-

Fletcher-Finucane Development

Offshore Geophysical & Geotechnical Survey (WA-26-L & WA-191-P) Environment Plan Summary

August 2011

(FF-1100-PLN-0008)

This Environment Plan summary has been prepared to comply with Regulation 11(7) of the Offshore Petroleum & Greenhouse Gas (Environment) Regulations 2009.

1. Introduction

Santos Ltd (Santos), as operator of the petroleum permits WA-26-L and WA-191-P in the Carnarvon Basin offshore Western Australia, proposes to develop the Fletcher and Finucane oil fields. As part of this proposal, it is planning to undertake a geophysical and geotechnical (G&G) survey in parts of the permit areas commencing in mid-August 2011. The survey area is located 150 km north of Dampier in water depths ranging between 130 m and 160 m (Figure 1).

The purpose of the survey is to provide sufficient information to enable suitable offshore pipeline and umbilical routes to be identified and quantify seabed properties for subsea structure design.

The Environment Plan (EP) for the G&G survey was approved by the WA Department of Mines and Petroleum (DMP) on the 10th of August 2011 in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 1999.

2. Proponent

Santos is the designated operator of both permits with a 33.4% interest (Kufpec Australia Pty Ltd holds an equal share, JX Nippon Oil and Gas Exploration Corporation has a 25% interest and Woodside holds the remaining 8.2% in WA-26-L while Tap (Shelfal) Pty Ltd holds the remaining 8.2% in WA-191-P).

