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Umwelt
Environmental Consultants

MDL Mineral Sands Group

Grande Côte Operations SA

Grande Côte Project

Definitive Feasibility Study

ENVIRONMENTAL AND SOCIAL

VOLUME 2 | JUNE 2010

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EXECUTIVE SUMMARY

Project Overview

In September 2004, Mineral Deposits Limited (MDL) was selected by the Government of the Republic of Senegal (GRS) to explore and develop the Grande Côte Project (GCP).

MDL's interest in the GCP is held by the Senegal-based company Grande Côte Operations SA (GCO). GCO is 90% owned by a Mauritius-based company Mineral Deposits Mauritius Limited, which in turn is 100% owned by MDL. The remaining 10% of GCO is held by the GRS. A Mining Convention with the Senegal Government was established in September 2004, which defines the general, legal, financial, fiscal, economic, administrative and specific corporate conditions under which GCO can undertake exploration and mining activities in the Grande Côte Permit Area.

As required under the Environmental Code (2001) and the Mining Convention, an Environmental and Social Impact Assessment Study (Etude d'Impact Environmental et Social, EIES) was completed in December 2005. In December 2005, MDL submitted the EIES in support of its application for a Mining Concession. The EIES was approved by the Environmental Department of the Ministry of Environment and Nature Protection of the GRS on 20 January 2006.

MDL applied for a Mining Concession and provided a preliminary Feasibility Study in 2007. The Mining Concession was granted to MDL on 2 November 2007 for a period of 25 years. The renewable Mining Concession allows for development, extraction, processing, transport and marketing of zircon, ilmenite, rutile, leucoxene and related minerals.

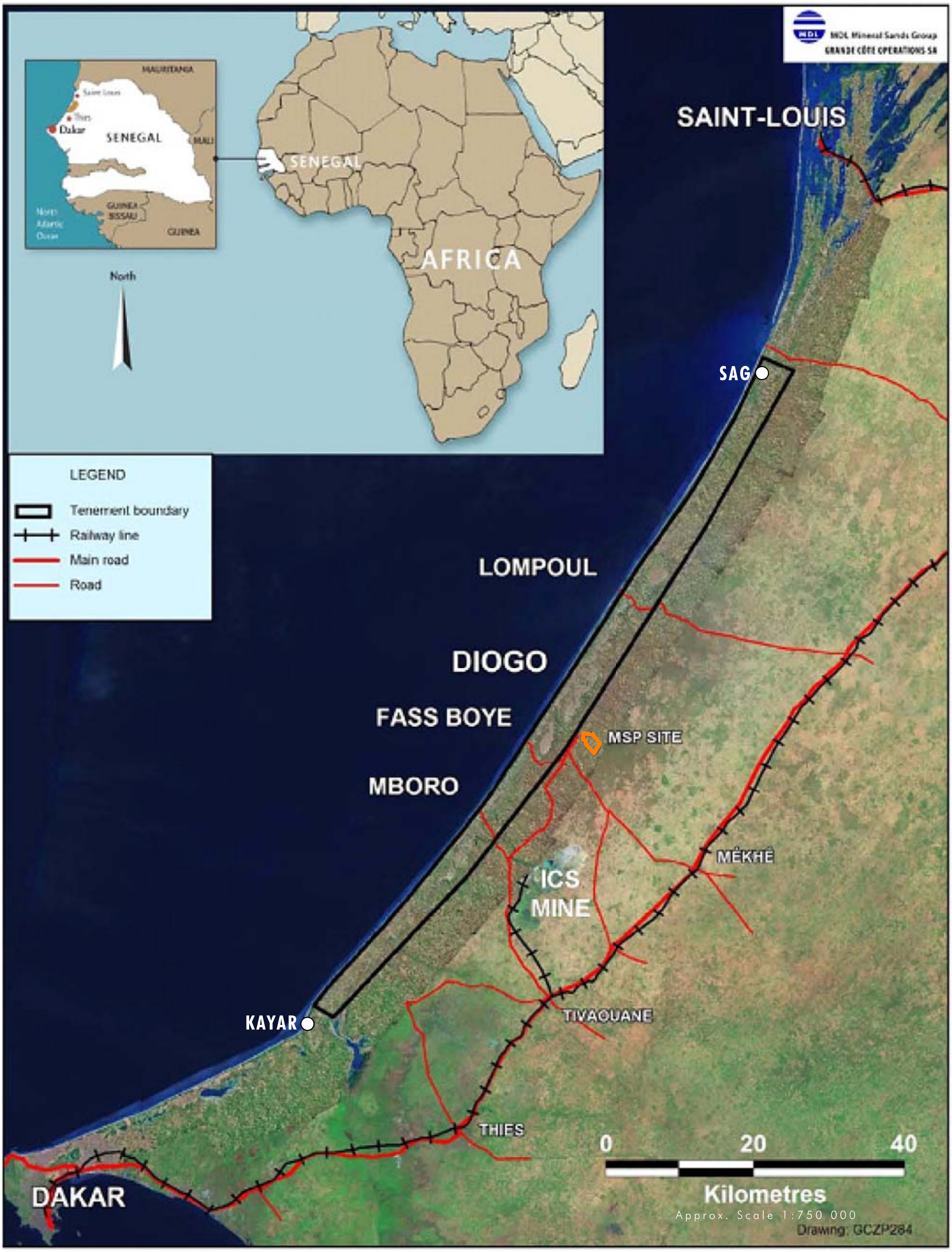
MDL also operates the Sabodala Gold Project in eastern Senegal, which was acquired by open tender from the GRS. Expertise from the development of Sabodala has been applied to the operational strategy, environmental and social guidelines proposed for the GCP.

Project Background

The Republic of Senegal is located on the western margin of northern Africa (Figure i). Senegal is a stable, democratic republic based on the French civil law system. Senegal gained its independence from France in 1960 after some 75 years of French rule.

Senegal has an estimated population of approximately 12 million people. Nationally, the population density is 50 people per km^2. Most people are Muslim (94%) with a Christian minority (5%) and the remainder following indigenous beliefs.

The capital, Dakar, is found on the most westerly point of the coastline of Africa. The topography of the country is generally low, rolling plains rising to foothills in the south-east. The area to be mined is located on a coastal dune system that begins 60 km north-east of Dakar northward for more than 100 km (Figure i).



