Maxima 3D Marine Seismic Survey – Scott Reef

Woodside Energy Ltd.

Report and Recommendations
of the Environmental Protection Authority

Environmental Protection Authority
Perth, Western Australia
Bulletin 1255
30 April 2007

Environmental Impact Assessment Process Timelines

Date	Progress stages	Time (weeks)
07/08/06	**Referral received**	
04/09/06	**Proponent requested to provide additional information**	**4**
15/01/07	**Intention to set EPS Level of Assessment advertised (no appeals)**	**19**
30/03/07	**Proponent's Final EPS document received by EPA**	**11**
26/04/07	**EPA report to the Minister for the Environment**	**4**

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1. Introduction and background

This report provides the advice and recommendations of the Environmental Protection Authority (EPA) to the Minister for the Environment on the environmental factors relevant to a proposal by Woodside Energy Ltd. to undertake a three dimensional (3D) seismic survey within State waters at Scott Reef.

The two adjacent coral reefs that are together known as Scott Reef are emergent atolls located 430 kilometres north of Broome on the 500 metre isobath. The southern reef has a small sand cay called Sandy Island. The waters surrounding the island and adjoining reef flat to a distance of three nautical miles lie within the jurisdiction of the Western Australian Government. The northern reef and waters surrounding State waters are under Commonwealth Government jurisdiction (Figure 1). The proposed Maxima 3D Marine Seismic Survey crosses both State and Commonwealth waters. The Commonwealth Department of the Environment and Water Resources has indicated that it is likely to recommend to the decision maker that the action is not a controlled action if undertaken in a specified manner.

The EPA was advised of the Maxima 3D Marine Seismic Survey proposal in August 2006. Based on the initial referral and additional information, the EPA considered that while the proposal had the potential to have an effect on the environment, it was likely that it could be managed to meet the EPA's environmental objectives. Consequently, notification was given in *The West Australian* newspaper on 15 January 2007 that, subject to the preparation of a suitable Environmental Protection Statement (EPS) document, the EPA intended to set the level of assessment at EPS.

The proponent has prepared the EPS document which accompanies this report (*Woodside, 2007*).

In accordance with the *Environmental Protection Act 1986,* the EPA has determined, under Section 40 (1)), that the level of assessment for the proposed Maxima 3D marine Seismic Survey is EPS. This report provides the EPA's advice and recommendations in accordance with Section 44 (1) of the Act.

2. The proposal

Seismic surveys provide a three dimensional image of subsurface features by analysing the patterns of sound energy waves reflected from geological formations within the earth's crust. Energy waves are created using airguns towed behind a slow moving vessel. These waves are directed down into the substrate and the reflected waves are detected by sensitive hydrophones attached to streamers which extend for several kilometres behind the vessel.

The Maxima 3D Marine Seismic Survey is designed to investigate the Torosa gas field which lies directly beneath Scott Reef. The survey covers a total area of 340 square kilometres with 172.43 square kilometres within State waters. The State waters component encompasses sections of the outer reef slope, waters within south reef lagoon and the deep chasm between north and south reefs (Figure 1). The seismic survey will pass over water depths ranging from less than 20 metres to 1100 metres.

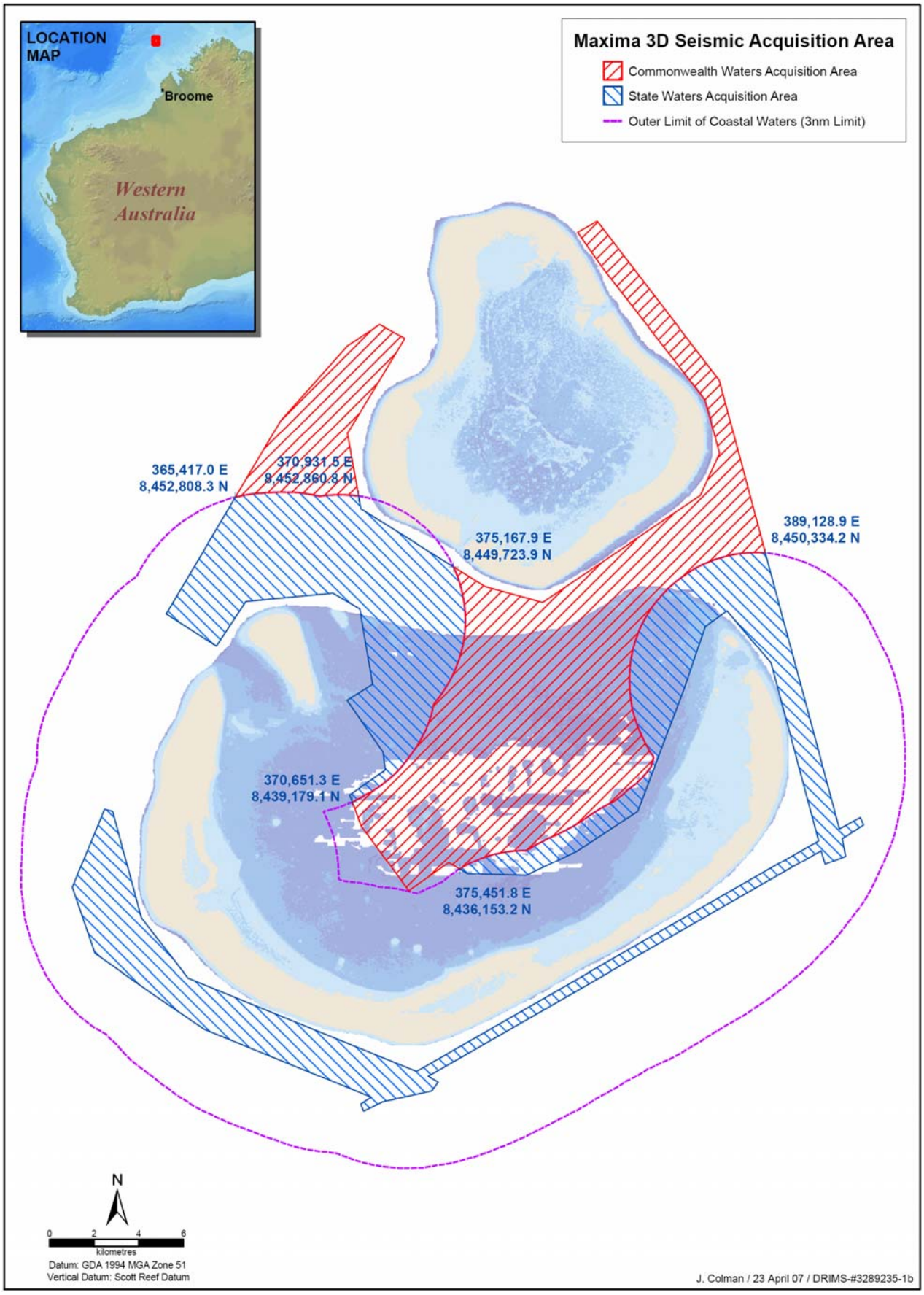


Figure 1: The distribution of seismic acquisition areas within State and Commonwealth waters at Scott Reef.

The survey is planned to commence during the middle of July 2007 and will be conducted 24 hours a day for approximately 50 days. A specialised seismic survey vessel, the M/V Veritas Voyager will be equipped with dual air gun arrays of up to 2,905 cubic inch capacity, towed at a depth of five metres. The vessel will move slowly at between three and five knots and the airguns will emit short pulsed (less than 200 milliseconds) low frequency (most spectral energy <500 Hz) shots every seven to ten seconds, equivalent to every 18.75 metres. The survey will require a total of approximately 70,000 shots in State waters. Reflected acoustic signals will be picked up by hydrophones located along four solid (not filled with kerosene) streamers which are fitted with pressure activated self inflating buoys and towed behind the vessel at a depth of seven metres. Each streamer will be four kilometres long and they are to be spaced 100 metres apart. The planned seismic lines are 200 metres apart.

The proposal is described in detail in the proponent's EPS document (*Woodside, 2007*). The predicted impacts of the proposal are also discussed by the proponent in the EPS document.

The key components of the proposal are summarised in Table 1 below:

Table 1: Summary of key proposal characteristics

Element	**Description**
Petroleum Permit area	TR/5
Area of seismic acquisition within State waters (approximate)	172.43 square kilometres.
Length of seismic lines (approximate)	920 kilometres
Distance between lines (approximate)	200 metres
Minimum distances of data acquisition from geographical features:	800 metres from the 10 metre lowest astronomical tide level within south Scott Reef Lagoon. 400 metres from the 10 metre lowest astronomical tide level around the outer edges of Scott Reef . 3 kilometres from the old weather station tower on Sandy Island 121°46'34"E 14°03'23"S (Datum GDA94)
Range of surveyed water depths (approximate)	20 metres to 1100 metres
Timing: • Commencement of preliminary survey • Duration of seismic acquisition survey	July 2007 Approximately 50 days
Number of seismic shots in State waters (approximate)	70,000
Acoustic emissions: • Airgun capacity	Dual air gun arrays with a combined capacity of up to 3,000 cubic inches

• Tow depth of airguns • Planned distance between seismic lines • frequency of emissions • Shot point interval • Noise profile	~5 metres ~200 metres 7 to 10 secs Approximately 18.75 metres Short pulsed (less than 200 milliseconds) low frequency (between 10 – 1000Hz), with most spectral energy less than 500Hz
Acoustic reception • Number of solid streamers • Length of solid streamers • Tow depth of streamers • Distance between streamers • Streamer type	 4 4 kilometres ~7 metres ~100 metres Solid (not filled with kerosene) and fitted with pressure activated self inflating buoys

The potential impacts of the proposal are discussed by the proponent in the EPS document (*Woodside, 2007*).