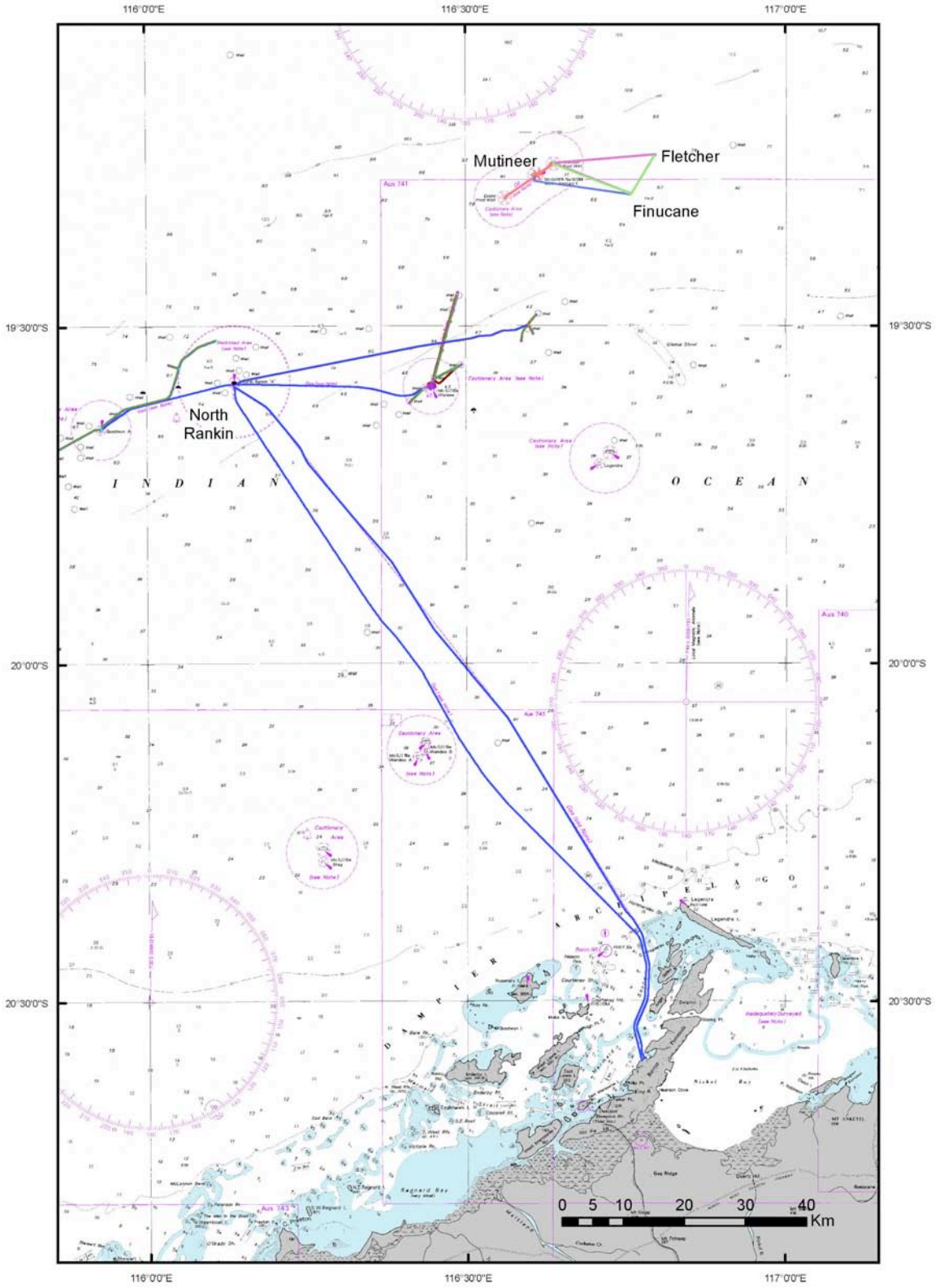

Figure 1. Fletcher-Finucane Development survey location

Santos has been operating in the North West Shelf (NWS) of Western Australia where it has been exploring and producing hydrocarbons for the last 20 years. Santos is an active oil and gas exploration and production company, having interests and operations in every major Australian petroleum province and in Indonesia, Papua New Guinea, Vietnam, India, Kyrgyzstan and Egypt. Santos has been actively producing hydrocarbons for the last 50 years.

Additional information regarding Santos can be obtained from its website at: www.santos.com.

3. Project Description

The geographic coordinates for the survey are outlined in Table 1 below. Potential flowline/pipeline routes between these points will also be surveyed.

Table 1 Survey coordinates

Infrastructure	Latitude	Longitude	Easting (m)	Northing (m)
Mutineer manifold	-19 15 32.79	116 38 16.36	461945.88	7870462.83
MV11 FPSO	-19 16 33.37	116 36 45.53	459298.46	7868594.85
Finucane manifold	-19 18 16.01	116 45 31.97	474668.78	7865465.20
Fletcher manifold	-19 14 43.80	116 47 43.98	478513.49	7871995.64

3.1 Geophysical Survey

The geophysical program will:

- Measure water depth using a multibeam echo sounder.
- Map the seabed topography along the proposed flowline/pipeline corridors (500 m corridor width centered on the notional centreline) and around the Fletcher and Finucane manifold locations using high resolution side-scan sonar, using 100% sidescan overlap with its 125 m scan range.
- Map the shallow geology using a high resolution sub-bottom profiler, to identify any shallow geological impediments (such as steep slopes, areas of seabed instability, coral outcrops, pock marks, near-surface and surface faults or construction obstacles such as shipwrecks, cables, pipelines and other man-made features) to drill rig anchor mooring, pipeline/flowline installation and manifold installation.
- Take ROV video footage of the seabed along the existing Exeter power umbilical.

3.2 Geotechnical Survey

The geotechnical survey will undertake:

- Piezo Cone Penetration Tests (PCPT) at the proposed Fletcher and Finucane manifold locations (one at each site) to a depth of 25 m. This will use the Ronson Wheeldrive cone penetrometer.

- Shallow PCPT (to a depth of 3 m) and coring at 3 km intervals along the proposed flowline/pipeline routes, using the same method as described above.
- T-bar tests at the Fletcher and Finucane manifold locations. A T-bar test measures in-situ low undrained shear strength. It has a larger area compared to a normal PCPT cone. A major advantage of the T-bar test over the PCPT test is that the *in situ* vertical stress is equilibrated across the T-Bar (soft soils close up the gap behind the probe) and there is no correction for ambient stress. The T-bar is used instead of a PCPT cone attached to the rods within the wheel drive on the seabed equipment.

The geotechnical sampling will not use any drilling additives – it will simply involve pushing the metal cone into the seabed to obtain sediment samples. Laboratory analysis of the nature and composition of seabed sediments will be undertaken onboard the survey vessel.