Source: Mineral Deposits Limited

Legend
Exploration Permit

FIGURE i

Grande Cote Project Location

Project Description

The GCP will be a sand dredging operation. Mineralised sand will be treated in a conventional floating spiral pre-concentrator, land-based fixed wet concentrator and dry mineral separation plants.

Mining will be carried out by dredging a continuous path through the dune ore body. The dredge will float in an artificial pond accompanied by the floating pre-concentrator. A tailings stacker behind the pre-concentrator will be used to place the tailings and achieve a final landform. Approximately 98% of all material mined by the dredge will be left as tailings.

The heavy mineral concentrate (HMC) from the floating concentrator will be pumped to the mineral separation plant (MSP) where it will be dewatered and stockpiled for batch processing in the MSP. On the basis of their different physical properties ilmenite, zircon, rutile and leucoxene products will be separated from the HMC; no chemicals are used to process HMC.

The following infrastructure is used to support dredging and mineral separation processes:

- **Buildings and storage facilities:** Mill buildings, administration offices, warehouses and lay-down areas will be located at the MSP.
- **Power station and liquid fuel storage:** GCP will own and operate a 28 MW dual-fuel (Heavy Fuel Oil (HFO)/Natural gas) fired power station.
- **Fuel storage:** A liquid fuel farm located at the MSP will have a standby HFO storage capacity of 1M litres and a gasoil storage tank of 0.1M litres. Gasoil (diesel) is required for vehicles and to fuel pilot burners on the dry mill and the Ilmenite Plant heating equipment.
- **Information and communications technology:** The key elements will be similar to those of Sabodala operation and include voice and data communications, wide and local area infrastructure, PCs and specialist software.
- **Road and rail infrastructure:** Ilmenite will be transported 25 km by road to purpose-built loading facilities and then by rail to the Port of Dakar. Zircon, rutile and leucoxene will be transported in shipping containers by road to the port.
- **Port and harbour facilities:** A new loading facility will be built for bulk ilmenite loading onto trains and ship loading facilities at the Port of Dakar.

If financing for the project is in place by the first quarter of 2011, the first sales products from the GCP are provisionally scheduled to be produced by June 2013.

Key project metrics are summarised in Table i.

Table i Key Project Assumptions and Metrics

Item	Assumption and Metrics
Saleable products and average annual production rates	Premium zircon – 32,000 tpa Intermediate zircon – 25,000 tpa Standard zircon – 20,000 tpa Secondary zircon – 2,500 tpa Sulphate ilmenite – 400,000 tpa Chloride ilmenite – 175,000 tpa Rutile – 6,000 tpa Leucoxene – 11,000 tpa
Mining strategy	Owner mining
Total metres drilled (MDL)	150,665 m reverse circulation (RC) drilling. 45,203 m auger drilling.
Classified Resource	Indicated Resource - 50 Mt at 1.7% HM. Measured Resource -980 Mt at 1.7% HM. Total Indicated and Measured - 1,030 Mt at 1.7% HM.
Mining rate	55 Mt per year of sand. Average 7,000 tonnes per hour.
Mining method	Floating cutter-suction dredging operation.
Classified Reserve	Probable Reserve - 5 Mt at 1.7% HM. Proved Reserve - 746 Mt at 1.8% HM. Total Probable and Proved - 751 Mt at 1.8% HM.
Processing method	Floating concentrator featuring banks of gravity-fed high capacity spirals followed by a land-based mineral separation plant (MSP), which includes a wet high-intensity magnetic separation plant (WHIMS), a zircon wet and dry plant and an ilmenite plant.
Processing rate	140 tph to a maximum of 200 tph.
Tailings disposal method	Cyclone and discharge with tailings stacker.
Product transport method	Road transport in containers to Port of Dakar for zircon, rutile and leucoxene. Combination of road and rail transport in bulk to Port of Dakar for ilmenite.
Project execution methodology	Engineering, procurement, construction management (EPCM) contractor.
Construction start date	Beginning of second quarter 2011.
Production start date	End of second quarter 2013.
Defined mining path	14 years.

Environmental, Legal and Other Requirements

Thirty-two laws and regulations apply to the environmental and social management of the GCP. The Senegal Environmental and Mining Codes also apply to the GCP.

The aim of the Environment Code (2001) is to manage and protect the environment against all possible forms of degradation arising from economic, social and cultural development. The Environmental Code sets out the government's environmental policies in four key areas:

1. Classified installations (mobile or fixed activities, capable of affecting the environment).
2. Water pollution.
3. Noise pollution.
4. Air pollution and unpleasant odours.

The Mining Code (2003) Senegal covers both exploration and mining activities in Senegal. The Mining Code considers environmental and social management in the following sections:

- Title IX, Chapter 5 'Environmental Protection' specifies the requirement for an environmental impact study.
- Title VIII, Article 55, 'Equalisation and Support' ensures that a portion of income from a mining operation is set aside as a fund for local communities.
- Article 76 of the Mining Code requires the holder of a mining title to compensate owners or occupants of land occupied by the mining title holder.
- Article 78 requires a mining title holder to rehabilitate mine sites at the expiry of each mining title.

International conventions ratified by the GRS that are relevant to the GCP are outlined in the Environmental and Social Impact Assessment (EIES).

Project Context and Baseline Studies

The project lies within the Regional Council administrative regions of Thiès and Louga. Within these administrative regions are several Rural Communities governed by Rural Councils, including Darou Khoudoss, Cab Gueye, Thieppe and Diokoul Diawrigne. Most villages in these Rural Communities are situated outside the mining concession.

Baseline environmental and land asset and livelihood studies were undertaken by GCO as part of the Definitive Feasibility Study (DFS) across the Grande Côte Project Development Area (GCPDA). The GCPDA is defined as a broader project impact area, including the current proposed mining area and the associated 50 m buffer zone (the allowance either side of the mine path), the mine construction camp, the MSP and all other associated project facilities.

The aim of the land asset and livelihood studies was to establish current social and environmental standards and conditions in the vicinity of the project enabling the development of a GCP-specific environmental and social management system (ESMS). Baseline study findings include:

- That settlements within the GCP region can be broadly clustered into three zones:
    1. Settlements located on the littoral dune, including: Foth, Keur Gou Mag and some Diogo hamlets. These settlements are located inside the GCPDA.

2. Coastal settlements located adjacent to the proposed mining area outside of the GCPDA.
3. Hinterland settlements located east of the littoral dune, again outside of the GCPDA (along the road leading to Diogo) and adjacent to the proposed mining area.