3. Consultation

During the preparation of the EPS document, the proponent has consulted key stakeholders including government agencies, conservation and industry peak bodies and the local community.

Stakeholder consultation included:

- Workshops for technical experts from government, research institutions and the World Wide Fund for Nature;
- Briefings and discussions with a Community Reference Group based in the Kimberley;
- Targeted correspondence with conservation, recreation and industry groups to disseminate information and invite input into the EPS process; and,
- The engagement of two technical expert peer reviewers, Dr Mardi Hastings and Dr Peter Sale.

A number of environmental issues were raised by the stakeholders during the consultation. Section four of the EPS document (*Woodside, 2007*) details the agencies, groups and organisations consulted, the issues raised, comments received and the proponent's responses.

The EPA considers that the consultation process has been appropriate and that reasonable steps have been taken to inform the community and stakeholders on the proposed development.

4. Key environmental factors

A summary of environmental factors and their management is outlined in sections seven and eight of the EPS document (*Woodside, 2007*). It is the EPA's opinion that the following environmental factors require evaluation in this report:

a) Impacts of acoustic emissions on marine fauna;
b) Introduced marine pests; and
c) Potential pollution.

4.1 Impacts of acoustic emissions on marine fauna

The EPA's environmental objective for fauna is:

> To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

Vulnerability to impacts from the impulsive, broad spectrum, low frequency (10 – 1000Hz), acoustic emissions from airguns is related to the presence of gas filled chambers within animal structures. Most invertebrates do not have gas filled chambers and therefore are not vulnerable. The cephalopods (squid and cuttlefish), which do have gas filled chambers, are expected to move away from areas where sound levels might have the capacity to cause physiological damage. The ear chambers, swim bladders and lungs of vertebrates however, make them more vulnerable to impacts from seismic surveys.

Cetaceans

The main humpback whale migratory pathway is located landward of the 100 metre isobath and no humpback whales were recorded at Scott Reef before 2006. Thirty-seven sightings of humpback whales (some likely to be the same animals) were made at Scott Reef during the 2006 winter season and sperm whales, large beaked and baleen whales may also occur.

The proposed Maxima 3D Marine Seismic Survey is planned to commence in mid July and to continue through the peak season for migrating humpback whales. The numbers in the area do not appear to be large and the proponent has committed to the implementation of the *Guidelines on the application of the EPBC Act to Interactions Between Offshore Seismic Operations and Larger Cetaceans*. These guidelines require:

- soft start procedures and signals between seismic lines (all acquisition sequences to commence with a series of shots with gradually increasing sound intensities to warn and allow time for wildlife to move away);
- daylight observation by a trained observer;
- an adaptive management framework requiring survey modification or postponement based on a framework of observed cetacean behaviours and/or minimum distance triggers; and
- the recording of whale sightings.

The EPA has received the following expert advice from the Department of Environment and Conservation;

> *...there is limited potential for significant impact to the environs of Scott Reef from this single event survey.*

The proponent should consider further survey work to investigate the occurrence and habitat use of a range of cetacean species in the study area, in particular during the anticipated time of year for the proposed survey program. This may assist in predicting impacts of this survey and / or further future surveys in the area.

Advice was also received from the Commonwealth Department of the Environment and Water Resources;

A significant impact on cetaceans is considered unlikely due to the relatively short duration of the survey, its location away from important whale habitat areas, and noting application of the cetacean interaction guidelines.

Summary

Based on the information provided, proponent commitments and expert advice, the EPA has reached the conclusion that the objective for fauna will be met in relation to cetaceans provided:

- Operations adhere to the *Guidelines on the Application of the EPBC Act to Interactions Between Offshore Seismic Operations and Larger Cetaceans;* and
- The proponent designs and implements a monitoring program to acquire information on cetacean species, abundances and seasonal patterns of use at Scott Reef.

Reptiles

Green and hawksbill turtles nest on Sandy Island. The proponent surveyed turtle tracks during February, September and November 2006. Although some nesting may occur all year round, most appears to take place during the summer months with mating commencing in October. The proposed Maxima 3D Marine Seismic Survey is planned to commence in mid July and to be completed prior to mid October. The proponent has also committed to maintaining a minimum buffer distance of 3 kilometres between the nearest seismic acquisition line and Sandy Island.

There is a small resident population of sea turtles and large numbers of sea snakes at Scott Reef. Turtles generally move away from acoustic emissions and sea snakes are expected to behave in a similar manner.

The EPA has received the following expert advice from the Department of Environment and Conservation;

If this proposal is considered appropriate for approval, the EPA should consider recommending a condition that restricts the seismic survey operations to times outside the marine turtle breeding, nesting and hatching seasons.

Summary

Based on the information provided, proponent commitments and expert advice, the EPA has reached the conclusion that the objective for fauna will be met in relation to reptiles provided:

- Operations take place outside the peak breeding season for marine turtles;
- A minimum distance of 3 kilometres is maintained between Sandy Island and the nearest seismic acquisition line; and
- The operator uses soft start procedures and maintains soft signals between seismic lines as set out in the *Guidelines on the Application of the EPBC Act to Interactions Between Offshore Seismic Operations and Larger Cetaceans.*

Fish

Fish communities at Scott Reef are very diverse with 898 species having been recorded from surveys to date and an expectation that this will rise above 1000 species when more surveys are carried out. No species endemic to Scott Reef have been recorded. However, Scott Reef represents a major portion of the habitat of six species that have been recorded only at Scott Reef, Seringapatam Reef and the Rowley Shoals.

Many reef fish inhabit restricted home ranges and when danger approaches they take cover amongst the coral colonies and other crevices on the sea floor. These species are unlikely to flee from the intense acoustic emissions from airguns. In response to a request for additional information about seismic impacts on non-fleeing fish species, the proponent prepared a semi-quantitative risk assessment involving:

- a review of the likely impacts on fish from acoustic emissions;
- the modelling and mapping of received sound energy levels (SELs) throughout the Maxima 3D Marine Seismic Survey area; and
- an analysis of the distribution of received SELs in relation to mapped benthic habitats at Scott Reef as an indication of potential impacts on fish communities.

The risk analysis provides a valuable tool for the environmental impact assessment. However, there remain significant gaps in knowledge relating to the impacts of noise on fish. The scientific literature on this subject is small, and relating the findings directly to the current proposal is not straight forward. The proponent has committed to the implementation of a rigorous monitoring and adaptive management program as part of the Maxima 3D Marine Seismic Survey proposal. The additional information from this monitoring program will reduce the level of uncertainty for future assessments of seismic surveys.

Noise impacts on fish include:

- low level behavioural responses, such as changes in the direction of swimming to avoid sources of noise;
- high level behavioural responses including 'C start' reactions – the fish contorts momentarily and forms the shape of the letter C;
- temporary reduced hearing, or temporary threshold shift (TTS). This refers to the increased sound levels required before the animal hears them. It occurs to humans when for example they attend a loud pop concert and feel a bit deaf for a few hours afterwards;
- permanent reduction of hearing or permanent threshold shift (PTS);
- other physiological damage to organs including swim bladder, kidneys and liver; and
- direct mortality.

There is significant variation among fish species regarding the magnitude of noise related impacts at different noise intensities. Based on a review of the limited scientific literature, three categories of received SELs were selected by Woodside Energy for the purpose of the risk assessment:

1. Category 1 (cumulative SELs of 180 – 187 dB re 1 $\mu Pa^2.s$). This category provides an estimate of received energy that could cause the onset of TTS.

2. Category 2 (cumulative SELs of 187 – 200 dB re 1 $\mu Pa^2.s$). This category provides an estimate of received energy that could cause onset of hair cell damage associated with long term TTS or PTS.

3. Category 3 cumulative SEL - >200 dB re 1 $\mu Pa^2.s$ The threshold of 200 dB re 1 $\mu Pa^2.s$ is based on a graph in Popper *et al*., (2006) and represents received energy levels that could cause TTS onset but no injury to non-auditory tissues in a 1kg size fish. The graph is presented on page 360 of the EPS document (*Woodside, 2007*).

Benthic habitats at Scott Reef have been mapped to a depth of 70 metres (Figure 2). Habitats below that depth have not been investigated. Areas likely to experience cumulative SELs in each of the three noise categories have been mapped and the proportional cover of each habitat type calculated to provide an estimate of potential impacts on fish communities. The results of this analysis are presented in Table 2.

A fish species would be at risk from acoustic emissions if both:

- a significant proportion of the population was exposed to SELs that cause serious impacts to individual fish; and
- the population's capacity to recover from such impacts was low.

Based on advice from the Australian Institute of Marine Science, approximately one third of fish species that occur in each mapped habitat are likely to flee the approaching air guns and are therefore less likely to be exposed to intense noise levels.