3.3 Survey Vessel Details

The survey will be undertaken by Neptune Geomatics. The vessel contracted to undertake both the survey is the multi-purpose supply and support vessel, the *Greatship Mamta*. It is owned and operated by Greatship Global Offshore Services Pte Ltd, which is headquartered in Mumbai, India, with a regional office in Perth. The *Greatship Mamta* was built in July 2010 and is a Class II dynamically-positioned (DP) vessel, capable of accommodating 66 personnel. The basic vessel specifications are provided in Table 2 below, with Plate 1 showing the vessel.

Table 2 'Greatship Mamta' vessel specifications

Aspect	Specification
Dimensions	
Length	86.6 m
Breadth	19.7 m
Deadweight	4,068 tons
Maximum draft	6.3 m
Capacities and speed	
Fuel	1,042 m^3
Maximum speed	14.5 knots (trial speed)
Fresh water	1,021 m^3
Other features	
Deck area	1,020 m2
Offshore crane	50/75 tons AHC, 2,000 m wire
Helcopter deck	Suitable for Sikorsky S92
Thrusters	3 x bow thrusters, 1,050 kW each
Anchors	2 x min 10 tons
Sewage treatment plant	Suitable for 66 people + holding tank

The vessel is currently working on the North West Shelf. It first arrived in WA on the 1st of December 2010 to undertake subsea construction activities, and left for southeast Asia in

mid February 2011. At the end of April 2011, the vessel was subject to an in-water inspection for invasive marine species (IMS) of concern in preparation for her voyage to Australia (Darwin) again.

As the survey vessels uses dynamic positioning systems, anchoring will not be necessary through the survey area unless in the event of an emergency. Support vessels will not be required and no crew changes (via helicopter or return trips to port) are required for the duration of the survey. No at-sea refuelling is planned during the survey.

Plate 1 The 'Greatship Mamta'

4. Stakeholder Consultation

As part of its recent activities in the WA-26-P and WA-191-P permit areas, Santos has consulted with various stakeholders, all of whom have expressed no concerns with its petroleum exploration activities in this area. A list of stakeholders being consulted about this survey is listed below:

- Australian Maritime Safety Authority (AMSA) – Rescue Coordination Centre (RCC).
- Department of Mines and Petroleum (DMP) – Petroleum Environment Branch.

- Dampier Port Authority.

Santos will make these stakeholders aware of the proposed survey via email, which allows for project information and mapping to be provided to stakeholders for perusal at a time of their choice. All correspondence with stakeholders will be recorded.

5. Receiving Environment

5.1 Physical Environment

Climate. The North West Shelf lies in the arid tropics region of Australia, which experiences high summer temperatures and periodic cyclones (with associated heavy rainfall). Rainfall is generally low, with evaporation exceeding rainfall. Mean ocean temperatures range from a minimum of 11ºC in winter to a maximum of 37ºC in summer. Shelf waters are usually thermally stratified at a depth of about 20 m.

Winds. Wind patterns are monsoonal with a marked seasonal pattern. From October to March, the prevailing non-storm winds are from the south-west, west and north-west at an average speed of less than 10 knots. From June to August, winds are generally lighter and more variable in direction than in spring and summer. Non-storm winds prevail from north-east through to south-east at average speeds of 5-6 knots. Transitional wind periods, during which either pattern may predominate, can be experienced in April, May and September each year.

Ocean currents. The Indonesian Throughflow is the dominant surface current of the region, but water circulation is highly seasonal. The southern flow of the Indonesian Throughflow is greatest during winter and is weaker in summer, when strong winds form the southwest cause intermittent reversals of the currents, which may be associated with occasional weak upwellings of colder, deeper water onto the shelf.

Bathymetry. A geophysical survey of the Finucane South-1 drill site and surrounds was undertaken in November 2010 by Neptune Geomatics Pty Ltd. It shows that the seabed in the area is relatively flat and featureless, gently shoaling to the south at a gradient less than one degrees, and is composed of low relief unconsolidated calcareous silty fine to medium sand. This survey also found that there are no significant bathymetric, seabed features (e.g., shipwrecks) or shallow hazards associated with the drilling location. This G&G survey will reveal more details of the seabed in the permits.

