6 PROJECT DESCRIPTION

6.1 PROJECT OVERVIEW

An Exploration and Production Concession Contract (EPC) was signed between PCMRB and the Mozambique Ministry of Mineral Resources (MIREM), through *Empresa Nacional de Hidrocarbonetos, Empresa Publica* (ENH, EP) for rights to conduct hydrocarbon exploration and production activities in the offshore Areas 3 and 6 in Rovuma Basin (see

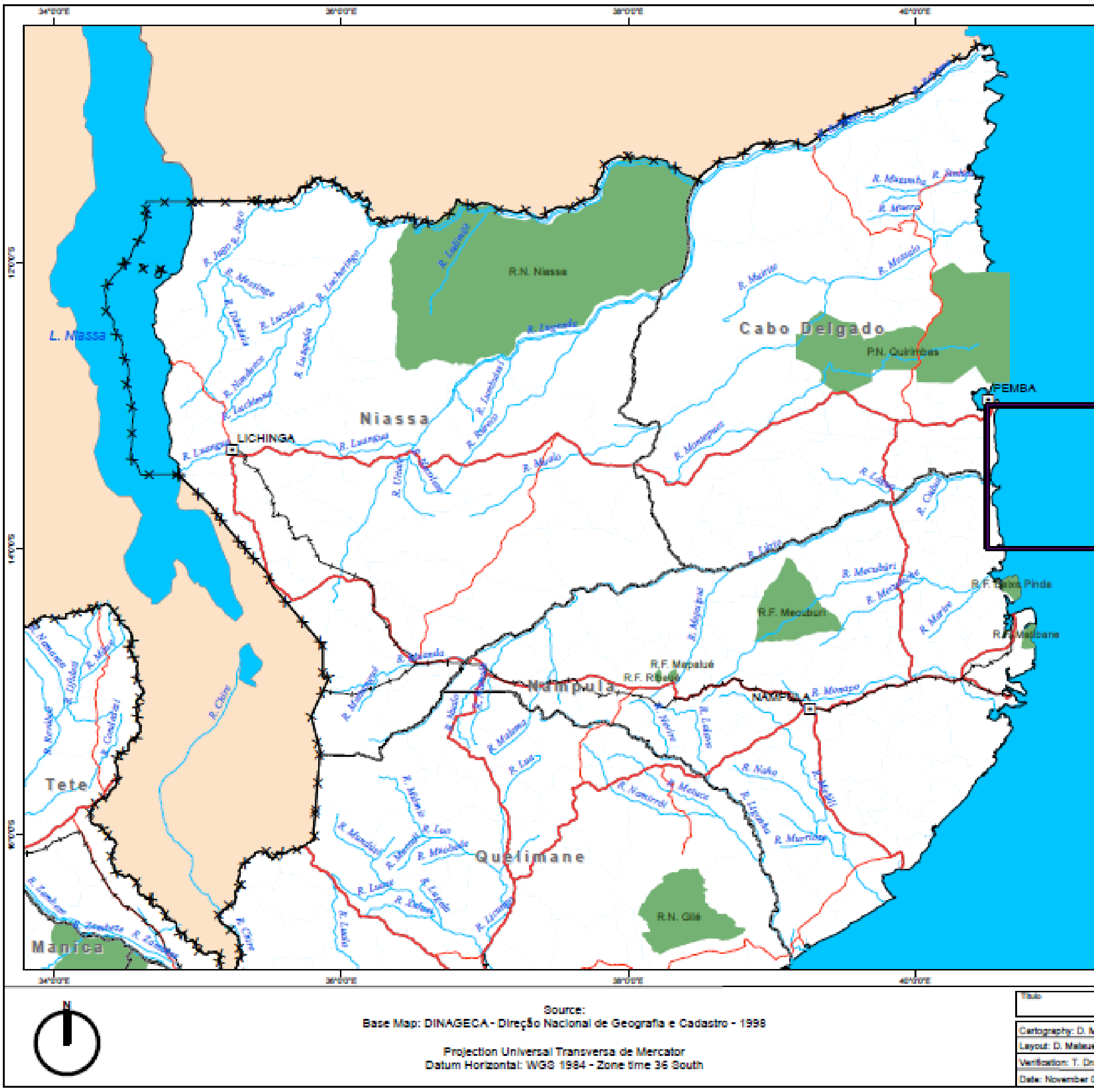

Figure 6.1).

In the initial phase of exploration covered by this EIA process, PCMRB intends to conduct seismic data acquisition surveys within the concession areas to more clearly define the location and quality of hydrocarbon reserves. The initial survey to be conducted between May and July 2010 will involve 2D seismic survey methods across the entire marine sections of Areas 3 and 6. Once the 2D seismic data has been processed, and depending upon these results, PCMRB may elect to focus on promising areas of the concession area using 3D survey techniques. The proposed timing of 3D surveys will not be finalised until the 2D results are analysed but at this stage PCMRB believe that the 3D surveys may be conducted at the end of 2010 (after the peak whale season) or early in 2011.

Subsequent exploratory phases during PCMRB's development of Rovuma Basin over the next eight years include more detailed geological and geophysical studies, and exploration drilling. Those aspects have not been assessed during the current EIA process and will need to be covered by future studies specifically focussed on those activities.

If exploration activities identify economically viable hydrocarbon reserves, PCMRB will enter into a production phase that will include the drilling and installation of production wells, and abstraction, storage and distribution of the hydrocarbons.