Category 1 received SELs are predicted to cause some behavioural responses and temporary hearing impairment (TTS). However, by ensuring sufficient recovery time between subsequent exposures from nearby acquisition lines, levels of TTS will not compound, and no long term impacts will occur in areas predicted to receive only category 1 SELs.

The proponent has committed to allow the maximum time period possible between lines, with no less than six hours between lines within 400 metres of each other. Studies on two fish species indicated complete recovery at 18 and 24 hours from TTSs of 25 and 20dB, (*Popper et al., 2005*). However, no measurements were taken at shorter time periods. The recovery period for a 35-55 dB TTS induced in a human by a continuous noise is 5 hours, while recovery times for a similar TTS induced by tone bursts are much shorter (*Patuzzi 1998a, 1998b*). The proposed no-return time of six hours between seismic lines would therefore appear reasonable for recovery from TTS.

The proportional areas of most habitats predicted to receive only category 1 SELs is low and is restricted to the periphery of the proposed survey acquisition area. This is because the union polygons of the whole survey overlap at category 2 SELs. However, during the acquisition of each individual seismic line, received SELs likely to result in TTS (above the threshold for category 1) impact a swath of seabed 800 metres wide. If the temporary nature of the TTS predicted for category 1 SELs is to be assured, then the minimum six hour no-return commitment will need to be extended from 400 metres to 800 metres at least in the shallower mapped environments, above 100 metres. Received SELs at depths greater than 100 metres will be lower than those at shallower depths.

Of the ten habitat types that occur within State waters at Scott Reef, the seismic survey passes directly over four which therefore receive category 3 SELs. These habitats all occur within the deep south reef lagoon. These habitats are characterised by high fish diversities and are of regional significance. However, none of the four habitats is predicted to receive category 3 SELs over more than about ten per cent of its total area.

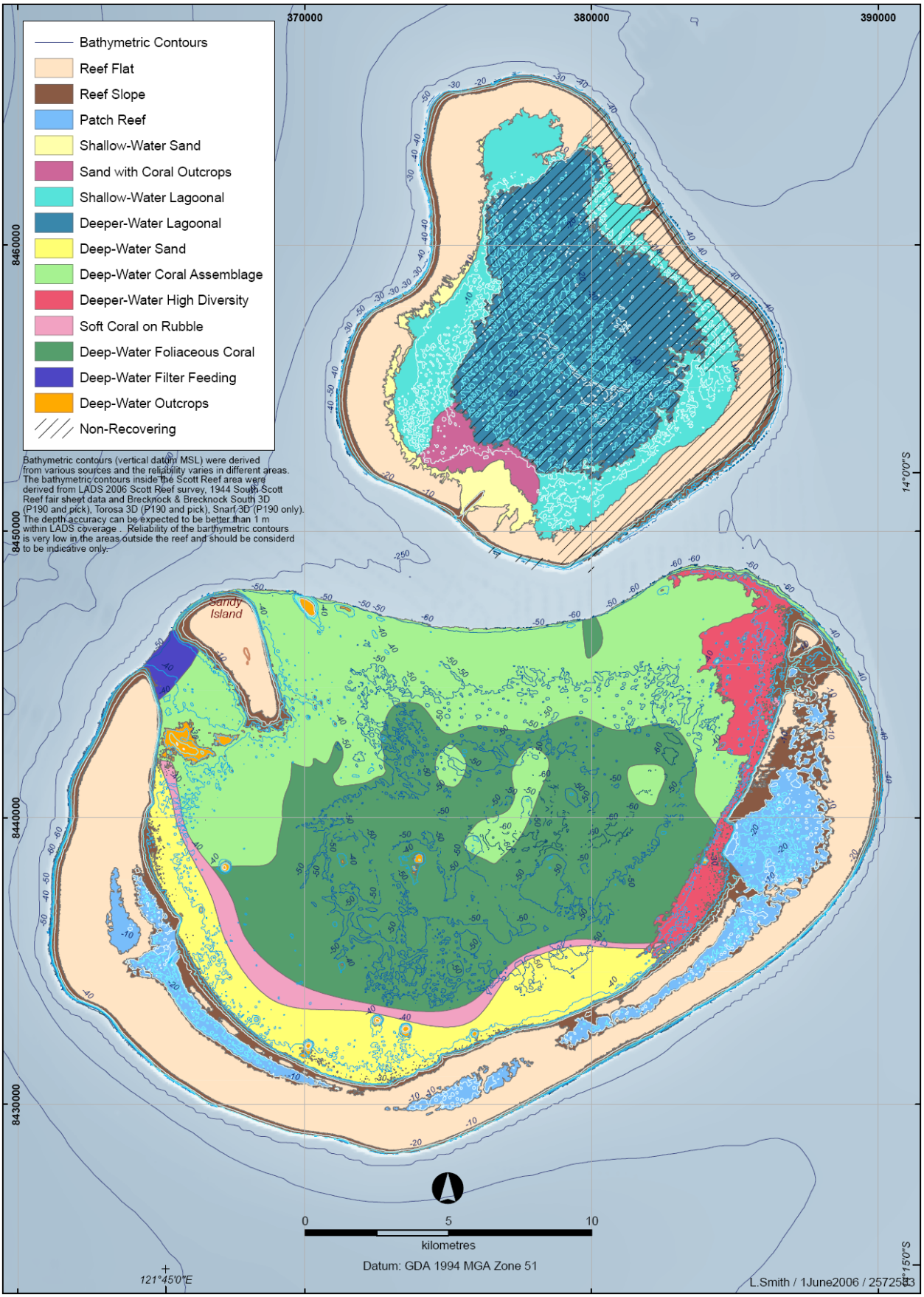


Figure 2. Benthic habitats of Scott Reef. (Source, Australian Institute of Marine Science).

Benthic Habitat Type	Water Depth (m)	Total Habitat Area (km^2)	Area and Percentage of Habitat Exposed at Different Sound Exposure Levels (SEL) – State Waters Only					
			Level 1 SEL (>180 dB re 1µPa^2.s)		Level 2 SEL (>187 dB re 1µPa^2.s)		Level 3 SEL (>200 dB 1µPa^2.s)	
			Area (km^2)	**%**	**Area (km^2)**	**%**	**Area (km^2)**	**%**
Deeper-Water High Diversity	30-45	16.38	8.03	49.04	7.14	43.56	1.42	8.64
Deep-Water Coral Assemblage	35-55	64.21	28.92	45.03	25.01	38.95	4.84	7.53
Deep-Water Foliaceous Coral	30-50	49.77	13.40	26.93	11.31	22.73	1.37	2.75
Reef Slope	4-30	35.87	4.67	13.03	0.03	0.08	0	0
Deep-Water Outcrops	20-40	3.21	0.23	7.14	0.18	5.61	0.02	0.78
Reef Flat	1-4	85.70	0.03	0.03	0	0	0	0
Deep-Water Sand	20-40	35.13	0	0	0	0	0	0
Patch Reef	1-20	26.54	0	0	0	0	0	0
Soft Coral on Rubble	30-50	10.17	0	0	0	0	0	0
Deep-Water Filter Feeding	35-100	2.26	0	0	0	0	0	0
Shallow-Water Sand	3-7	0	0	0	0	0	0	0
Deeper-Water Lagoonal	12-25	0	0	0	0	0	0	0
Shallow-Water Lagoonal	3-12	0	0	0	0	0	0	0
Sand with Coral Outcrops	3-8	0	0	0	0	0	0	0
Totals		**329.24**	**55.28** **16.79%***		**43.67** **13.26%***		**7.64** **2.32%**	

[*Percentage of Total Habitat Area]

Table 2. Percentage areas of habitats within State waters predicted to receive sound energy levels within category 1, category 2 and category 3. (source, Woodside, 2007)

Reef fish have characteristically high fecundity as an adaptation to the naturally high levels of disturbance associated with coral reef ecosystems. The capacity of coral reef fish populations to recover from events such as cyclones is therefore high. Severe storms cause both direct fish mortality and habitat destruction. The proposed seismic survey is not predicted to damage reef habitat or to cause direct mortality (other than to insignificant numbers of pelagic fish eggs and larvae within about five metres of the airgun array). Even if ten per cent of reef fish populations were eliminated, rapid population recovery would be expected to occur because of their characteristically high fecundity and undamaged coral reef habitats. The predicted extent and distribution of category 3 SELs, on their own, are therefore not likely to result in any significant ecological impacts.

Many coral reef fish exhibit strong habitat preferences, and a risk assessment based on an analysis of received SELs on different habitats provides a useful guide to impacts on fish. The analysis does not however, take account of differential distributions of fish abundance or biomass; i.e. the data are not available to distinguish between, and therefore to analyse the impacts on, areas of high and low fish abundances. The model is also limited by not taking account of the number of species with distributions that extend over two, three or more habitat types. If a species that occurs within a habitat that is predicted to have high proportional areas of received SELs but also occurs throughout other habitats with smaller proportional areas of impact, then it is likely to be at less risk than a species restricted to a single high impact area.