- More than 80% of the population within the GCPDA were born in the village in which they reside.
- The main occupation in the project area is agriculture, with the majority of adult men (92%) and women (58%) in the 2007 baseline survey area identifying agriculture as their principal occupation. Other occupations include fishing, fish processing, housekeeping, labouring and trades. Only 1% of men identified themselves as being unemployed or retired. Households within the project area are heavily reliant on cash income sourced from horticultural activities.
- A cash income is required for staple and supplementary foods, household items and emergencies such as medical expenses. The average annual household cash income for the settlement clusters on the littoral dune varied from 3,000,000 FCFA (~US$6,833) in Foth to 4,200,000 FCFA (US$~9,567) in Diourmel hamlets. There are few opportunities for off-farm employment.
- Life expectancy in Senegal is relatively low at 56 years. Infant mortality and under-five mortality rates are 78 and 137 (per 1,000 live births) respectively (UNDP 2006). Access to health facilities is a major constraint to the population of the Rural Community of Darou Khoudoss. Within the project area, health posts are situated at Darou Fall, Fass Boye and Lompoul. Common health issues in the project area include malaria, dysentery, diarrhoea, parasites, malnutrition and tuberculosis.
- Based on interviews with heads of household from the project area, 28% of males and 42% of females described themselves as illiterate. Only 10% of men and 8% of women have attended primary school. Within the project area, French language primary schools are located in Darou Fall, Fass Boye and Lompoul (CR Darou Khoudoss 2004).
- Approximately 50% of the project area consists of savannah – native grassland with scattered and isolated shrubs and trees, while approximately 31% consists of plantations of filao (casuarinas) and eucalyptus. Approximately 17% of the project area consists of active dunes and the remaining 2% consists of gardens and habitation areas.
- Eleven threatened flora species and eight endemic flora species have been identified in the GCPDA.
- About 10% of the existing dunes within the dredge path are active and not vegetated. The remaining 90% of dunes are vegetated have a range of different land covers, including gardens, scrubland, savannah, woodland and plantation forest.
- The only surface water present in the project area is the water contained in small ponds adjacent to dunes, where trenches have been dug by farmers to intersect the groundwater body and to provide water for irrigation. No flowing streams are found in the GCP area.
- Dredging activities associated with the GCP will directly impact a small number of cultural sites located within the proposed mining area under the first six years of mining. These include two cemeteries and one mosque associated with Diogo hamlets.

- The only known cultural heritage material mapped within the Mining Concession, is a “shelly heap”. It occurs close to the coast in the approximate vicinity of Fass Boye (Tropica 2005). This site is outside the proposed mining path.

Key Environmental/Social Issues and Mitigation Measures

The project lies within an area of sand dunes with arable inter-dune depressions known as ‘niayes’. The niayes are situated mainly on the eastern side of the dunes in the hinterland areas and will generally not be impacted directly by the proposed mining operation, except during construction of the initial dredge pond. The types of social and environmental impacts that may occur include impacts on:

1. Land
2. Relocation
3. Rehabilitation
4. Water

These are discussed further below.

1. Land

Impacts on land use will primarily be associated with the disturbance of land within the proposed dredge path and buffer zone. Key potential impacts include loss of agricultural production; loss or restricted access to agricultural land and community land; loss of local community timber and non-timber forest resources; and loss of income and employment.

Extensive stakeholder consultation will take place to develop suitable compensation and replacement land options. Compensation will include replacement land on the littoral dune or in the hinterland areas, new housing and appropriate fiscal compensation for livelihood disruption and temporary/permanent loss of land access.

2. Relocation

Dredging activities associated with the GCP will directly affect a small number of cultural sites located within the proposed mining area under the first six years of mining (Table 5.9). These include two cemeteries, one mosque and a small Arabic school associated with Diogo hamlets

Thirty-eight settlements associated with the villages of Foth, Diourmel, Diogo and Thiakmat, with 209 households and 1,167 people within the proposed mining area and buffer zone will be relocated. Compensation is proposed for disturbance to housing, property assets, agricultural land, community land, and livelihood restoration. Detailed government and community consultation will be undertaken to fully define feasible relocation options and procedures.

3. Rehabilitation

In consultation with stakeholders, GCO will develop a rehabilitation strategy for the GCP, which will define the final site rehabilitation objectives and establish quantifiable criteria to help determine rehabilitation success.

Rehabilitation trials will be conducted prior to the start of mining. Rehabilitation trials and baseline surveys will determine what general categories of land use will be rehabilitated and where this rehabilitation will take place.

As part of the Annual Mining Operations Plan, a vegetation survey of the proposed dredge path will be conducted and authorisation will be sought from the Forestry Commission for clearing. Impacts on protected species will be managed by avoiding them, by replacement planting, or by offset planting.

Rehabilitation and closure of the mine site will take place in two stages.

- As the dredge progresses through the sand dunes, the landscape will be re-formed and revegetated behind it. This is ongoing closure.
- When the dredge has finished working in the project area a program of activities for final closure will be undertaken.

Native and plantation plant production will be undertaken at either a nursery established for the purpose at the mineral separation plant site or via a partnership with the community and/or the Forestry Department's nursery at Lompoul.

4. Water

Water management is one of the key issues affecting the success of GCP. It is important for the operation of the mine; the transfer of concentrates to the MSP; the mineral separation processes and for the needs of the local community, who depend on it for their survival. The predominant uses of water for the GCP are:

- To create a pond within the dunes for flotation of the mining dredge, surge bin and wet concentrator modules and slurrying of dune ore body for processing.
- Pumping and processing of mineral concentrates between the dredging operation and the MSP and within the MSP.

Water will be obtained from groundwater aquifers for the GCP operation: The upper sand aquifer (Quaternary age) and a lower Maestrichtian (Cretaceous age) aquifer. The GCP will primarily source water from the lower aquifer via a series of large bores.

Where the dredge pond is close to niayes, and the water table is raised, there is potential to temporarily flood some niayes. This flooding will be short-lived and minimised through installation of a system of lateral bores into the upper aquifer, which will be used to recover 80% of water that escapes from the dredge pond.

Extensive hydrogeological modeling of existing water resource and the effects of mining on the water table has been undertaken as part of the DFS. This included natural hydrogeological processes.