6.2 Biological Environment

Benthic Invertebrates. Diverse assemblages of benthic fauna are likely to exist at the site, especially if unconsolidated sediments are present. Mobile burrowing species that may be present include crustaceans (crabs and shrimps), worms, sea stars, sea urchins and other small animals. Spatial and seasonal distribution of such species depends on factors such as substrate composition, season, water depth and temperature.

Marine Mammals. Dolphins are relatively common in the region. Species known to occur in the region are the bottlenose dolphin (*Tursiops truncatus*), common dolphin (*Delphinus delphis*), Indo-pacific humpback dolphins (*Sousa chinensis*) and the striped dolphin (*Stenella coeruleoalba*). A number of whale species, including the short-finned pilot whale (*Globicephala macrorhynchus*), false killer whale (*Pseudorca crassidens*), tropical byrdes whale (*Balaenoptera edeni*), southern minke whale (*Balaenoptera acutorostrata*) and humpback whale (*Megaptera novaeangliae*), also occur in the region, the most commonly sighted of these being the humpback whale. This species migrates between the Antarctic waters and the Kimberly region of Western Australia. The peak of their northerly migration between the Exmouth Gulf and the Dampier Archipelago occurs around late July to early August, while the southerly return migration peaks around late August – early September. The proposed survey area is located on the northern edge of the humpack whale migration route.

Fish. The demersal habitat of the NWS hosts a diverse assemblage of fish, many of which are commercially exploited by trawl and trap fisheries, for example the genera Lethrinus (emperor) and Lutjanus (snapper). Pelagic fish in this area include tuna, mackerel, herring, pilchard and sardine. The inshore habitats in this region are not considered to be significant nursery grounds for commercially important deeper-water fish species.

Reptiles. Four species of marine turtle nest on sandy shore sites of the Dampier Archipelago, Montebello Islands, Lowendal Islands, Barrow Island, and other coastal islands in the region. These are the green turtle *(Chelonia mydas*), flatback turtle (*Natator depressus*), hawksbill turtle (*Eretmochelys imbricata*), and the loggerhead turtle (*Caretta caretta*). All four species are on the National List of Threatened Species. The leatherback turtle (*Dermochelys coriacia*) may also visit the open waters of the shelf. The loggerhead, flatback and leatherback turtles are known to feed on mid-water plankton and benthic animals, and can forage in continental shelf waters, so may occur around the survey location.

Birds. Eighteen species of seabird have been recorded over the NWS waters. These include petrels, shearwaters, tropicbirds, frigate birds, boobies and terns, and silver gulls. Of these, eight species occur year round and the remaining 10 are seasonal visitors.

6.3 Socio-economic Environment

Settlements. Dampier and Karratha are the main service and population centres for this region. Local people seeking aquatic recreation such as boating, diving and fishing use the coast and islands of the Pilbara. The open waters of the Commonwealth permit areas do not support significant recreational or tourism activity.

Marine Conservation Reserves. The Mermaid Reef Marine National Nature Reserve is located about 372 km northeast of the permits. This reserve surrounds Mermaid Reef and

covers 53,987 ha (540 km^2) near the edge of the continental shelf and in waters as deep as 500 m. Mermaid Reef is the most north-easterly of the three reefs forming the Rowley Shoals, and is totally submerged at high tide. Mermaid Reef contains a diverse array of biota, including over 216 species of hard corals and 12 genera of soft corals, and more than 390 species of fish.

The Ningaloo Marine Park (Commonwealth Waters) is located 373 km to the southwest of the permit areas, and covers 246,000 ha (2,435 km^2) of Commonwealth ocean territory. The reserve was declared in 1987 and stretches for 260 km along the west coast of the Cape Range Peninsula. It is the longest fringing barrier reef in Australia, and the only example in the world of extensive fringing coral reef on the west coast of a continent. The reserve is recognised internationally for its annual aggregations of whale sharks.