The habitat predicted to have the highest percentage area (>43% in the State waters component of the habitat) of received SELs in categories 2 and 3 is called *Deeper-Water High Diversity* (DWHD), (Table 2 and Figure 2). This habitat occurs below 30 metres within the lagoon of south Scott Reef. It is unlikely that fish species will be confined to this habitat with most also occurring in the other two deep coral habitats where the predicted proportional areas impacted by SELs above the threshold for category 2 are lower (39% and 23% in State water components). The deep coral habitats are continuous with *Reef Slope* which is the shallower coral habitat. Many of the fish species that occur within the deep water coral habitats will also occur within the *Reef Slope* habitat where the predicted received SELs above the threshold for category 2 cover less than 0.1 per cent of the habitat. For these fish species, their broader distributions have the potential to significantly lower the overall risk of impacts on their populations.

Received SELs of category 2 intensities could cause the onset of hair cell damage associated with long term TTS or PTS. Although hair cell damage was not analysed, the results of additional investigations into the impacts of seismic emissions on tropical reef fish indicate no other abnormal histopathology, prolonged behavioural responses or changes in fish abundances, biomass or diversity that could be attributed to the impacts of acoustic emissions, (section 6.2.1.3 of the EPS document, *Woodside, 2007*). The effects of hearing impairment on, for example vulnerability to predation or feeding and breeding success, remain unknown. However, for the pattern of received SELs predicted within State waters to cause impacts of ecological significance, species would need to be non-fleeing, have a distribution restricted to areas of high impact, and have a low fecundity. This combination of factors is considered unlikely.

To minimise impacts from acoustic emissions, the proponent has committed to testing the adequacy of smaller airguns prior to the proposed survey and to the use of the lowest capacity necessary for data acquisition.

The deep chasm between north and south Scott Reef is unique in the region. It is also more likely to provide habitat for fish species with low fecundity and hearing specialisations which could make them more vulnerable to the impacts of acoustic emissions than most of the shallower reef fish.

The component *Deep Reef Walls* and *Ocean Floor* are likely to be 'habitats' well represented beyond the chasm itself. For this reason, fish species are not expected to be restricted to the chasm alone. The noise model outputs over the chasm indicate high percentage areas of received SELs above the threshold for category 2. However, the model outputs are based on received SELs at a standard depth of 40 metres and the received SELs at depths of several hundred metres in the chasm will be lower.

The majority of marine fish species are predicted to be "hearing generalists". Hearing generalists do not have a connection between chambers in the ear and other gas filled organs in the body. This makes them less sensitive to the impacts of acoustic emissions than fish species that are hearing specialists. Hearing specialisations are associated primarily with fresh water and possibly also deep sea fish species that occur in quiet areas often with poor visibility where acute hearing provides a mechanism to improve awareness of their surroundings. Coral reefs are one of the noisiest habitats in the ocean, but while hearing specialists are uncommon on coral reefs, squirrel fish (Holocentrids) and big eyes (Priacanthids) are exceptions. The predicted impacts for category 2 SELs are based on those likely to affect hearing generalists. The impacts experienced by squirrel fish and big eyes are unknown but could be more acute. However, there are unlikely to be any species belonging to either of these two families that are restricted to the deep water coral habitats where higher percentage areas are predicted to receive SELs above the threshold for category 2.

The Australian Institute of Marine Science (AIMS) expressed some concern in relation to the level of impacts, especially for SELs in categories 2 and 3, and both AIMs and the Western Australian Museum expressed concerns relating to gaps in knowledge about the impacts of noise on fish. However, the independent peer reviewers and the Department of Fisheries are of the view that the proposed Maxima 3D Marine Seismic Survey will not cause any significant biological impacts to fish populations:

Source of advice	Advice
Department of Fisheries	*Based on the information presented in the revised EPS, the Department of Fisheries considers the possible impacts from the proposal to be at an acceptable level of risk.*
Independent peer reviewer Mardi Hastings	*The proposed Maxima 3D seismic survey should not have any significant biological impact due to cumulative exposure to impulsive sounds from the airgun array on the fishes in Scott Reef.*
Independent peer reviewer Peter Sale	*… there should be trivial, if any measurable, increases in mortality of fish.*

Uncertainties associated with the model output and predicted impacts would ideally be managed through an adaptive management program and the proponent has made a commitment to develop and implement a rigorous monitoring and adaptive management program. The program is to include:

- The development of an adaptive management framework involving a brief preliminary survey plus a framework for modification and/or cessation of the main Maxima 3D Marine Seismic Survey based on trigger values to be developed during the preparation of an environmental management plan; and
- The gathering of data for analysis after the Maxima 3D Marine Seismic Survey with a view to informing subsequent survey assessments both at Scott Reef and in other tropical reef locations.

The monitoring program is to include a verification of the model by comparing modelled with actual SELs. Observations and measurements of behavioural, physiological and anatomical impacts on fish will also be undertaken.

Expert advisers and other stakeholders strongly advocate the consultative development of an adaptive management framework and monitoring program if the proposal is progressed. A brief preliminary survey will also address some of the concerns expressed by AIMS and the WA Museum about knowledge gaps.

Summary
Based on the risk assessment presented in the EPS, the limited available literature, plus the balance of expert advice, the EPA has reached the conclusion that the objective for fauna will be met in relation to fish if:

- The percentage areas of each habitat receiving SELs equivalent to category 1, category 2 and category 3 do not exceed those presented in the EPS document (*Woodside, 2007*);
- The impacts on fish predicted for each noise category are maintained within those predicted in the EPS document (*Woodside, 2007*);
- The operator uses soft start procedures and maintains soft signals between seismic lines as set out in the *Guidelines on the Application of the EPBC Act to Interactions Between Offshore Seismic Operation and Larger Cetaceans* to alert fish that will flee;
- A minimum TTS recovery time of six hours is allowed before the acquisition of seismic lines within 800 metres of one another at depths less than 100 metres; and
- Operations are conducted in accordance with an approved adaptive management framework and rigorous monitoring program that will include a brief preliminary survey and agreed triggers to modify and/or cease operations.

4.2 Introduced marine pests

The EPA objective for marine pest management is:

> To minimise the risk of introducing unwanted, non indigenous marine organisms.

Marine pests can be transported into areas on ships hulls and released as a result of ballast water discharges. Australia has mandatory ballast water management requirements for international shipping that prohibit all international vessels from discharging "high risk" ballast water in Australian Ports. There are no regulatory requirements in place that deal specifically with hull fouling.

The seismic and support vessels are not likely to pose a significant risk of carrying pest species with the potential to invade Scott Reef unless they have recently stayed for an extended period in an overseas port or an Australian port known to be infected with pest species.

This issue is routinely managed by the Department of Fisheries in accordance with Regulation 176 of the Fish Resources Management Regulations 1995, that states;

> *A person must not bring into the State, or a particular area of the State, a live fish of a species not endemic to the State, or that part of the State…*

The proponent will comply with a requirement to provide a history of vessel locations, antifouling schedules and other treatments to assess the level of risk and identify appropriate management actions.

Summary

Based on the proponent commitments and expert advice, the EPA has reached the conclusion that the Maxima 3D Marine Seismic Survey can be managed to meet the objective for marine pest management provided an environmental management plan considered appropriate by the Department of Fisheries to address the level of risk outlined in the vessel histories is prepared and implemented.

4.3 Potential pollution

The EPA objectives for marine pollution are:

- Ensure that planned emissions are in accordance with statutory requirements and do not adversely affect environmental values; and
- Ensure that the risk of an oil spill is extremely low and that there is a high level of preparedness to effectively manage accidental spills.

The proponent has committed to ensuring that all planned discharges of sewage and galley waste will take place outside State waters at a minimum distance of four nautical miles from shore or coral reef habitats for macerated galley waste and treated sewage and, beyond 12 nautical miles for untreated sewage. Although there are no planned discharges within State waters, the EPA have clearly communicated to the proponent that they expect waste disposal to be in accordance with best management practice.

In relation to accidental spillages of fuel and oils, the proponent has made the following commitments:

- Vessel refuelling will take place during daylight hours only, outside State waters and the lagoon of south Scott Reef, at a distance of at least 12 nautical miles from the reef;
- The seismic survey vessel will comply with MARPOL 73/78 Annex 1 requirements to prevent oil pollution;
- No oily effluents from bilges, etc will be discharged in shallow coastal water or near coral reefs; and
- Fuel and oil spills will be managed according to the oil spill arrangements and procedures outlined in Woodside's *Western Australian and Dampier Sub-Basin Oil Spill Contingency Plan.*

Scott Reef is a navigational hazard and although very unlikely, the potential for a significant fuel or oil spill in close proximity to the reef cannot be discounted. The Department of Industry and Resources has notified the proponent that they are to prepare and implement a revised oil spill contingency plan prior to the commencement of the Maxima 3D Marine Seismic Survey. The revised oil spill contingency plan will take account of the sensitive

environmental values at Scott Reef and will be in line with the National Oil Spill Contingency Plan (Natplan) and with the Western Australian Oil Spill Contingency Plan, Westplan (Marine Oil Pollution).

Summary
Based on the proponent's commitments, and the requirement by the Department of Industry and Resources for a revised oil spill contingency plan, the EPA has reached the conclusion that the Maxima 3D Marine Seismic Survey can be managed to meet the objective for potential pollution without additional conditions.