Project water requirements are well defined and the hydrogeological modelling indicates these requirements can be met from regional groundwater in the area to be mined.

Environmental and Social Management System

An environmental and social management system (ESMS) will be developed. This will identify the processes that require measurement and evaluation of appropriate mitigation measures for environmental and social impacts from the GCP. The primary intent of the ESMS is to minimise adverse social and community impacts of proposed mining and mineral processing activities.

An Environmental Social Management and Monitoring Plan (ESMMP) has been developed based on commitments made in the EIES and on requirements of the GRS and financial institutions involved in the project. The ESMMP incorporates the following corporate codes and international standards:

- MDL's Corporate Code of Ethics.
- International Finance Corporation (IFC) Performance Standards.
- Equator Principles.
- African Development Bank Safeguard Policies.
- AS/NZS ISO 14001 (2004) Environmental management systems.

The ESMMP will provide a framework for ongoing environmental and social management, and sets guidelines for development of management plans and standard operating procedures that will be developed as part of the ESMS. Important environmental and community management plans include:

- **Social Development Plan:** Preparation of a SDP will provide a comprehensive strategy for the re-establishment and security of the livelihood of project-affected persons.
- **Resettlement Action Plan:** Preparation and implementation of a well-resourced RAP will outline in detail the procedures and actions that GCO will take to mitigate adverse effects, compensate losses and provide development benefits to persons and communities affected by the GCP.
- **Rehabilitation and Closure Plan:** The overall objective of the GCP rehabilitation and revegetation program is to restore the land to be suitable for activities that existed prior to the mining.
- **Groundwater Quality Monitoring Plan:** A proposed program for the baseline monitoring, production monitoring and post-closure monitoring of groundwater quality has been identified and developed for the GCP. The groundwater quality monitoring will occur in four stages: baseline monitoring, production monitoring, closure monitoring and post-closure monitoring. Developed by Umwelt, 2010.

Environmental and Social Benefits

Construction and operation of the GCP will produce substantial financial and social benefits for surrounding communities.

These benefits will include:

- Direct and indirect job creation.
- Creation of local industry to support mobile and fixed mining plants.
- Training and skills transfer through employment.

- Improved health and education through provision of new facilities.
- Improved local infrastructure such as roads.
- Enhanced rehabilitation strategy for mobile dunes.
- Establishment of a social fund for local communities from project income.

1 INTRODUCTION

Mineral Deposits Limited (MDL), an Australian-based mineral resources company, proposes to establish a heavy mineral sands mine on coastal sand dunes along the Grande Côte of Senegal. The Grande Côte Project will be operated by Grande Côte Operations SA (GCO), which is owned by MDL (90%) and by the Government of the Republic of Senegal (GRS) (10%).

MDL executed a Mining Convention with the GRS on 9 September 2004 and obtained an official exploration licence (*permis de recherché*) to explore for zircon, rutile, ilmenite, leucoxene and other associated minerals within a rectangular 445.7 km^2 licence area, extending for 90 km along the Grande Côte, on the north coast of Senegal (Figure 1.1). The exploration area extends over coastal sand dunes in parts of the Darou Khoudoss, Kab Gaye, Thieppe and Diokoul Diawrigne Rural Communities.

Following an extensive drilling program, and preparation of an Environmental and Social Impact Assessment (Etude d'Impact Environnemental et Social [EIES]) by Tropica Environmental Consultants (2005), MDL applied for a Mining Concession (Concession Minière) to allow exploitation of heavy mineral sand resources along the Grande Côte. The EIES was approved by the Environmental Department, which is part of the Ministry of Environment and Nature Conservancy (MEPN in French) of the Senegal Government on 20 January 2006. The Mining Concession was granted on 2 November 2007 and covers the same area as the original exploration licence.

The Grande Côte Project (GCP) will establish mineral sand mine, a mineral separation plant and associated infrastructure. The mine will target heavy minerals found in unconsolidated sand dunes and initially aims to produce approximately 80,000 t of zircon per annum. Nominally a further 575,000 t of ilmenite per annum will be produced. Heavy mineral will be separated from the sand by a wet separation process, which includes an electric cutter-suction dredge and a floating wet concentrator. MDL has used this mining method successfully in similar mineral deposits on the east coast of Australia.

1.1 Purpose

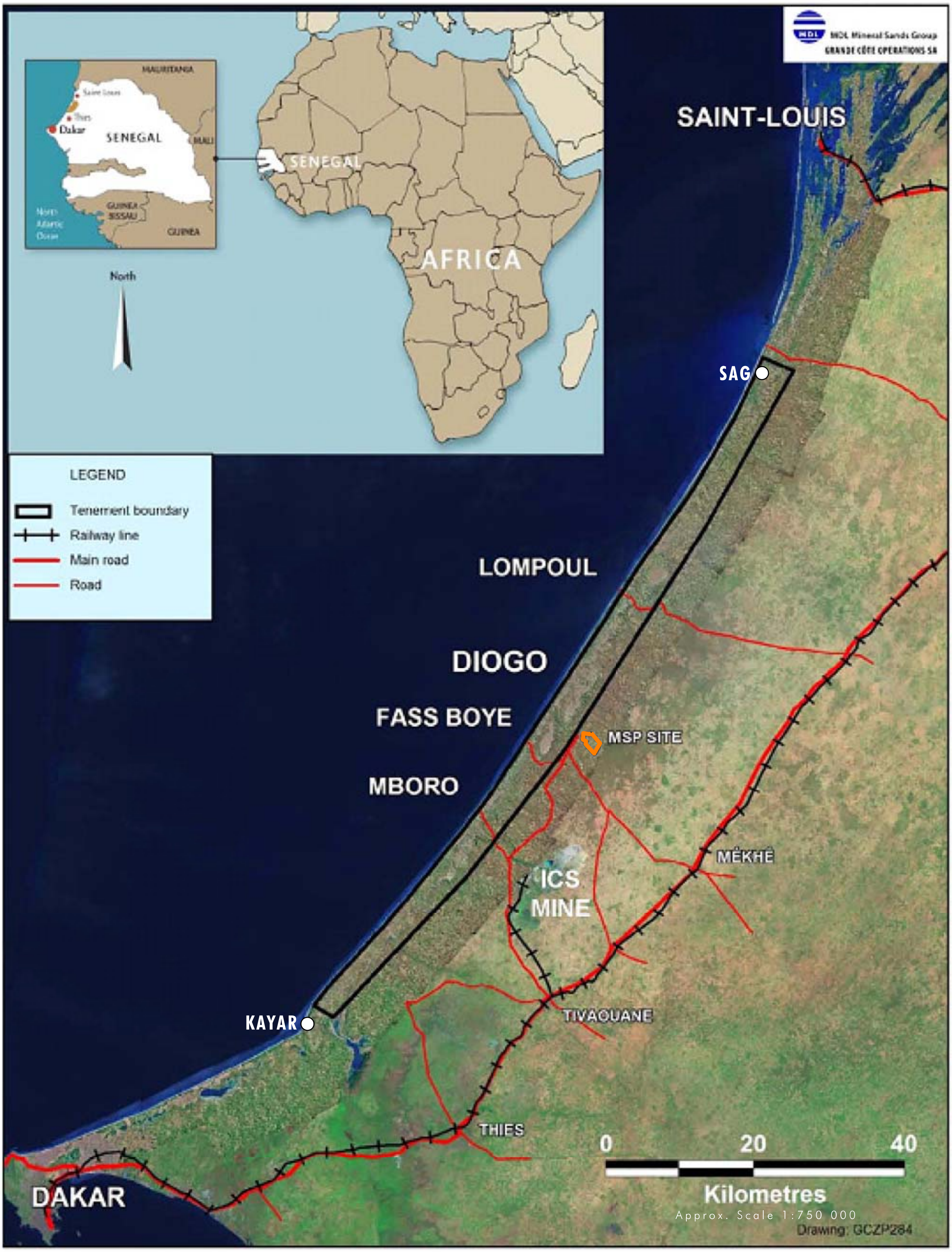
This volume of the Definitive Feasibility Study provides an overview of the environmental and social issues associated with the development of the GCP and the mitigation measures proposed to minimise the potential impacts of the development.