6.2 PROJECT LOCATION

The seismic acquisition area is a rectangular area located offshore of the coast of Mozambique within Areas 3 and 6 within the Rovuma Basin Concession Area

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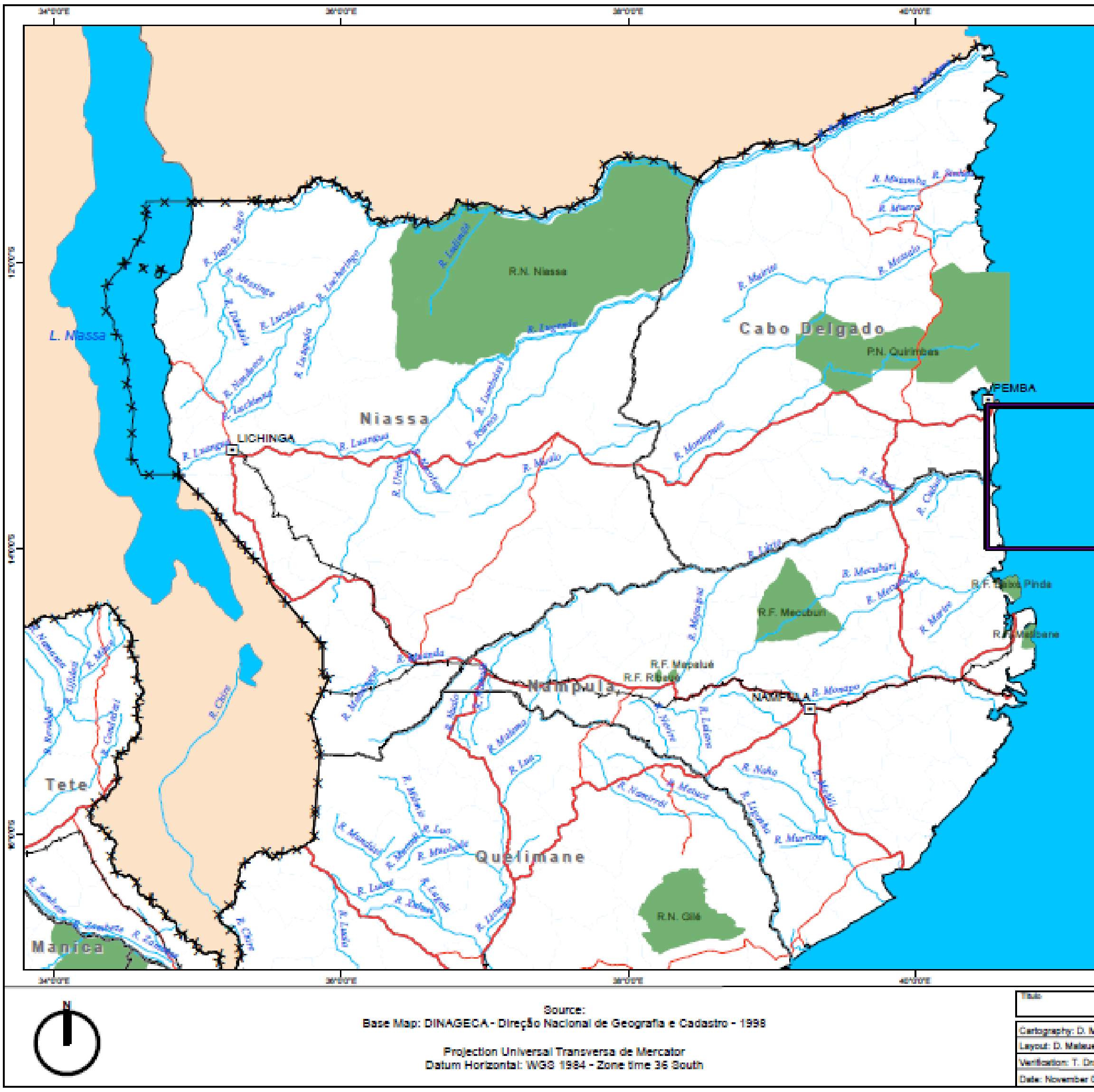
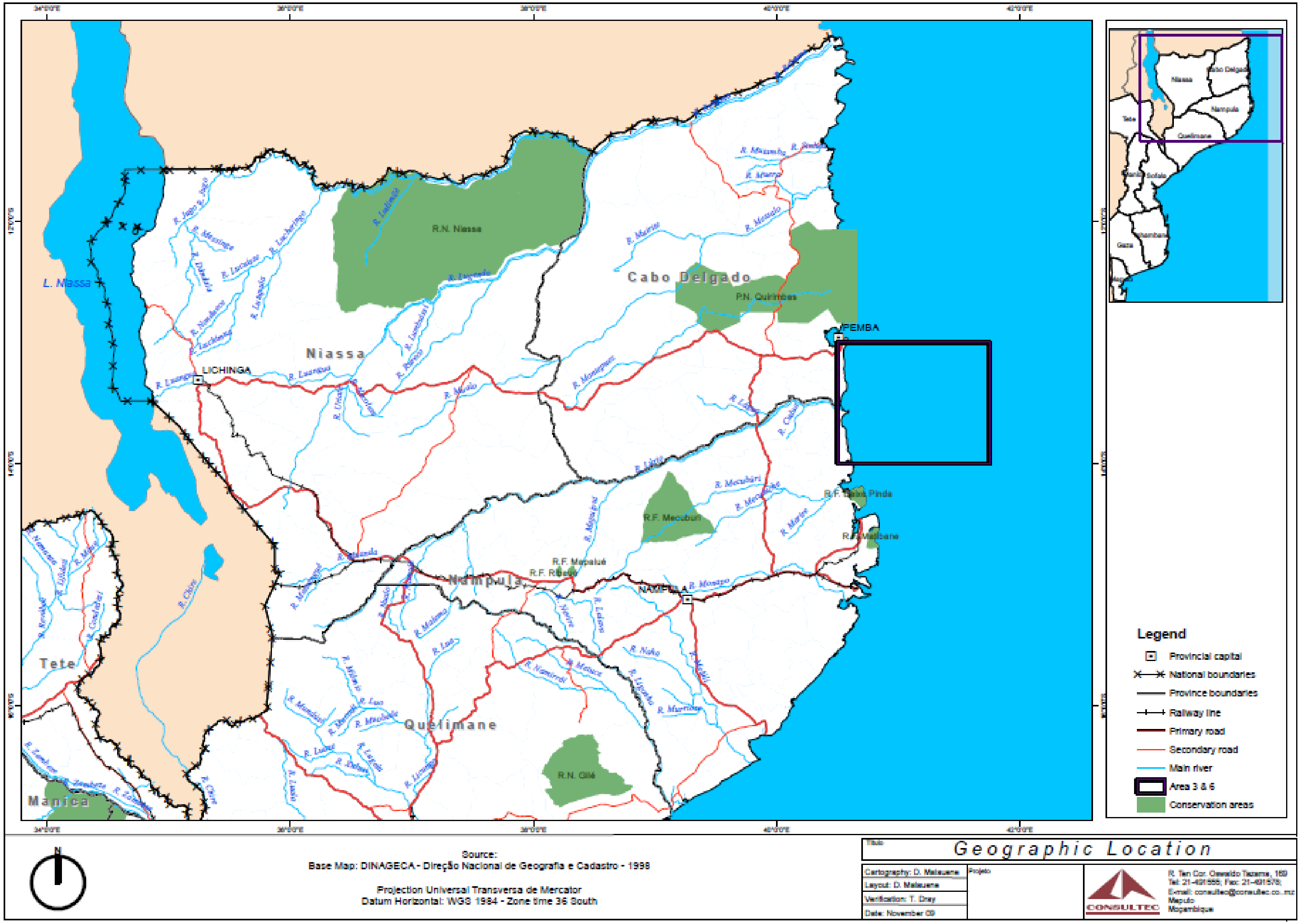


