patch;
- white patched on throat and ventral surface
- low curved dorsal fin with broad base
- low bushy blow
- highly social, sometimes in very large groups
- often lie or swim quietly at surface
- Australian distribution:
  All waters, often oceanic.
  All seasons.

OTHER SMALL CETACEANS


Common Dolphin


Spinner Dolphin


Risso's Dolphin

- wide range of sizes and shapes
- can be seen bow-riding, leaping, surfing
- usually seen in groups
- Australian distribution:
  All waters, open ocean and inshore.
  All seasons.

GUIDELINES FOR WHALE AND DOLPHIN WATCHING

Watching whales and dolphins in their natural environment is a very rewarding experience. It is important to remember that our actions can be disruptive to cetaceans. Whale and dolphin watching regulations are in place in all Australian waters and you can minimise disturbance by following these carefully.

The key point to remember is that –
"your actions should not interrupt the normal behaviour patterns of the animal".

When near cetaceans remain quiet. Do not throw rubbish in the water or attempt to feed or touch the animals. Always approach cetaceans as shown in the diagrams opposite, and do not go any closer than the minimum approach distances given.

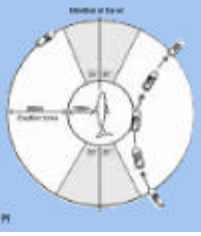



Photo credits: B Thiele, M Bowles, R Higgins, S Whiteside, D Hawkins