1.2 Scope

In 2005 Tropica identified the main environmental and social impacts associated with the proposed Grande Côte Project. Since that time, additional studies have been completed.

Earth Systems conducted the Land, Asset and Livelihood Baseline Study in 2007, covering the proposed dredge path. This has been updated for this Definitive Feasibility Study (Earth Systems 2010A). A Land, Asset and Livelihood Impact Assessment and Management Strategy Report has also been prepared by Earth Systems (2010B) for 10 years of the current 14-year mine plan.

This Definitive Feasibility Study considers material from 2007 documents updated in 2010, including the Environmental and Social Management and Monitoring Plan and the updated Environmental and Social Monitoring Manual.



Source: Mineral Deposits Limited

Legend
Exploration Permit

FIGURE 1.1

Grande Cote Project Location

Additional reports included here are a Groundwater Monitoring Plan and work on revegetation.

1.3 MDL Policies

The following MDL policies have been considered in writing the Definitive Feasibility Study as they apply to the GCO:

- MDL Corporate Code of Ethics.
- MDL Sustainability Policy Statement.

1.3.1 Corporate Code of Ethics

The Corporate Code of Ethics underpins the company attitude to implementing environmental and social management strategies. In June 2004 MDL formally adopted a Code of Ethics, which applies to GCO, to the GCP and to all its employees. Under the code, all company officers and employees are expected to:

- Comply with the law.
- Act honestly and with integrity.
- Not place themselves in situations that result in divided loyalties.
- Use GCO's assets responsibly and in the best interests of GCO.
- Be responsible and accountable for their actions.

MDL's board will review and assess the implementation of the code each year.

MDL's Corporate Governance Statement identifies the company's core values and code of conduct to:

- Act with integrity and fairness.
- Create a safe, challenging and rewarding workplace.
- Respect and protect the environment.
- Be commercially competitive.
- Foster a performance-driven culture.

1.3.2 Sustainability Policy Statement

MDL displays its commitment to environmental management and community support on its website. The company's objective is to "ensure that we conform to sustainable development principles". GCO is committed to developing and maintaining an integrated management system that incorporates the requirements of the following standards:

- AS/NZS ISO 14001 (2004) Environmental management systems – specification with guidance for use.
- AS/NZS 4801 (2001) Occupational health and safety management systems – specification with guidance for use.
- AS/NZS 4360 (2004) Risk management.

- International Finance Corporation (IFC) Performance Standards.
- Equator Principles.

1.4 History of Mineral Deposits Limited

MDL traces its history to Mineral Deposits Syndicate, which started mineral sand mining operations in Southport, Queensland in 1940 and continued along parts of the east coast of Australia. The company has a long history of wet dredging along dunes and strandlines to produce a heavy mineral concentrate, which was transported to a dry separation plant for separation of rutile and zircon. In line with best practice, each mine site has been rehabilitated progressively as dredging moved through the ore body.

MDL ceased mining on the east coast of Australia in July 2003 and closed down mineral separation operations at its dry mill plant at Hawks Nest, New South Wales in September 2003.

Over the past six years, MDL has developed a world class 2 Mtpa gold mine and processing plant at Sabodala, Senegal.

Concurrently with its work at Sabodala, MDL (GCO) has been investigating the feasibility of mining zircon, ilmenite, rutile and leucoxene from sand dunes along the Grande Côte in Senegal. The main resource areas for the GCP are currently: Mboro, Diogo, Fass Boye and Lompoul (Figure 1.1). Mining will commence in the Diogo sector mid 2013.

2 PROJECT OVERVIEW

The proposed Grande Côte Project (GCP) intends to produce nominally 80,000 tpa of zircon and approximately 575,000 tpa of ilmenite by wet dredging from littoral sand dunes along the Grande Côte. The project will not operate in the older red dunes to the east. The ilmenite may be transported off site to markets or may be stockpiled at the mineral separation plant (MSP) while markets are developed for this product.

An initial pond to accommodate the construction of the dredge and floating facility will be excavated near Diogo (Figure 2.1). The pond will be approximately 250 m long x 200 m wide, (i.e. approximately 5 ha in area) and a maximum of 6 m deep. The dredge and dredge pond construction site will occupy an area of more than 8 ha in an inter-dune depression (niaye).

Once the dredge is operational, it will mine along a dredge path located entirely within the dunes. The landscape will be restored progressively as the dredge proceeds along the mine path. It is estimated that the dredge pond construction site will be rehabilitated approximately 12 months after the dredge commences mining. Rehabilitation of the hardstand area beside the initial dredge pond will be undertaken when the site is no longer required.