Figure 6.1). Area 3 is located to the west of Area 6 and lies on- and offshore of the coast of the Mozambican provinces of Cabo Delgado and Nampula. The area covered by Areas 3 and 6 stretches from approximately 15 km inland from the coast to approximately 130 km offshore to the east. The town of Pemba is located just north of the northwestern corner of the PCMRB concession area, and the concession area extends approximately 110 km south from this point. The southern edge of the concession area is located just south of the village of Simuco, and approximately the same latitude as the town of Mazula in the Nampula Province.

Figure 6.1 Geographical Location of Project Area



6.3 PROJECT TIMING

The 2D seismic surveys will take approximately 62 days (just over two months). PCMRB aims to initiate the seismic surveys in May 2010 so that the surveys will be finished before August 2010, the start of the whale migration season. If the 2D seismic surveys provide promising data, PCMRB intends to undertake 3D surveys at the end of 2010 or early in 2011. The 3D survey is expected to cover approximately 500 km^2 and take between three and four weeks to complete.

6.4 GENERAL PRINCIPLES OF SEISMIC ACQUISITION

Marine geophysical seismic surveys are an integral component of offshore oil and gas exploration and development activities, and are used to define possible sub-seabed deposits and promising geological structures.

During marine seismic surveys, a slow moving survey vessel (typically steaming at 4 to 6 knots) tows an impulse emitting sound source (an array of multiple airguns). The sound reflects off the sea bottom and the seismic data are recorded by onboard computers and processed to produce profiles of the sub-seabed geology. The data are interpreted by geophysicists to identify potential locations of hydrocarbon reservoirs. A schematic diagram of marine seismic survey operations is provided in *Figure 6.2*. The 2D survey vessels will have a single long cable (called *streamer*), of a length between 6 and 8 km, while the 3D vessels have multiple streamers (typically 4 - 20) that are between 3 and 6 km in length, and are towed at a spacing of up to 120 m from one another (*Figures 6.3* and *6.4*).

Figure 6.2 Illustration of the principles of offshore seismic acquisition surveys