The Dampier Archipelago (consisting of 42 islands, islets and rocks within a 45 km radius of Dampier) has also been proposed as a marine park under Western Australia's *Conservation and Land Management Act 1984*, and the area between Cape Preston and the Dampier Archipelago has been proposed as a marine management area. The proposed Dampier Archipelago Marine Park comprises a number of management zones, including sanctuary zones, special-purpose zones for benthic and mangrove protection, and recreational use zones. All other areas within the park are designated for general use (approximately 50% of the marine park). This proposed marine park encompasses many of the islands of the Dampier Archipelago and is the richest area of marine biodiversity known in Western Australia, and is an important nesting area for many turtle species.

Commercial Fisheries. Consultation with the Australian Fisheries Management Authority (AFMA) indicates that the North West Slope Fishery was the only Commonwealth-managed fishery with logbook data for the region from 2008-2010, with only periodic activity through the year concentrated from January to mid-March and June-July (when the nearby Northern Prawn Fishery is not operational).

Petroleum Exploration and Production. The North West Shelf is Australia's most prolific oil and gas production area, resulting in Western Australia accounting for 70% of the country's oil and condensate production (2008) and 50% of the country's gas production (2008).

The Santos Mutineer-Exeter Floating Production, Storage and Offtake (FPSO) development occurs 17 km to the west of the proposed survey area. Other nearby petroleum production facilities include:

- Cossack-Wanaea FPSO – 47 km southwest, operated since 1995 by Woodside.
- Legendre oil platform – 44 km southeast, operated since 2001 by Apache Energy (previously operated by Santos).
- North Rankin A gas platform – 73 km southwest, operated since 1984 by Woodside.

- Goodwyn A gas platform – 97 km southwest, operated since 1995 by Woodside.
- Angel gas platform – 26 km south, operated since 2009 by Woodside.

Shipping. The ports of northwest Australia (Onslow, Dampier, Cape Lambert, Port Hedland and Broome) handle large tonnages of iron ore and petroleum exports, resulting in very busy shipping routes through the area. For example, the closest port to the survey area is Dampier, and in 2006-07, it had 3,404 vessel visits. In 2006, offshore support vessels made up 40% of total vessel movements in the region. Advice from the Australian Maritime Safety Authority (AMSA) indicates that the southern and eastern-most portion of the survey area is located 5 nm west of the Dampier Shipping Fairway; traffic travelling to or from the Port of Dampier is concentrated in this area and should not come near the drilling operations.

Maritime Heritage. The Australian National Shipwreck Database lists 51 shipwrecks registered as occurring within the Dampier region, generally in and around Butchers Inlet, Flying Foam Passage, Nickol Bay and Roebourne. There are no historic shipwreck protected zones in the permit areas. Likewise, the Western Australian Shipwrecks Database (WA Museum, 2010) indicates 58 shipwrecks around the Dampier area.

The geophysical survey will identify whether any previously unrecorded shipwrecks occur within the survey area, but such a find is not expected. All pre-1900 shipwrecks are protected under the *Maritime Archaeology Act 1973* (WA) and the *Historic Shipwrecks Act 1976* (Cwlth) (DEC/MPRA, 2007).

6. Environmental Impact Assessment

The potential environmental impacts resulting from routine activities and accidental discharges associated with the proposed G&G survey are outlined in detail in the original Fletcher-Finucane G&G Survey Environment Plan.

Table 2 provides a summary of the detailed environmental impact assessment and mitigation measures that will be put in place to ensure that impacts are as low as reasonably practicable.

The risk assessment methodology used to undertake risk assessments for the activities associated with the G&G survey includes:

- Identify risks - risk causes, consequences, assumptions, existing controls;
- Analyse risks – inherent consequence, consequence, exposure, probability, likelihood, residual risk;
- Evaluate risks;
- Treat risks (where required); and
- Monitor and review.