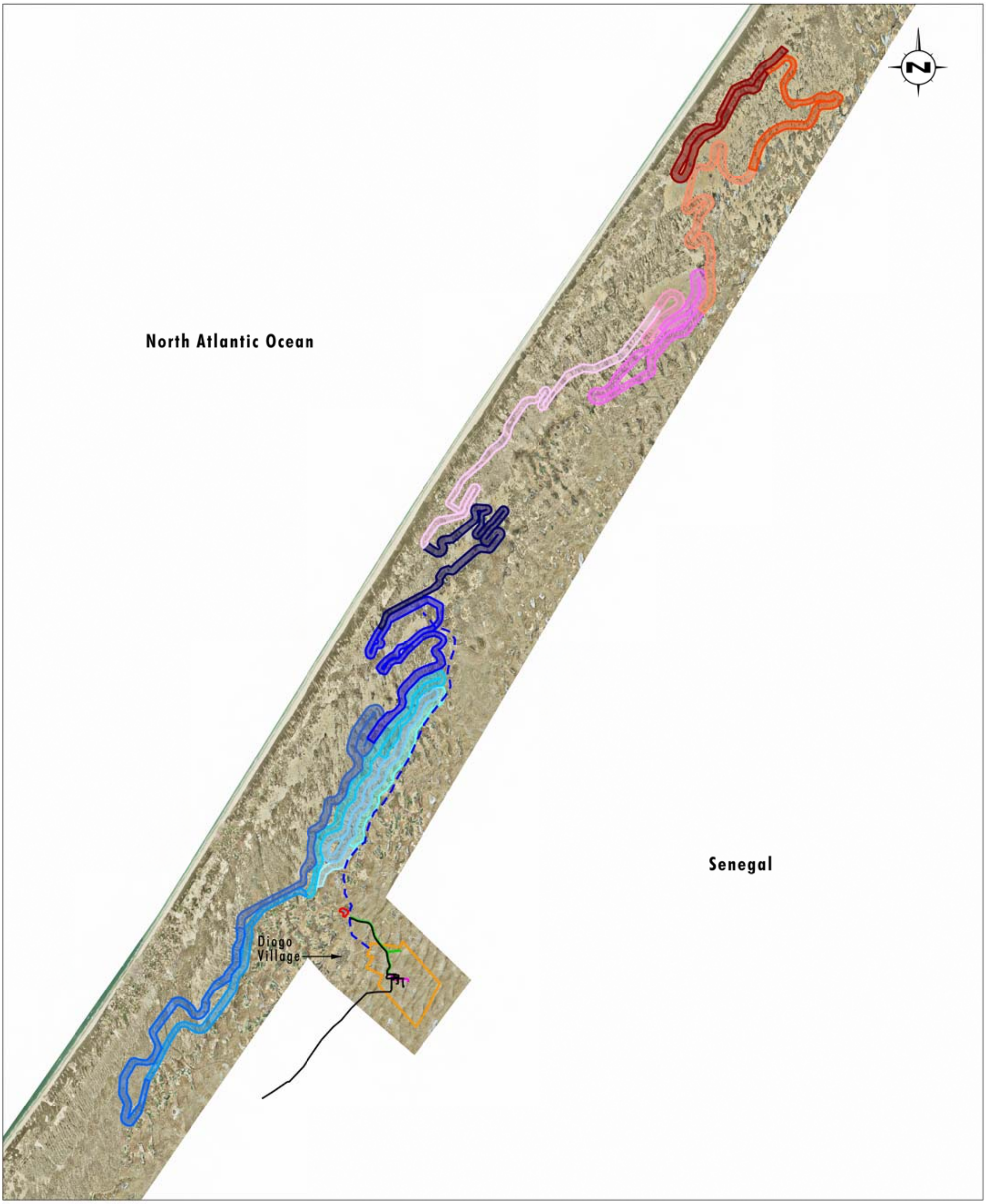
A mineral separation plant (MSP), power station, construction camp and access road to connect the mine site with the MSP will be constructed. Construction and commissioning will last approximately 24 months. Around 800 workers will be required during construction of the dredge, dredge pond, MSP, power station and access roads. After the construction period, approximately 280 permanent employees will be required to operate the GCP (dredge, MSP, transport, laboratory and revegetation). The dredge and MSP will operate 24 hours a day, seven days a week, 52 weeks a year.

As the dredge mines through the dunes, the floating wet concentrator separates the mineral concentrate (which is approximately 2% of the sand mass) and the remaining sand is pumped to the rear of the dredge pond. The pumped sand is shaped and restored to resemble the original landscape. In this way, the dredge moves progressively through the sand ore body, at a rate of approximately 14 ha per month, and the landscape is reshaped as it goes. The re-formed landscape will be revegetated progressively, as required. Rehabilitation requirements will be determined in consultation with the local community and with the Forestry Commission.

2.1 Project Objectives

The GCP aims to:

- Supply zircon and ilmenite to world markets for a minimum of 20 years.
- Conduct operations in an environmentally responsible manner by understanding and effectively managing environmental impacts.
- Comply with all relevant laws, regulations and permits of Senegal and with the Equator Principles.
- Develop an ongoing relationship with local communities through effective community consultation programs, employment opportunities and implementation of a social support program.
- Contribute to local, regional and national economies through employment and royalties.



Source: MDL (2010)
Note: Dredge Path Package as Received from MDL May 2010

0 2.0 4.0 8km
1:175 000

Legend

MSP Site
GCO Exploration Camp
Proposed Road
Road Upgrade
Powerline
Pumpline

Proposed Dredge Path

Year 1, Year 2, Year 3, Year 4, Year 5, Year 6, Year 7, Year 8, Year 9, Year 10, Year 11, Year 12, Year 13, Year 14, Year 15

FIGURE 2.1

Proposed Grande Cote Mine Path and Ancillary Infrastructure

2.2 Project Description

GCO proposes to extract heavy minerals from the Quaternary sand dunes along the Grande Côte by wet dredging. The dredge will float in a pond excavated into the groundwater table or at nominal levels above this natural water table and will progress through the dunes at a rate of approximately 7 km pa. A cutter-suction dredge will deliver mined sand to a floating concentrator, which will separate the heavy mineral concentrate (approximately 2%) from the remainder of the sand. The remainder of the sand will be returned to the rear of the dredge pond to approximate the original topography.