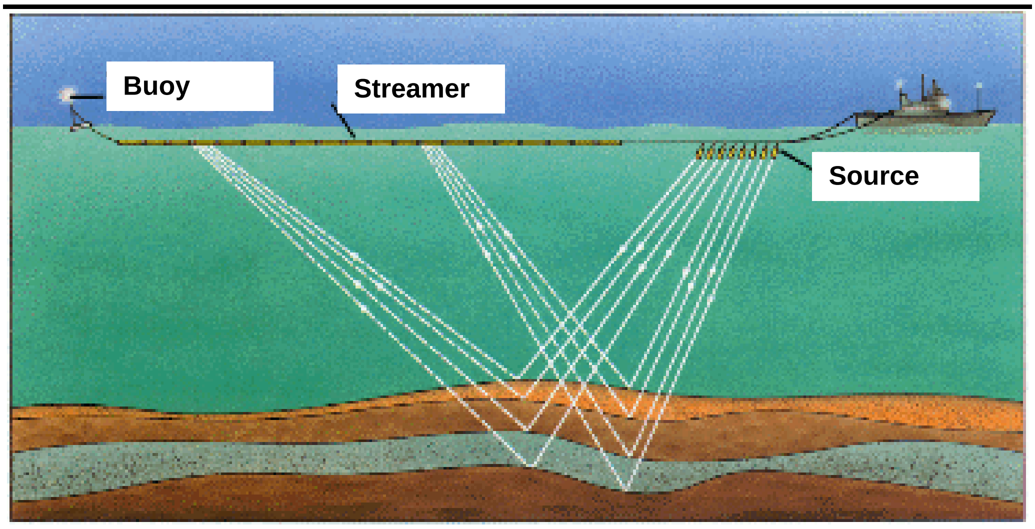


Figure 6.3 Examples of 2D seismic survey vessel

Source: Fugro Geoteam

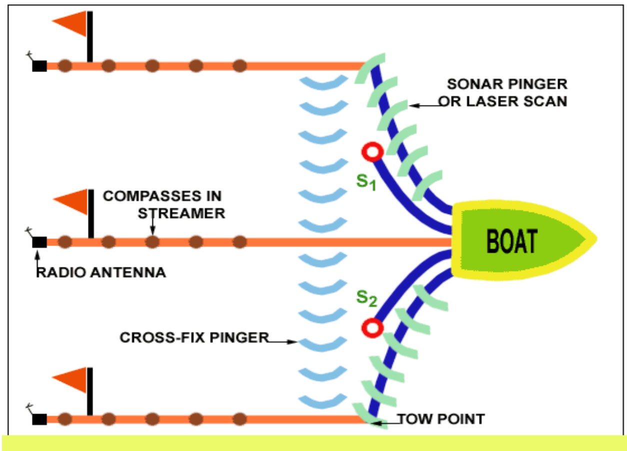
Figure 6.4 Examples of 3D seismic survey vessels

6.4.1 Sound sources

Sound sources (commonly referred to as 'airguns') are underwater pneumatic devices from which high-pressure air is released into the surrounding water (see *Figure 6.5*). These high energy, low frequency sounds (called 'shots') are produced by the airguns and pulsed downward toward the seabed and propagate through the seabed. The seismic shock waves bounce off the sub-surface rock formations and return toward the water surface where an array of receivers (hydrophones) detects the returning seismic energy. The sound source is submerged in the water, typically at a depth of 5 to 10 m.

Airguns are used as singly or as an array of up to six airguns, that are typically towed 50 - 100 m behind the seismic vessel (S_1 and S_2 in *Figure 6.5*).

Figure 6.5 *Figure Diagram representing 3D seismic survey outlay*

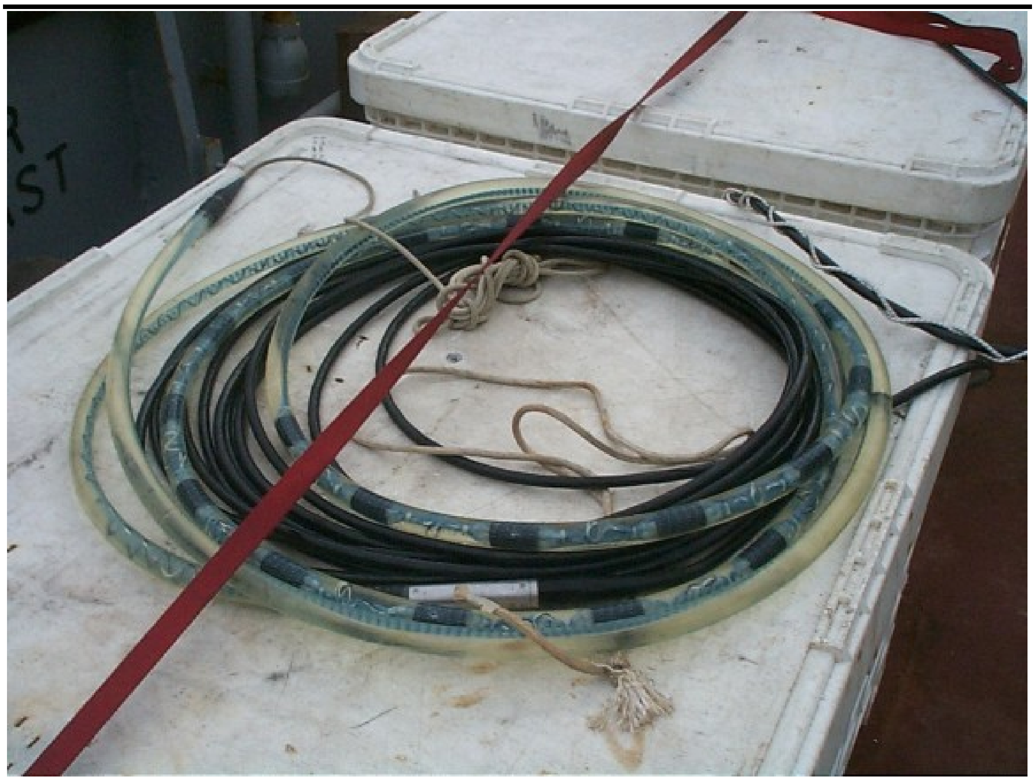


A single airgun typically produces sound levels in the order of 220 -230 dB (decibels) re 1mPa (1 micro-Pascal per metre) @ 1m, while airgun arrays produce sound typically in the region of 250 dB re 1mPa @ 1m. Most of the energy produced is in the 0 to 120 Hz bandwidth, although energy at much higher frequencies is also produced. High resolution surveys and shallow penetration surveys require relatively high frequencies of 100 – 1000 Hz, while the optimum wavelength for deep seismic work is in the 10 – 80 Hz range. There are no viable alternatives to airgun sources for petroleum exploration seismic surveying. The airgun frequencies will be confirmed on appointment of the seismic contractor.