5. Conclusions

The EPA has considered the proposal by Woodside Energy Ltd. to conduct a three dimensional seismic survey at Scott Reef.

The EPA notes that Scott Reef is of high conservation value and that the proposed Maxima 3D Marine Seismic Survey could adversely impact this environment if not managed appropriately. The three key environmental factors identified in relation to this proposal are; acoustic emission impacts on marine fauna, introduced marine pests and potential pollution.

By avoiding the most sensitive seasons of the year, maintaining appropriate buffer distances, adhering to operational guidelines for wildlife interactions and implementing rigorous adaptive management and monitoring programs, the impacts to marine fauna associated with acoustic emissions are expected to remain within acceptable levels.

The risk of introducing marine pests through ballast water or from ship's hulls will be reduced to acceptable levels through the preparation of an environmental management plan detailing the necessary actions to be taken commensurate with the recent maintenance and deployment histories of the vessels to be used.

No planned discharge of wastes will take place within State waters and with the requirement by the Department of Industry and Resources for the proponent to prepare and implement a revised oil spill contingency plan, the risk of pollution is low.

The EPA has therefore concluded that the proposal can be managed to meet the EPA's environmental objectives, provided there is satisfactory implementation by the proponent of their commitments and the recommended conditions set out in Appendix 2.

6. Recommendations

The EPA submits the following recommendations to the Minister for the Environment:

1. That the Minister notes that the proposal being assessed is for a three dimensional seismic survey at Scott Reef;
2. That the Minister considers the report on the key environmental factors as set out in Section 4;
3. That the Minister notes that the EPA has concluded that the proposal can be managed to meet the EPA's environmental objectives, provided there is satisfactory implementation by the proponent of the recommended conditions set out in Appendix 2, including the proponent's commitments; and

4. That the Minister imposes the conditions and procedures recommended in Appendix 2 of this report.

Appendix 1

References

Patuzzi R., (1998a), Exponential onset and recovery of temporary threshold shift after loud sound: evidence for long-term inactivation of mechano-electical transduction channels. Hear Res. 125(1-2): 17-38.

Patuzzi R., (1998b), (1999), *A four-state kinetic model of the temporary threshold shift after loud sound based on inactivation of hair cell transduction channels.*. Hear Res. 125(1-2): 39-70 (erratum in Hear. Res. 130(1-2): 231-2).

Popper *et al*., (2005), *Effects of exposure to seismic airgun use on hearing of three species.* Journal of the Acoustical Society of America. 117(6): 3958-3971.

Popper *et al*., (2006), *Interim Criteria for Injury of Fish Exposed to Pile Driving Operations:* A White Paper. (May 2006; in review)

Woodside Energy Ltd., (2007), *Environmental Protection Statement, Maxima 3D Marine Seismic Survey, Scott Reef*. Perth, WA.

Appendix 2

Recommended Environmental Conditions and Proponent's Consolidated Commitments

Statement No.

RECOMMENDED ENVIRONMENTAL CONDITIONS

STATEMENT THAT A PROPOSAL MAY BE IMPLEMENTED (PURSUANT TO THE PROVISIONS OF THE ENVIRONMENTAL PROTECTION ACT 1986)

MAXIMA 3 DIMENSIONAL MARINE SEISMIC SURVEY
SCOTT REEF

Proposal: The acquisition of three dimensional seismic data using towed airguns and towed hydrophones at Scott Reef.

Proponent: Woodside Energy Ltd.

Proponent Address: Woodside Plaza, 240 St. George's Terrace, PERTH WA 6000

Assessment number: 1675

Report of the Environmental Protection Authority: Bulletin 1255

The proposal referred to in the above report of the Environmental Protection Authority may be implemented. The implementation of that proposal is subject to the following conditions and procedures:

1 Proposal Implementation

1-1 The proponent shall implement the proposal as documented and described in schedule 1 of this statement subject to the conditions and procedures of this statement.

2 Proponent Nomination and Contact Details

2-1 The proponent for the time being nominated by the Minister for the Environment under sections 38(6) or 38(7) of the *Environmental Protection Act 1986* is responsible for the implementation of the proposal.

2-2 The proponent shall notify the Chief Executive Officer of the Department of Environment and Conservation (CEO) of any change of the name and address of the proponent for the serving of a notice or other correspondence within 30 days of such change.

3 Time Limit of Authorisation

3-1 The authorisation to implement the proposal provided for in this statement shall lapse and be void within five years after the date of this statement if the proposal to which this statement relates is not substantially commenced.

3-2 The proponent shall provide the CEO with written evidence which demonstrates that the proposal has substantially commenced on or before the expiration of five years from the date of this statement.

4 Compliance Reporting

4-1 The proponent shall submit to the CEO an environmental compliance report within three months after completion of the Maxima 3D Marine Seismic Survey.

4-2 The environmental compliance report shall address each element of an audit program approved by the CEO and shall be prepared and submitted in a format acceptable to the CEO.

The environmental compliance report shall:

1. be endorsed by signature of the proponent's Managing Director and Chief Executive Officer or a person, approved in writing by the CEO, delegated to sign on behalf of the proponent's Managing Director and Chief Executive Officer;

2. state whether the proponent has complied with each condition and procedure contained in this statement;

3. provide verifiable evidence of compliance with each condition and procedure contained in this statement;

4. state whether the proponent has complied with each key action contained in any environmental management plan or program required by this statement;

5. provide verifiable evidence of conformance with each key action contained in any environmental management plan or program required by this statement;

6. identify all non-compliances and non-conformances and describe the corrective and preventative actions taken in relation to each non-compliance or non-conformance; and

7. provide an assessment of the effectiveness of all corrective and preventative actions taken.

4-4 The proponent shall make the environmental compliance reports required by condition 4-1 publicly available in a manner approved by the CEO.

5 Seismic Survey Parameters

5-1 Seismic acquisition shall not take place outside the survey area defined in Schedule 2 and illustrated in Figure 1 and is to approach Sandy Island no closer than three kilometres from the Sandy Island weather station tower located at 121°46'34"E 14°03'23"S (Datum GDA94).

5-2 To minimise impacts to nesting turtles and the mass spawning of corals, the proponent shall not conduct the Maxima 3D Marine Seismic Survey outside the period between 1 May and 16 October in any year.

5-3 Prior to the commencement of data acquisition, the proponent shall conduct preliminary surveys to determine minimum airgun capacities required for data acquisition and shall use these minimum levels for all seismic acquisition. At no time are airguns with a combined capacity greater than 3000 cubic inches to be discharged.

5-4 Seismic shots are to be no less than 18 metres apart when airguns are fired at the capacity required for data acquisition.

5-5 The total number of survey shots in State waters shall not exceed 70,000 without the written approval of the CEO.

5-7 In water depths of 100 metres or less, the proponent shall not discharge seismic shots within a mapped horizontal distance of 800 metres from a previous series of seismic shots unless a minimum of six hours has lapsed since the previous series of seismic shots was discharged.

5-7 In water depths greater than 100 metres, the proponent shall not discharge seismic shots within a mapped horizontal distance of 400 metres from a previous series of seismic shots unless a minimum of six hours has lapsed since the previous series of seismic shots was discharged.

6 Prevention of disturbance to marine fauna

6-1 To prevent damage to benthic communities the seismic and support vessels shall not anchor within State waters except in the case of an emergency.

7 Adaptive Management Program for seismic operations

7-1 Seismic operations are to be undertaken in accordance with the operational framework outlined in Schedule 3.

7-2 Prior to the commencement of the Maxima 3D Marine Seismic Survey, the proponent shall prepare an Adaptive Management Plan, to the requirements of the Minister for the Environment on the advice of the following agencies:

Department of Environment and Conservation;
Department of Fisheries; and
Department of Industry and Resources.

The objective of the plan is to:

- Develop an operational framework that will maintain the actual levels of impacts generally within those levels predicted in the EPS document (Woodside, 2007, Environmental Protection Statement, Maxima 3D Marine Seismic Survey, Scott Reef)

The Adaptive Management Plan shall include:

1. Defined and measurable trigger values plus a framework of associated operational responses to ensure that within State waters:

    - the actual percentage areas of each mapped habitat depicted in Figure 2 receiving cumulative sound energy levels within 1 metre of the sea floor, equivalent to category 1, category 2 and category 3 as defined in Table 1, do not exceed the predicted percentage areas in Table 3 by more than five per cent;
    - death of reptiles, mammals and fish other than pelagic fish eggs and larvae within ten metres of the airgun array, as a result of seismic shots is avoided;
    - damage to habitat, for example coral breakage, as a result of seismic shots, is avoided; and
    - the observed impacts from received cumulative sound energy levels equivalent to category 1, category 2 and category 3 as defined in Table 2, do not exceed the predicted impacts outlined in Table 2 either as a result of exposure to the sequence of seismic shots associated with a single seismic line or as a result of exposure to seismic shot sequences associated with the acquisition of adjacent and infill seismic lines.

2. Operational procedures for ensuring trigger values in 1. above are consistently met, including:

    - time-frames for responses;
    - responsible personnel; and,
    - communication pathways that will ensure that the responsible personnel can assess measured impacts against the required trigger values and implement necessary operational procedures within the required time frames.