Concentrate will be pumped via pipeline to the MSP and will be further separated into a magnetic (primarily ilmenite) stream and a non-magnetic (zircon, rutile, leucoxene and waste) stream. Both the streams will be stockpiled at the MSP site for batch processing. Zircon, rutile and leucoxene will be separated from the other heavy minerals in the non-magnetic concentrate stream and stockpiled under cover ready for transport via road to the Port of Dakar. Likewise, primarily ilmenite with small quantities of zircon and leucoxene will be separated from the magnetic stream. Ilmenite product will be transported by rail to the Port of Dakar.

Waste minerals remaining after separation of all streams will be pumped back to the dredge pond where they will be incorporated in the re-formed dunes.

2.3 Geology and Hydrogeology

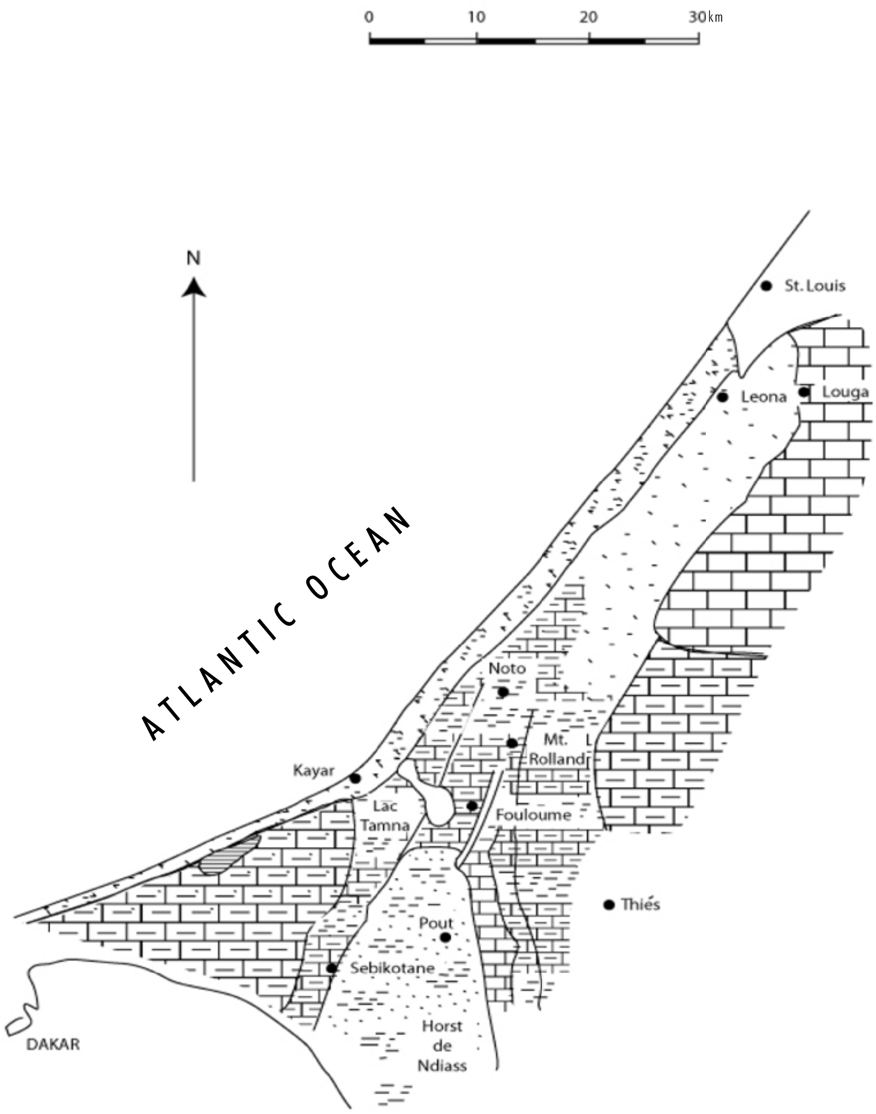
The Grande Côte lies on the western edge of the extensive Senegal–Mauritania Basin, which covers most of Senegal and extends north into Mauritania. The basin is composed of Mid-Jurassic to Quaternary poorly cemented marine sand, marl, limestone and shale overlain by continental, lake and marine sediments.

A Quaternary sand sheet extends in a 100 km-long strip along the Grande Côte, ranging in width from 10 km to 15 km. It is composed of Holocene sands, which have accumulated during the last 8,000 years (Figure 2.2 – based on BRGM 1983, Figure 1). Holocene sand contains variable amounts of heavy minerals and is the target of the Grand Côte Project. The sand sheet also contains a significant groundwater resource that is utilised for domestic and agricultural purposes. This is discussed later in Section 4.2.4. Groundwater is the only source of water for the mining project.

West of the highway, between Tivaouane and Louga, the Quaternary sand sheet overlies Upper Eocene marl, which forms an impermeable substrate to the sand sheet aquifer. This substrate slopes towards the coast and is 20 m below sea level at Diogo, and more than 40 m below sea level at the coast (BRGM 1983). Contours showing the depth to the base of the sand sheet are illustrated on Figure 2.3 (based on BRGM 1983, Figure 3). Underlying the impermeable basement of the sand sheet aquifer at depths of more than 400 m is an aquifer of Maestrichtian age, which is used to supply drinking water for Dakar from bores near Thiès and process water for the ICS phosphate plant located some 23 km south of Diogo. Groundwater will be sourced from this aquifer to supply make-up water for the dredge pond, processing water for the MSP and drinking water for mining personnel.

Other mineral resources of the Senegal–Mauritania Basin include Tertiary limestone, an important source of cement (south-east of the Dakar peninsula); Tertiary phosphate deposits (at Taiba–Tobene, south-east of Mboro); and gas.