6.4.2 Recording equipment

Signals reflected from geological discontinuities below the sea floor are recorded by hydrophones mounted inside streamer cables. Hydrophones are typically made from piezoelectric material encased in a rubber plastic hose. This hose containing the hydrophones is called a streamer. Some hydrophone streamers contain up to eight litres of kerosene per meter to provide buoyancy, however, more modern streamers are 'solid' and do not contain kerosene. It is envisaged that 'solid' streamers will be used by the seismic contractors during the proposed survey by PCMRB. A typical marine streamer containing hydrophones is illustrated in *Figure 6.6*. The reflected acoustic signals are recorded and transmitted to the seismic vessel for electronic processing, where analysis of the returned signal data allows for interpretation of subsea geological formations.

Figure 6.6 A Typical Marine Streamer Containing Hydrophones



Source: http://woodshole.er.usgs.gov/operations/sfmapping/images/stream.jpg

Typically, each streamer is provided with electronic cable levelling devices (adjustable fins or hydroplanes known as 'birds') that allows streamer depth to be altered for optimal data collection and to avoid hazards (eg shoals, reefs, seabed obstructions, etc.). In addition, the length of each streamer is adjusted depending on water depth and data acquisition requirements.

6.5 PROPOSED SEISMIC ACTIVITIES

6.5.1 *Existing survey information*

During past decades, several exploration techniques have been used in the search for hydrocarbons in Mozambique. These include the acquisition of gravity and magnetic data, remote satellite sensing, geochemical sampling as well as aerial photography. All of these techniques are used for regional evaluation in determining the hydrocarbon potential of an area but are not able to identify a specific prospect, that is, an exact location where to drill. To identify and evaluate a specific potential hydrocarbon accumulation, seismic data must be acquired and evaluated. The seismic data is used to not only determine where to drill but to estimate potential hydrocarbon resource volumes.

6.5.2 *Rovuma Basin 2D/3D Seismic Programme*

The seismic programme is proposed for deep water areas with depths of between approximately 200 and 2500 m. Although the distance varies, the coastal edge of the proposed seismic survey area is within approximately 10 km of the shoreline, however, during turning the vessel will approach to as close as 2 km of the shore (depending on water depths), especially in the northern area of the study area.

The towed-streamer seismic surveys (2D and 3D) will be undertaken in three stages:

- Mobilisation of survey vessel from port to survey area;
- Data Acquisition throughout the survey area; and
- Demobilisation of survey vessel from survey area to port.

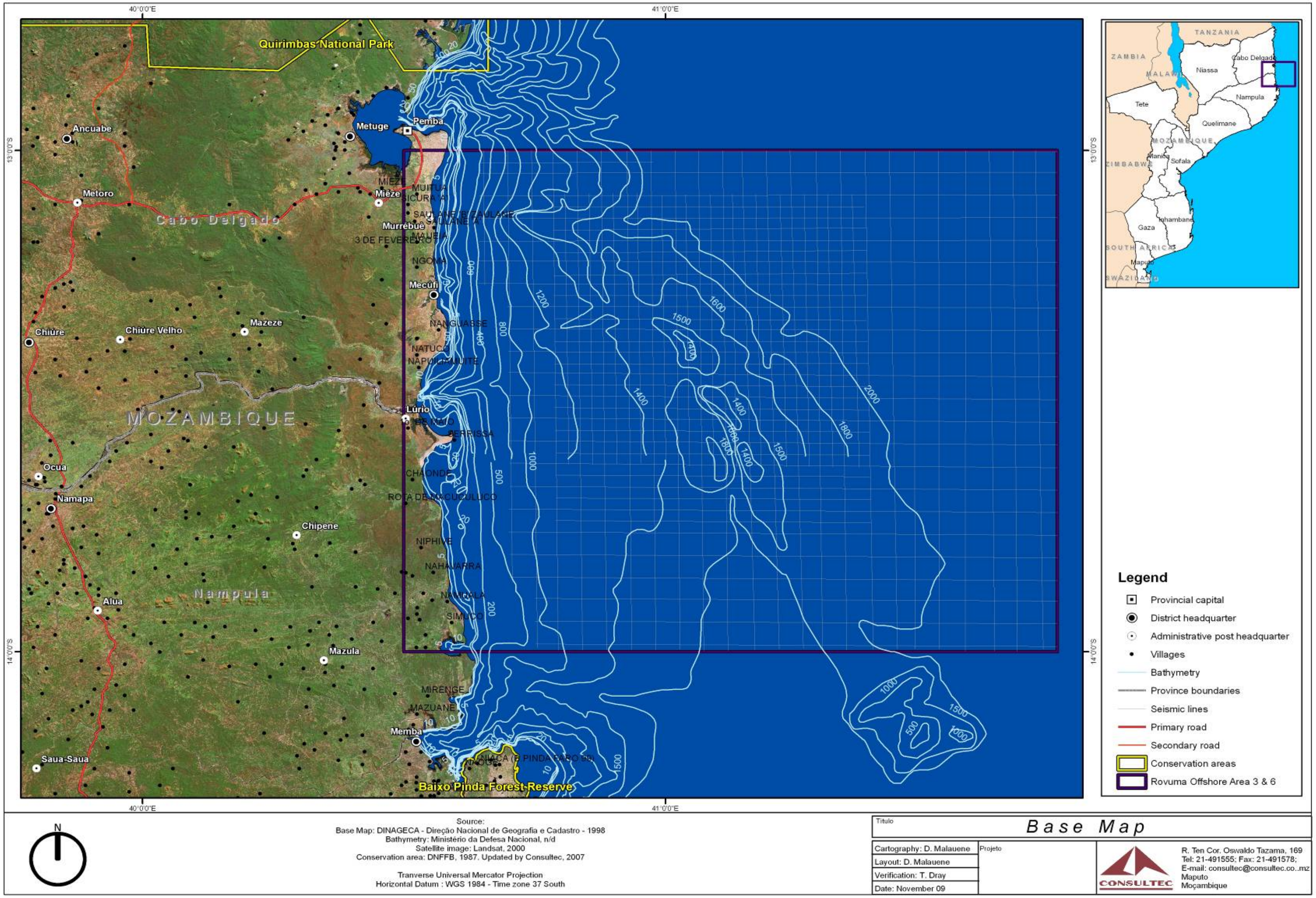
The PCMRB seismic survey will cover a total area of approximately 15,500 km^2 within Areas 3 and 6. PCMRB is planning to acquire 7000 km of 2D data over a two month period, followed by approximately 500 km^2 of 3D data over a four week period (if required). The seismic survey lines will be orientated both north-south and east-west within the survey area (Figure 6.7).