Table 3. Summary environmental impact assessment for the G&G survey

Potential risk	Potential consequence	Avoidance, Mitigation & Management Measures	Risk ranking
Physical impacts			
Vessel anchoring	Temporary and localised seabed disturbance, shallow seabed depressions.	• No anchoring planned. • Previous seabed surveys in permits reveal no sensitive seabed features.	Negligible
Introduction of invasive marine organisms (IMS)	Establishment of foreign species to open ocean and/or seabed, competing with and displacing native species.	• Vessel has been cleared by AQIS to enter Australian waters. • Vessel have been working in waters of the North West Shelf for some time. • IMS survey undertaken in April 2011 – no species of concern noted. • In-water survey equipment will be cleaned onshore prior to use.	Negligible
Overboard discharge of sewage and putrescible waste	Temporary and localised reduction in water quality. Modification of fauna feeding patterns.	• MARPOL-approved sewage treatment system used. • No discharge of sewage and putrescible waste within 12 nm of land. • Putrescible waste macerated prior to discharge.	Negligible
Overboard discharge of solid waste	Marine pollution.	• Solid wastes bagged and sent ashore for disposal. • All bins secured to deck and covered with lids/netting. • No waste incinerated on board. • Waste Management Plan in place.	Negligible
Waste oil, chemical and/or oil-contaminated drainage water spill/leak Overboard discharge of contaminated deck drainage	Temporary and localised reduction in water quality.	• Oily water treatment systems in place, with no discharge over 15 ppm oil-in-water. • Chemical storage areas bunded. • Fuel transfer areas bunded. • Decks cleaned with biodegradable detergents. • SOPEP kits available on board for rapid clean-up response.	Negligible
Refuelling spill or spill due to vessel to vessel collision	Temporary marine pollution.	• Vessel bunkering procedure in place. • Job hazard analysis undertaken prior to refuelling. • In most seasons, all the diesel from a refuelling spill would evaporate within 72 hours.	Negligible

Underwater vessel noise	Temporary physiological impacts on sensitive fauna, such as cetaceans. Disruption to migration, feeding or breeding patterns.	• Visual pre-start observations for whales prior to start-up of sonar equipment. • Implementation of the EPBC Act Policy Statement 2.1, Part A procedures. • Region not a known cetacean breeding or feeding area. • Short-term survey.	Negligible
Atmospheric emissions	Temporary and localised reduction in air quality.	• Marine-grade (low sulphur) diesel used. • All engines and machinery maintained in accordance with maintenance systems. • Fuel use and greenhouse gas emissions monitored and reported by Santos to the DMP and other regulatory agencies.	Negligible
Commercial fishing and shipping	Vessel collision. Fuel spills.	• Consultation with key fisheries in the region indicates low fishing effort in the permit areas. • Survey area not located in or near recognised shipping lane. • Standard maritime safety measures will be in place.	Negligible
Artificial lighting	Attractant to fauna, temporary increase in predation rates on fauna attracted to lights. Nuisance to fishers.	• Lighting will be kept as minimal as possible but in accordance with safety standards. • Lights directed downwards to the water will be minimised. • Survey is not located adjacent to turtle nesting beaches. • Short-term activity.	Negligible
Release of core cuttings to seabed	Temporary and localised smothering/burial and disturbance of immediate seabed area. Temporary and localised loss of water quality from suspended sediments.	• No use of drilling fluids. • Shallow depth sampling – minor volumes of sediment. • Less than 10 m^3 disturbance at each sampling site.	Negligible
Single/multi-beam echo sounder and side-scan sonar	Alteration of marine mammal behaviour interfering with normal activities such as feeding and migration.	• Short-term activity. • Visual pre-start observations for whales prior to start-up of sonar equipment. • Implementation of the EPBC Act Policy Statement 2.1, Part A procedures. • Region not a known cetacean	Negligible

		breeding or feeding area. • Adherence to National Guidelines for Whale and Dolphin Watching for mobile vessels (2005). • Cetacean information provided on vessel.	

7. Environmental Management

Santos manages the environmental and safety impacts of all its activities and operations, both existing and planned, through implementation of its environment, Health and Safety Management System (EHSMS). The EHSMS is certified against ISO 14001 (Environmental Management Systems) and meets the requirements of AS4801-2001 (Occupational Health and Safety Management Systems). The EHSMS includes 17 management standards and 30 hazard standards.

An environmental implementation strategy for the G&G survey is detailed in the EP and approved by the DMP. This strategy involves a crew training and awareness program, environmental audits, government communication, environmental monitoring and recording and incident reporting, and is supported by the Santos EHSMS.

8. Further Information

For further information about the Fletcher-Finucane Development G&G survey, please contact:

Mr Giulio Pinzone
Environmental Adviser
Phone: 0409 772 170
Email: giulio.pinzone@santos.com