3. A preliminary field survey:

    - at Scott reef;
    - using the same airgun array and other seismic acquisition equipment to be used for the Maxima 3D Marine Seismic Survey;
    - of sufficient duration to complete field experimentation necessary to ensure that the Maxima 3D Marine Seismic Survey will be compliant with the four points outlined in condition 7-2 (1.) above and to address the requirements of condition 5-3; and
    - in sufficient time prior to commencement of the Maxima 3D Marine Seismic Survey to allow the results of field experimentation to be interpreted and used where necessary to refine the design and operational procedures for the delivery of the Maxima 3D Marine Seismic Survey in a manner compliant with this statement.

7-3 The proponent shall submit the Adaptive Management Plan to the Department of Environment and Conservation for approval on the advice of the Department of Fisheries and the Department of Industry and Resources at least ten business days prior

to the scheduled commencement of the preliminary field survey outlined in condition 7-2 (3.) above.

7-4 The proponent shall implement the approved Adaptive Management Plan required by condition 7-2.

7-5 The proponent shall make the Adaptive Management Plan required by condition 7-2 publicly available in a manner approved by the CEO.

8 Cetacean Monitoring Program

8-1 Prior to the commencement of the Maxima 3D Marine Seismic Survey, the proponent shall design a Cetacean Monitoring Program.

The objective of the monitoring program is to:

- Gather information about the patterns of use by cetacean species of the waters around Scott Reef.

The monitoring program shall:

1. Determine the seasonal abundance and locations of listed and priority cetacean species around Scott Reef during all twelve months of the year; and
2. Record whale sightings in a manner compatible with the Cetacean Sightings and Strandings Database (CSSD) which is housed at the Australian Antarctic Division.

8-2 The proponent shall ensure that the Cetacean Monitoring Program has been peer reviewed and is submitted to the Department of Environment and Conservation together with peer reviewer reports and the proponent's responses to the peer reviewer reports at least ten business days prior to the scheduled commencement of the Maxima 3D Marine Seismic Survey.

8-3 The proponent shall implement the peer reviewed Cetacean Monitoring Program required by condition 8-1.

8-4 The proponent shall make the peer reviewed Cetacean Monitoring Program required by condition 8-1 publicly available in a manner approved by the CEO.

8-5 Within two years of the commencement of the Maxima 3D Marine Seismic Survey, the proponent shall:

- forward to the Department of Environment and Conservation and to CSSD, all whale sightings data from the Scott Reef Cetacean Monitoring Program; and
- have prepared peer reviewed reports or publications addressing the patterns of use by cetaceans of the waters surrounding Scott Reef. Copies of this report or publication are to be provided to the Department of Environment and Conservation as soon as they are completed.

9 Fish Monitoring Program

9-1 Prior to the commencement of the Maxima 3D Marine Seismic Survey, the proponent shall design a Fish Monitoring Program.

The objective of the Fish Monitoring Program is to:

- Acquire information about the impacts of seismic surveys on fish.

The Fish Monitoring Program shall include:

1. Characterisation of the behaviours of tropical marine fish species representing members of those groups predicted to flee from seismic shots and members of those groups predicted not to flee from seismic shots, prior to, during and after exposure to a range of seismic shot sequences;

2. Investigate the types, and magnitudes of physiological impacts to the auditory and non-auditory tissues of tropical marine fish as a result of exposure to a range of seismic shot sequences;

3. Investigate the time related sequence of damage to, and repair of, auditory hair cells of tropical marine fish following exposure to a range of seismic shot sequences;

4. Investigate the hearing sensitivity of tropical marine fish species prior to and after exposure to a range of seismic shot sequences; and

5. Characterise any changes to the levels of fish diversity and abundance resulting from the Maxima 3D Marine Seismic Survey and if changes are detected, characterise the recovery of fish diversity and abundance levels until there are no significant differences from the levels of diversity and abundance prior to the Maxima 3D Marine Seismic Survey, or until three years has lapsed since completion of the Maxima 3D Marine Seismic Survey.

9-2 The proponent shall ensure that the Fish Monitoring Program has been peer reviewed and is submitted to the Department of Fisheries and the Department of Environment and Conservation together with peer reviewer reports and the proponent's responses to the peer reviewer reports at least ten business days prior to the scheduled commencement of the Maxima 3D Marine Seismic Survey.

9-3 The proponent shall implement the approved Fish Monitoring Program required by condition 9-1.

9-4 The proponent shall make the Fish Monitoring Program required by condition 9-1 publicly available in a manner approved by the CEO.

9-5 Within two years of the commencement of the Maxima 3D Marine Seismic Survey, the proponent shall have prepared peer reviewed reports or publications addressing the first four components of the Fish Monitoring Program listed above (condition 9-1, points 1 to 4). Peer reviewed reports or publications addressing the fifth component of the Fish

Monitoring Program shall be completed within twelve months of finding no significant difference between the pre-survey and post- survey levels of fish diversity and abundance or within a year after monitoring ceases in accordance with condition 9-1 (5). Copies of each report are to be provided to the Department of Fisheries and to the Department of Environment and Conservation as soon as they are completed.

10 Non-Indigenous Marine Species Management Plan

10-1 Prior to the deployment to Scott Reef of vessels or any other in-water equipment required to conduct the Maxima 3D Marine Seismic Survey, the proponent shall prepare a Non-Indigenous Marine Species Management Plan, to the requirements of the Minister for the Environment on advice from the Department of Fisheries.

The objective of the Non-Indigenous Marine Species Management Plan is to:

- prevent the introduction of non-indigenous marine organisms.

The Plan shall:

1. Address the risk of introducing pest species to Scott Reef by documenting a comprehensive recent history of:
   - activities;
   - locations;
   - anti fouling maintenance; and
   - ballast water management including a description of any internal treatment systems,

   relating to all vessels and in-water equipment required for the seismic survey.

2. Identify management measures, required to achieve the objective of preventing the introduction of pest species, commensurate with the level of risk associated with the vessel and equipment histories outlined in point 1 above.

3. Identify operational protocols and response procedures should marine pests be identified. This shall include a flow chart of actions, designation of responsibilities and clear communication pathways.

10-2 The proponent shall submit the Non-Indigenous Marine Species Management Plan to the Department of Fisheries for approval at least ten business days prior to the scheduled deployment to Scott Reef of any of the vessels or in-water equipment to be used in the preliminary survey or Maxima 3D Marine Seismic Survey.

10-3 The proponent shall implement the approved Non-Indigenous Marine Species Management Plan required by condition 10-1.

10-4 The proponent shall make the Non-Indigenous Marine Species Management Plan required by condition 10-1 publicly available in a manner approved by the CEO.

Schedule 1

The Proposal (Assessment No. 1675)

A three dimensional marine seismic survey covering an area of 172.43 sq km at Scott Reef, 430 kilometres north of Broome.

The proposal involves short pulse, low frequency, acoustic emissions from airgun arrays towed behind a dedicated seismic vessel. During the acquisition of seismic data, the vessel will move slowly and airguns will be fired every seven to ten seconds which is equivalent to every 18.75 metres. Reflected sound waves are recorded by sensitive hydrophones attached to four solid streamers. The streamers are each four kilometres long and they are to be spaced 100 metres apart while being towed behind the seismic vessel. The survey is planned to commence during the middle of July 2007 and will be conducted 24 hours a day for approximately 50 days.

The proposal is described in the following document – Environmental Protection Statement, Maxima 3D Marine Seismic Survey, Scott reef, Woodside Energy Ltd., March 2007.

Summary Description
A summary of the key proposal characteristics is presented in Table 1

Table 1 – Summary of Key Proposal Characteristics

Element	**Description**
Petroleum Permit area	TR/5
Area of seismic acquisition within State waters (approximate)	172.43 square kilometres.
Length of seismic lines (approximate)	920 kilometres
Distance between lines (approximate)	200 metres
Minimum distances of data acquisition from geographical features:	800 metres from the 10 metre lowest astronomical tide level within south Scott Reef Lagoon. 400 metres from the 10 metre lowest astronomical tide level around the outer edges of Scott Reef. 3 kilometres from the old weather station tower on Sandy Island 121°46'34"E 14°03'23"S (Datum GDA94)
Range of surveyed water depths (approximate)	20 metres to 1100 metres

Timing: • Commencement of preliminary survey • Duration of seismic acquisition survey	mid July 2007 Approximately 50 days
Number of seismic shots in State waters	No more than 70,000
Acoustic emissions: • Airgun capacity • Tow depth of airguns • Planned distance between seismic lines • Frequency of emissions • Shot point interval • Noise profile	Dual air gun arrays with a combined capacity of up to 3,000 cubic inches ~5 metres ~200 metres 7 to 10 secs Approximately 18.75 metres Short pulsed (less than 200 milliseconds) low frequency with most spectral energy less than 500Hz
Acoustic reception • Number of solid streamers • Length of solid streamers • Tow depth of streamers • Distance between streamers • Streamer type	4 4 kilometres ~7 metres ~100 metres Solid (not filled with kerosene) and fitted with pressure activated self inflating buoys