The corner coordinates for the proposed 2D seismic area are provided in *Table 6.1* but because the exact location of the 3D survey will not been decided until the 2D data has been analysed, the boundary coordinates are not currently available.

Table 6.1 Latitude and longitude for the four corners of the 2D seismic survey area

	Latitude	Longitude
1	13^{o} 00^{o} 00^{0}	40^{o} 30^{o} 00^{0}
2	13^{o} 00^{o} 00^{0}	41^{o} 45^{o} 00^{0}
3	14^{o} 00^{o} 00^{0}	41^{o} 45^{o} 00^{0}
6	14^{o} 00^{o} 00^{0}	40^{o} 30^{o} 00^{0}

Figure 6.7 Map showing proposed seismic survey lines within Areas 3 and 6, Mozambique



6.5.3 *Seismic Vessels*

PCMRB is currently looking at three options for the 2D seismic survey vessel (SSVs), and one option for subsequent 3D surveys. The selected vessel will only be confirmed on appointment of the SSV contractor, but key specifications for these vessels are provided in *Figure 6.4* below.

Table 6.2 Key Seismic Vessel Specifications –Vessel A

Factor	Value or Type
Flag Of Registry	China
Type	Research Vessel
Built	2007, DaLian, China
Port Of Registry	Tianjin, China
Owner	HILONG GEOPHYSICAL CO. LTD
	A subsidiary of BGP Inc, CNPC
Length overall	65.82 m
Breadth	13.8 m
Draft (max)	3.8m
Draft (mean)	3.5 m
Gross Tonnage	2257 t
Net Tonnage	677 t
Cruising Speed	13.5 kts, transit, max.in calm sea
	12.5 kts, transit, economy
Cruising Range	6000 nautical miles
Accommodation	47 Beds (including one bed in hospital)

Table 6.3 Key Seismic Vessel Specifications –Vessel B

Factor	Value or Type
Flag	NIS (Norway)
Port Of Registry	Bergen
Built / Rebuilt	1986/2008
Length	67.8 m
Beam	14.5 m
Max Draft	6.62 m summer
Dead Weight / Net Tonnage	1145 / 983 t
Gross Registered Tonnage	3276 t
Cruising Speed	14 knots
Accommodation	30

Table 6.4 *Key Seismic Vessel Specifications –Vessel C*

Factor	Value or Type
Owner	Falcon Energy Projects Pte Ltd
Flag State and Port Of Registry	Panama
Date Of Build	2007.03.18
Date Of Rebuild	2008.12.01
Gross Tonnage (Grt)	1987 t
Net Tonnage	596 t
Length Over All (LOA)	55.00 m
Length Between Perpendiculars	48.00 m
Breadth (Moulded)	13.80 m
Breadth (Extreme)	13.80 m
Depth (Moulded) 1st deck	5.50 m
Draft (Max)	4.75 m
Draft (Mean)	4.25 m
Air Draft (To Highest Antennae)	20 m at fully loaded draft
Accommodation	45 persons
Max Speed (In Calm Sea)	11.5 knots
Economy Speed, Ditto	11.00 knots

Table 6.5 *Key Seismic Vessel Specifications –Vessel D*

Factor	Value or Type
Owner	Arrow Seismic Invest IV Limited
Maritime Operator	GC Rieber Shipping Limited
Flag	Nassau
Port Of Registry	Bahamas
Length	84.70 m
Breadth	16.80 m
Draft	5.50 m
Gross tonnage (IMO-69)	3375 t
Net tonnage	1013 t
Streamers	1 x 8100 m PGS GeoStreamer (solid)
Source	Dual
Maximum range at cruising speed	15,400 nm
Vessel Speed (cruising / maximum)	8 kn / 10 kn (at present with one stern thruster)
Main propulsion systems	1 x diesel electric Liaanen TCN92/68A 1492 kW
Accommodation (single berths)	58

Until confirmation of the SSV contractor, the port of embarkation will also be unknown, although the closest large port to Areas 3 and 6 is Pemba. Once at the survey location, depending on the boat endurance at sea, the SSV is likely to be able to undertake the full survey without returning to port for supplies, although if required supplies can be ferried to the SSV during the survey period. Support vessels are usually provided by the SSV contractor and typically consist of one mother boat and several chase boats. Local vessels are sometimes contracted to be chase boats.