Schedule 2

Delineation coordinates for Maxima 3D Marine Seismic Survey

Coordinate boundaries for survey in State Waters

North-Western block

Coverage
365417.008, 8452808.337
362325.776, 8447607.134
364572.000, 8446166.496
365893.910, 8448170.670
369783.595, 8448546.235
370984.811, 8447835.001
371559.607, 8444434.642
370415.016, 8443724.337
372024.234, 8441394.074
372119.045, 8440613.938
370537.114, 8439491.573
370651.308, 8439179.149
and
370931.459, 8452860.820
371031.128, 8452293.989
375167.876, 8449723.912

South-Eastern block

Coverage
389128.888, 8450334.215
392443.275, 8437964.296
393369.619, 8438482.221
393523.773, 8438151.641
392561.080, 8437524.621
392718.425, 8436732.136
391803.390, 8436379.170
391627.814, 8436989.354
374035.647, 8426901.771
374496.004, 8426619.663
374206.436, 8426231.746
372013.477, 8425742.041
371159.762, 8425326.197
371026.177, 8425648.700
371496.929, 8425953.023
364028.597, 8429005.509
359135.607, 8432382.934
358124.482, 8435341.206
359575.477, 8438855.102
359928.858, 8438760.414
361214.925, 8433962.602
363296.259, 8431292.056
373519.384, 8427112.911
391510.020, 8437429.012
389372.942, 8445404.688
387415.251, 8447750.816
386441.480, 8447044.831
385478.304, 8444199.125
383414.810, 8438758.361
380682.340, 8436950.607
378448.623, 8435880.225
375792.311, 8435948.073
375451.767, 8436153.163

Schedule 3
Operational Framework for Fauna Interactions

Interpretation

Where this operational framework refers to large cetaceans, this term should be interpreted to mean all species of baleen whales plus sperm whales.

A Marine Fauna Observer

1. A designated Marine Fauna Observer (MFO) will be based onboard the seismic survey vessel at all times during on-site preliminary surveys and the main seismic survey at Scott Reef.
2. The MFO will be a suitably qualified and experienced person to identify marine wildlife and accurately interpret wildlife behaviors.
3. The survey MFO shall have access to assistants who have had training in whale and other wildlife observation techniques plus distance estimation. As a minimum, trained assistants will have studied and demonstrated familiarity with the APPEA CD-based identification and reporting package.
4. The MFO and assistants will be equipped appropriately for carrying out their duties (e.g. range finder binoculars, camera, plus positioning equipment, recording and communication equipment).
5. The MFO and assistants will have access to support vessels and opportunistic access to aircraft for the purpose of wildlife observation.
6. MFOs and any assistants will conduct visual observations throughout the survey and maintain a log of observational activities and wildlife sightings.

B Vessel operations without airgun discharge

1. All vessels are to alter course in order to maintain a distance of 300 metres from large whales.
2. In the event that a large whale or whales approach to within 300 metres, vessel speed is to be reduced to “no wake” and a course is to be steered away from the whale or whales.
3. Vessels will anchor only in case of emergency.

C Pre Start-up Visual Observation Procedures

1. The MFO will survey all State waters of south Scott Reef lagoon for the presence of any large cetaceans within 24 hours prior to commencement of airgun array operations within the lagoon and at least every three days during seismic surveys within the lagoon.
2. Data from lagoon surveys for large cetaceans are to be used to inform decisions relating to the timing and sequencing of acquisition of the different seismic lines in an attempt to avoid large cetaceans by at least 10 kilometres both during day-light and night time operations.
3. Night time operations are not to take place within south Scott Reef lagoon if large cetacean interactions resulted in three or more shut-down or power-down procedures within the lagoon during the previous day.
4. MFO observations which ensure effective visual monitoring of a 3 km radius around the seismic survey vessel (concentration of observations within the 210 degree forward arc) will begin at least 90 minutes prior to, and continue during, the use of any high-energy acoustic sources.

5. The MFO and assistants are: to use binoculars, be located in suitably elevated observation areas with 360 degree vision and be able to communicate with each other and with the Party Chief.

D Start-up Delay Procedures

1. The discharge of airguns will not commence if large cetaceans are within 3 kilometers from the survey vessel.
2. If large cetaceans are detected within 3 kilometres of the seismic survey vessel, the start up of acoustic sources will be delayed until they have been observed to move outside the 3 kilometers radius or, if they are no longer observable, 30 minutes after the last sighting within 3 kilometers.

E Soft Start Procedures

1. Airgun operations can commence when:
   a. pre Start-up Visual Observation Procedures have been completed;
   b. there are no large cetaceans within 3 kilometres of the seismic vessel; and
   c. the Department of the Environment and Water Resources has not issued directives to the contrary.
2. All airgun operations will commence with a sequential build-up of warning pulses. These soft start procedures are to commence with a gun (guns) of no more than 50 cubic inch capacity and increase emissions by approximately 6 dB per minute over a period of 20 minutes until the data acquisition airgun capacity is reached.
3. Airguns can be used continuously during line turns or changes, but must be 'powered down' to the smallest airgun of no more than 50 cubic inch capacity.
4. MFO visual observation will be maintained continuously during soft start and 'powered down' operations to establish the presence or absence of large cetaceans within 3 kilometres of the vessel and to make observations of other marine fauna.
5. If whales are sighted within 3 kilometres during soft start procedures, the seismic source will be shut down or 'powered down'. Re-commencement of soft start procedures can take place after 30 minutes has lapsed since the last whale sighting within the 3 kilometre zone whether the array has been shut down or 'powered down'.
6. If the airgun array is completely shut down between survey lines, the full start-up delay procedures and soft start procedures will be undertaken prior to the commencement of the next survey line.

F Survey Line Procedures

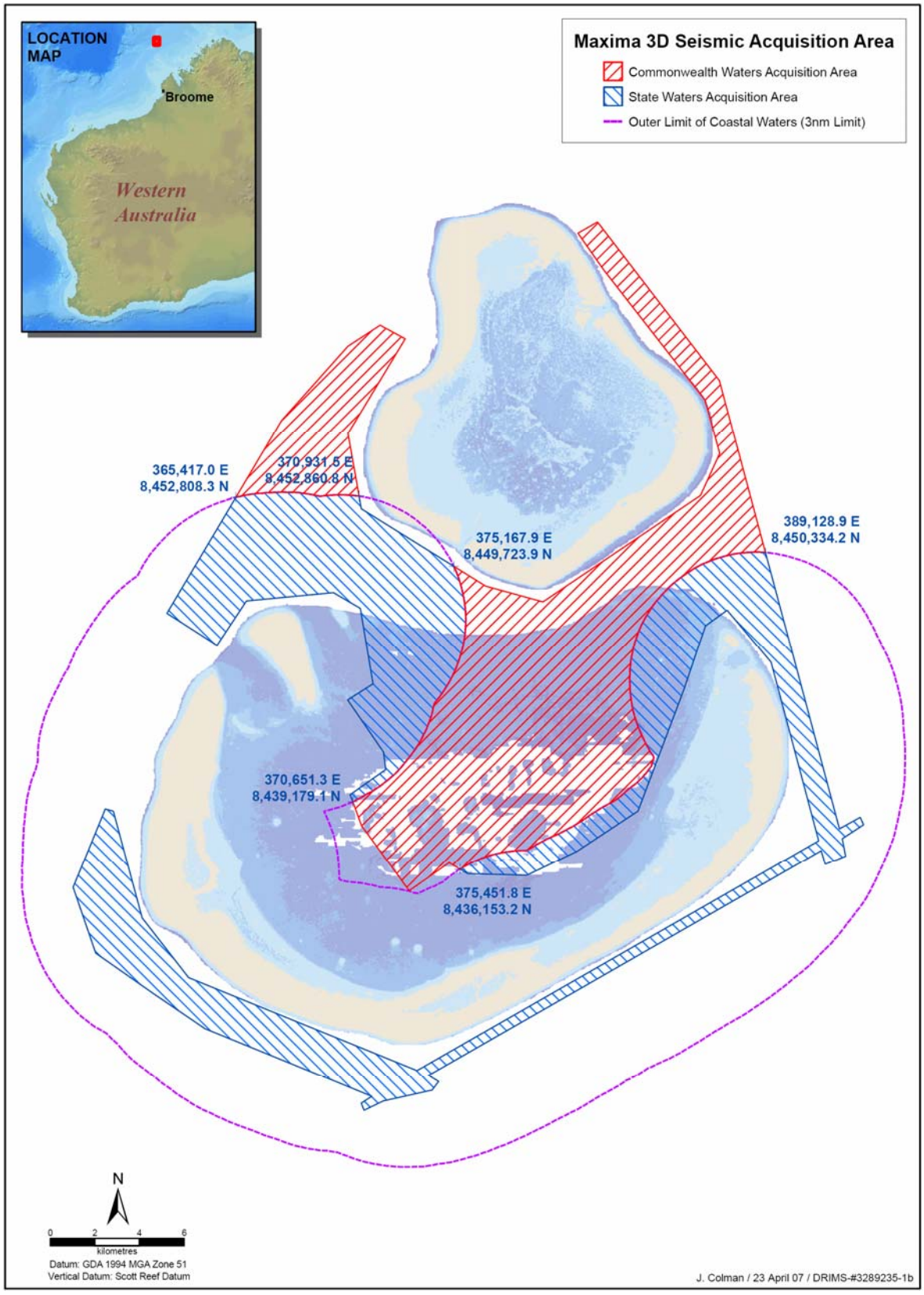
1. Continuous day light visual observations of the waters within 3 kilometres of the seismic vessel will be carried out during seismic operations by the MFO and trained assistant.
2. Where a seismic vessel with an operating acoustic source approaches within 3 kilometres of an individual whale or pod of whales, the acoustic source will be shut down or 'powered down' to a gun (guns) of no more than 50 cubic inch capacity.
3. Where an individual or pod of large cetaceans approaches within 3 kilometres of a seismic vessel, the acoustic source will be' powered down' or shut down unless the animal or animals are seen to be skirting the edge of the 3 kilometre limit.