6.5.4 *Sound Source and Streamers*

The source of seismic energy used during the surveys is likely to be from individual Bolt Long Life, Sleeve or Sodera-G low-pressure air guns which will be towed immediately behind the seismic vessel at a water depth of approximately 6 m below the surface of the ocean (± 1 m). Although the specific details will need to be confirmed on appointment of the seismic contractor, the total chamber pressure is likely to be between 3,000 – 4,000 cubic inches and during recording, the sound sources pressurised to 2,000 psi and fired every 12.5 seconds to produce the acoustic pulses.

The streamers towed behind the seismic vessel contain geophones to record the refraction of the seismic waves. Streamers may contain kerosene within internal compartments to enable them to float on the ocean surface, although newer styles of streamer that do not require internal fluids will be used if possible. If required, approximately 7,200 L of kerosene will be stored in separate sealed compartments along the length of each streamer.

6.5.5 *Support Operations*

While seismic survey tracks are planned (where possible) to avoid submerged obstacles such as reefs, once on track a seismic survey vessel towing one or more streamers is unable to easily change course to avoid smaller, more transient obstacles such as fishing gear/ fish traps and boats. Therefore, at least one support vessel in the form of a chase boat will accompany the seismic vessel and scout ahead to remove these obstacles and to warn any shipping that might be ignoring radio warnings to exit/ avoid the survey area. In addition, a second support vessel will be used to transport equipment, personnel and supplies from the onshore support base.

Bunkering of the seismic survey vessel is expected to be undertaken at Pemba, with no requirement for refuelling while at sea.

6.5.6 *Exclusion Zone*

The SSV typically requires an exclusion zone of 2 km radius around the vessel and streamers to ensure the area is clear of small vessels at all times. The exclusion zone is necessary for the safety of small vessels and the SSV, and reduces the chance of damage to the streamers from accidental impacts from other vessels. PCMRB will attempt to acquire seismic data as close as possible to the shore as permitted by HSE regulations.

Exclusion zones will be monitored by "chase boats" which will warn fishers and other vessels of the approaching seismic vessel and ensure that there are no obstacles in the path of the vessel.

6.5.7 *Employment and Vessel Supplies*

Any additional labour for the project will be employed through the seismic acquisition contractor. The crew size will depend on the size of the vessel, and is expected to consist of between 35 and 50 people on-board at any one time. Highly skilled and experienced crew and seismic operators are required for the seismic operations and are therefore likely to be foreigners of various nationalities. On-board marine mammal observers as well as some unskilled and semi-skilled workers may be sourced from Mozambican nationals.

Vessel supplies, including food and water will likely be loaded in the Port of Pemba. PCMRB will inspect the seismic vessel at Pemba before the start of the seismic acquisition activities. Fuel and lubricants used during the seismic acquisition period will also likely be purchased at Pemba.

6.6 EMISSIONS AND WASTE MANAGEMENT

6.6.1 *Vessel Emissions*

Sulphur oxide (SOx) and nitrogen oxide (NOx) emissions from ship exhausts, and emission of ozone-depleting substances such as halons and chlorofluorocarbons contribute to greenhouse gas emissions. The preferential use of low sulphur fuels (1.5% v/v compared to 4.5% v/v) helps to reduce the total amount of SOx emissions from operating vessels, although low sulphur fuels are not always available at all bunkering locations.

In addition, the incineration of certain waste products generated on board vessels, such as packaging materials and polychlorinated biphenyls, will also contribute to air pollution.

6.6.2 *Vessel Discharges and Wastes*

Effluent discharges from the seismic and support vessels will include treated sewage and domestic wastes, deck drainage, and bilge waters. The handling and disposal of operational wastes generated by the seismic survey vessel will be the responsibility of the vessel operator who will be contractually required to do so according to local Mozambican legislation and MARPOL requirements.

The seismic vessel is expected to have a crew of around 35 - 50 people. A crew of 50 persons may be expected to generate 5,000 L of sanitary wastewater (1.2 kg of biochemical oxygen demand [BOD]) and 11,000 L of domestic wastewater per day. Each escort vessel with a crew of ten people can be estimated to generate 1,000 L of sanitary wastewater (0.24 kg of BOD) and 2,200 L of domestic wastewater per day. Sanitary waste will be treated with a U.S. Coast Guard-approved Type II marine sanitation system (or equivalent) prior to discharge and will produce no floating solids. All liquid waste discharges will be consistent with the international standards (eg MARPO*L*). All solid waste disposal and bunkering is likely to be undertaken at the Port of Pemba.

6.7 PROJECT ALTERNATIVES CONSIDERED

There are a number of alternatives that will be considered by PCMRB in the detailed planning phase of the seismic survey. The alternatives include the No Go alternative, Ocean Bottom Cabling and alternative equipment and vessels to undertake conventional seismic surveys.

The choice of sound levels and spacing of seismic acquisition lines will be based on the consideration of the level of data required versus potential environmental impacts. A brief discussion of the No-Go alternative is also provided in this section.

6.7.1 No-Go alternative

This alternative involves evaluating the consequences of not pursuing the proposed offshore seismic exploration activities in Areas 3 and 6. This No-Go alternative will have both positive and negative effects.

Should the proposed seismic activities not go ahead, the obvious consequence is that there will be no opportunity for negative impacts on the marine environment, artisanal and industrial fishing activities or tourist related activities. While this will result in the status quo being maintained for artisanal fishermen, it may result in a benefit for the tourism industry in that it will not be threatened in the medium and long term by the potential development of oil and gas operations in the area. Investors will remain confident in the potential for high-end tourist developments and the high levels of foreign investment will continue unless threatened by other external factors. Continued investment in the tourism sector will enable this sector to maintain its status as the largest formal sector employer in the area resulting in significant local benefits. Benefits will also continue to accrue to the local suppliers to the tourist sector.

The negative consequence of the No-Go alternative is related to the cost of missed economic opportunity of exploiting a natural resource that can provide foreign exchange income to Mozambique at an order of magnitude greater than that of the tourism sector. Should no exploration activities be allowed to take place, the Government of Mozambique will not be able to realise this benefit.

Major oil and gas resources are currently unexploited in developing or emerging economies, due to lack of access to viable commercial markets. Should viable reserves be discovered as a result of the proposed exploration activities, subsequent development of these reserves will have the potential to bring substantial economic benefits to Mozambique. The development of a discovered petroleum reserve is likely to generate government revenue, add to the country's Gross National Product, create job opportunities and generate foreign exchange. However, global experience shows that developments of this scale and nature seldom result in substantial benefits to the local communities. Benefits generally only accrue locally if there is a direct commitment by the Government to ensure that a certain percentage of the revenues generated from the exploitation of the natural resource is circulated back into the local economy in the form of social development and infrastructure projects. A further requirement for realising local benefits is for the developer to actively assist with building human resource and institutional capacity in the local area to assist with effectively administrating revenue that may accrue. Sustainable development in this context would depend on an understanding of the necessary trade-offs in various economic sectors to ensure that the development of one sector does not significantly compromise the development of other important sectors.

6.7.2 Alternative technology

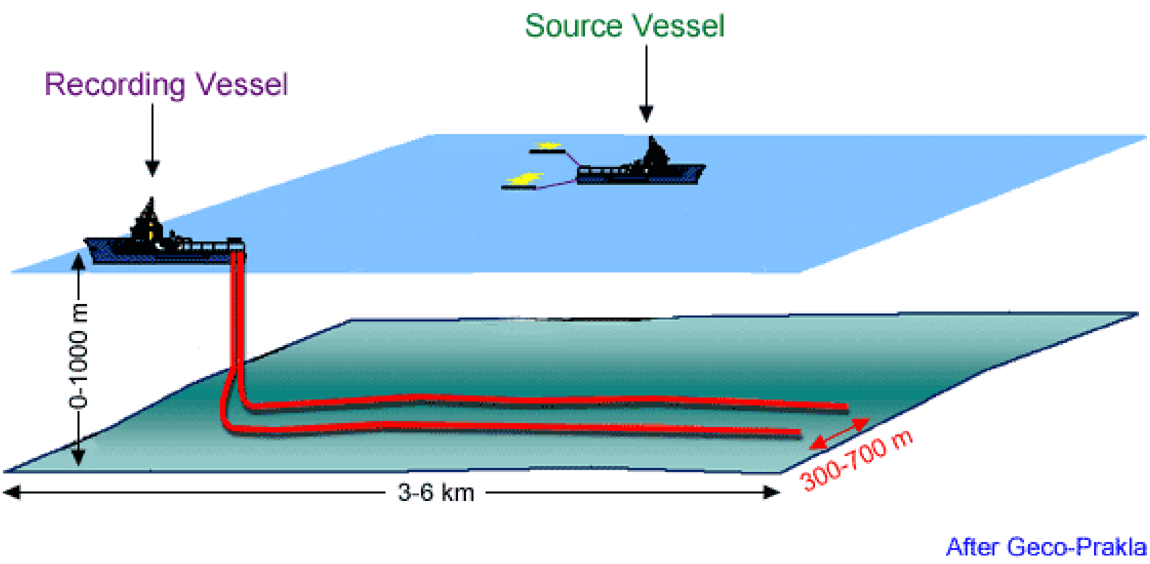
Alternative technologies have been considered with regard to the proposed exploration project, including alternative seismic methodologies. Two methods are suitable for seismic acquisition in the deep water, namely the conventional seismic surveys proposed, or the use of Ocean Bottom Cables (OBC). These methodologies present different benefits and disadvantages in terms of their impacts on the environment. The method to be used can only be finalised after a contractor has been assigned to perform the work.

Ocean Bottom Cabling (OBC)

Although this method is probably best suited for shallow water environments where water depths range from 5 to 10 m, it is very often used in deepwater areas. The streamers are laid on the seafloor by a support vessel which doubles as the recording vessel, while the energy source array is towed behind the source vessel (see *Figure 6.8*).

Advantages of this method include the fact that the streamers can be left on the seafloor for a period of time, making re-surveying easy and cost effective. The length of the equipment behind the vessel is also shortened making it easier to manoeuvre the vessel into tight spots. However, OBC may result in significant physical disturbance of benthic habitats as the cables are laid directly on the sea bed.

Figure 6.8 ***Schematic representation of ocean bottom cables and seismic vessels***



6.7.3 *Equipment Choice and Detailed Plan for Seismic Acquisition*

The method used to acquire seismic data will depend on the physical restrictions of the area, environmental considerations, the cost of acquiring data and the timing of the survey. The best available technology will be used to acquire the seismic data. Potential alternatives could include variations in the size and number of streamers, the energy source used (frequency) and the positioning and spacing of seismic lines.

Although PCMRB have a clear understanding of the area for the 2D survey, the 3D programme will only be decided once the 2D data has been collected and analysed. Therefore, several location alternatives will need to be identified.

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