4. The array will be fully shut down if any large cetaceans approach within 1.5 kilometres of the vessel or if large cetaceans show signs of distress or disorientation in the 1.5 to 3 kilometre zone.
5. The maximum frequency of shots during soft start and powered down procedures is 6 pulses per minute.
6. Where large cetaceans are seen as part of the observation procedures, continual observations should occur until 2 hours have passed since the last observation has occurred.
7. Following 'power down' or shut down procedures triggered by large cetacean encounters, unless contrary to instruction from the Department of the Environment and Water Resources seismic source operations can recommence when the large cetacean or cetaceans has been seen to move more than 3 kilometres from the seismic survey vessel, or has not been seen for 20 minutes.
8. Following acquisition of the first line and the first adjacent lines over each mapped habitat acquired during day light hours, the MFO will conduct post seismic line observations of the waters over these seismic lines for a period of no less than six hours.
9. The array will be fully shut down if observations of wildlife made from the seismic vessel, during post seismic line observations, or during any other surveillance activity, provide evidence of non-compliance with condition 7-2 (1).
10. If marine wildlife show signs of distress that could be attributed to seismic shots, the operator is to investigate the observation and must report the observations and results of the investigation to the Department of Environment and Conservation within six hours of the observation having been made.

G Recording and Reporting Procedures

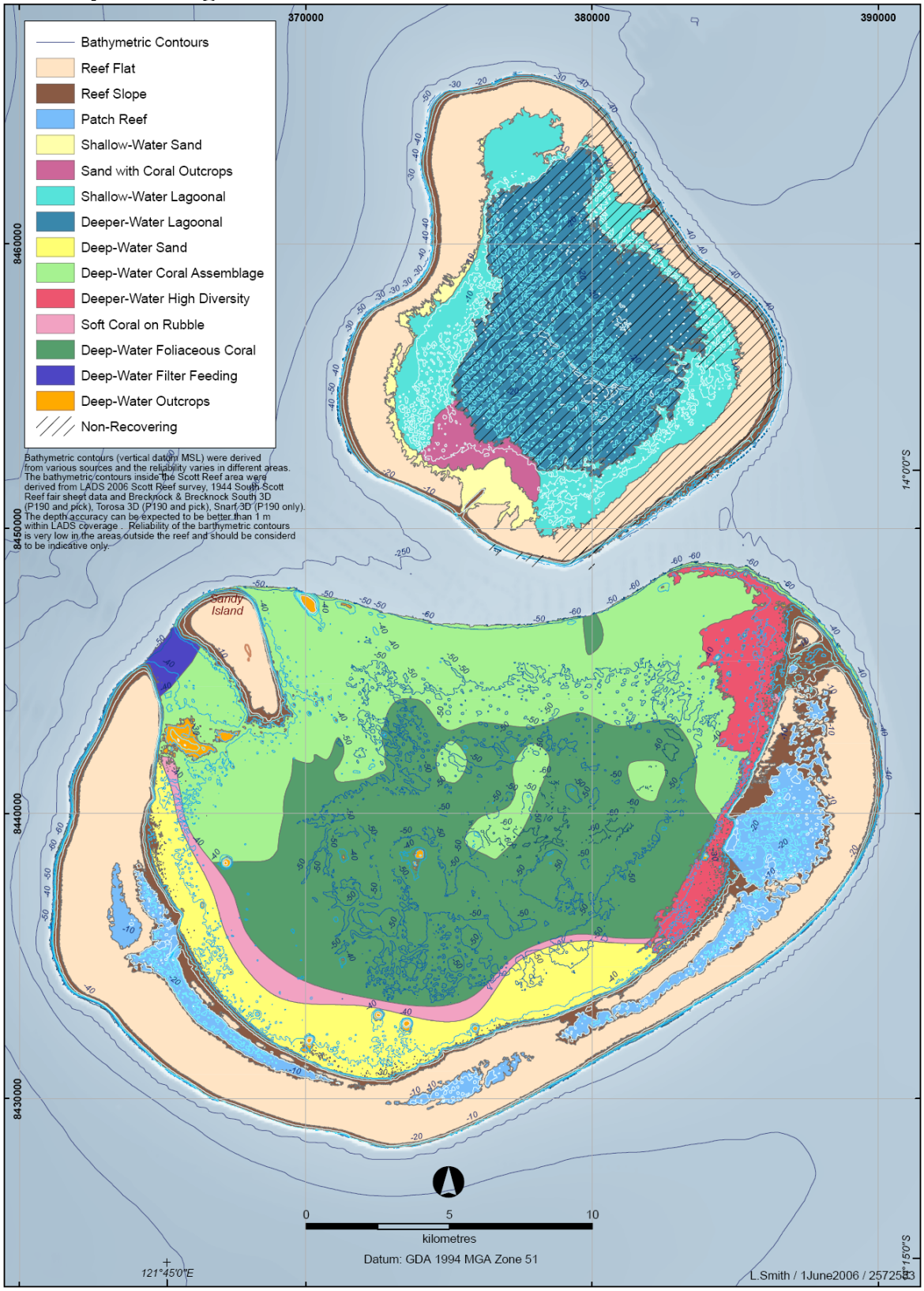
The MFO is to maintain a log of observation effort and of marine fauna observations. Data that will not be incorporated into the cetacean monitoring report, outlined in condition 8-5, are to be forwarded to the Marine Branch of the Department of Environment and Conservation within six months of completing the Maxima 3D Marine Seismic Survey.

Figure 1
Maxima 3D Marine Seismic Survey Acquisition Areas in State and Commonwealth Waters



Source: Woodside (2007)

Figure 2
Map showing the distribution of benthic habitats at Scott Reef



Source: Australian Institute of Marine Science (2006)

Table 2.
The three categories of cumulative sound energy level and the predicted impacts associated with each category.

Sound energy level category	**Range of Cumulative (*over single seismic line sequence*) Sound Energy Levels within each category (dB re 1 µPa^2.s)**	**Predicted impacts**
1	180 to 186.99	Temporary threshold shift from which fish recover within six hours of exposure to the seismic shot series causing the impact. No non-auditory tissue damage.
2	187 to 199.99	Long term temporary threshold shift (greater than 50 days) or permanent threshold shift associated with hair cell damage. Non-auditory tissue damage unlikely.
3	>200	Temporary threshold shift. Auditory hair cell damage. Possible injury to non-auditory tissues.

Table 3: Areas and percentages of benthic habitats exposed at different sound energy levels – State waters

Benthic Habitat Type	Water Depth (m)	Total Habitat Area (km^2)	Area and Percentage of Habitat Exposed at Different Sound Exposure Levels (SEL) – State Waters Only					
			Level 1 SEL (>180 dB re 1µPa^2.s)		Level 2 SEL (>187 dB re 1µPa^2.s)		Level 3 SEL (>200 dB 1µPa^2.s)	
			Area (km^2)	**%**	**Area (km^2)**	**%**	**Area (km^2)**	**%**
Deeper-Water High Diversity	30-45	16.38	8.03	49.04	7.14	43.56	1.42	8.64
Deep-Water Coral Assemblage	35-55	64.21	28.92	45.03	25.01	38.95	4.84	7.53
Deep-Water Foliaceous Coral	30-50	49.77	13.40	26.93	11.31	22.73	1.37	2.75
Reef Slope	4-30	35.87	4.67	13.03	0.03	0.08	0	0
Deep-Water Outcrops	20-40	3.21	0.23	7.14	0.18	5.61	0.02	0.78
Reef Flat	1-4	85.70	0.03	0.03	0	0	0	0
Deep-Water Sand	20-40	35.13	0	0	0	0	0	0
Patch Reef	1-20	26.54	0	0	0	0	0	0
Soft Coral on Rubble	30-50	10.17	0	0	0	0	0	0
Deep-Water Filter Feeding	35-100	2.26	0	0	0	0	0	0
Shallow-Water Sand	3-7	0	0	0	0	0	0	0
Deeper-Water Lagoonal	12-25	0	0	0	0	0	0	0
Shallow-Water Lagoonal	3-12	0	0	0	0	0	0	0
Sand with Coral Outcrops	3-8	0	0	0	0	0	0	0
Totals		**329.24**	**55.28 16.79%***		**43.67 13.26%***		**7.64 2.32%**	

[*Percentage of Total Habitat Area]

Source: Woodside (2007)