SCHEMATIC GEOLOGICAL MAP OF THE NORTH COAST OF SENEGAL



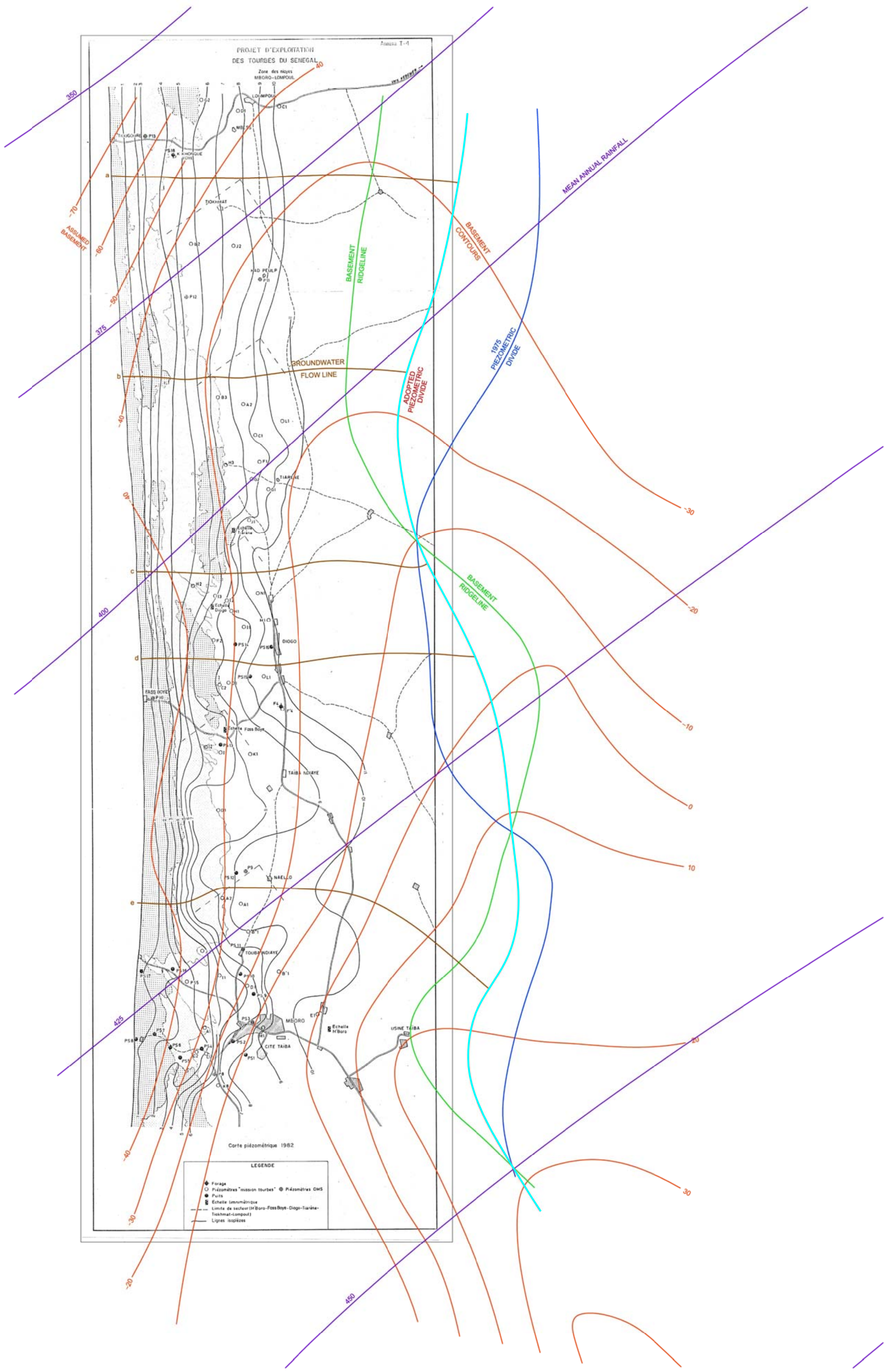
Legend

Recent Dunes (Mobile & Partly Stabilised)	Lower Eocene - Ypresien Claystone, Marl, Marly Limestone
Red Dunes	Palaeocene Limestone
Middle & Upper Lutetian - Limestone	Maestrichtien Clayey Sandstone
Lower Lutetian - Marls & Marly Limestone	

Source: BRGM (1983) "Hydrogeological Study M'Boro - Lompoul Sector Senegal"

FIGURE 2.2

Schematic Geology Map of Grande Cote Area



Source: Pells Sullivan Meynink (2004) Assembly of Data from
BRGM (1983) Report "Hydrogeological Study M'Boro - Lompoul Sector"

Legend

- Adopted Piezometric Divide
- 1975 Piezometric Divide
- Mean Annual Rainfall
- Basement Contours
- Basement Ridgeline
- Groundwater Flowline

FIGURE 2.3

Hydrogeological Data for the Grande Cote Project Area

Copy 3

A detailed description of the geology and geomorphology of the proposed heavy mineral mining project is provided in Section 4.2.2, while more detail on the hydrogeology is provided in Section 4.2.4.

2.4 Heavy Mineral Resource

Heavy minerals generally compose less than 2% of the sand sequence. Economic grades of heavy mineral will define the dredge path, and are based on the cumulative percentage of heavy minerals present in the sand sequence.

Heavy minerals are defined as having a specific gravity >2.9. Valuable heavy minerals include zircon, rutile, leucoxene and ilmenite. These are the minerals to be mined by the Grande Côte Project.

Between 1989 and 1992, DuPont conducted exploration drilling for heavy minerals (HM) along a 50 km section of the Grande Côte, from Mboro in the south to north of Lompoul. It is understood that DuPont was targeting ilmenite (Figure 2.5).

Significant heavy mineral (HM) deposits are known in the areas of Mboro, Fass Boye, Diogo and Lompoul and extend over a distance of some 50 km. Other deposits have been found both to the south-west and north-east over approximately 70 km. There is potential for additional deposits well beyond the limits of present drilling.

Based on work by the Geological Survey and DuPont, a model of heavy mineral sand deposits suggests three Aeolian phases of deposits. The greater amount of heavy minerals is found in the oldest phase (the orange dunes), which is now the most inland part of the mobile dune system (Figure 2.4).

Mineralogical data for the Fass Boye, Diogo and Lompoul proposed mining sites, derived by MDL (2006) from exploration work completed by DuPont (between 1989 and 1992), is summarised in Table 2.1. Further analysis has been completed, with similar results.

Table 2.1 Mineralogical Assemblage Information

Item	Grade (% of HM)
Zircon	10.7%
Rutile	2.5%
Leucoxene	3.2%
Ilmenite	74.5%
Magnetic other	4.5%
Non-magnetic other	4.7%

Ilmenite (iron titanium oxide) is the most abundant heavy mineral in the Grande Côte deposits and the magnetic fraction of the concentrate is primarily ilmenite. The large volumes of this mineral (approximately 575,000 tpa) require rail transport to Dakar from the existing rail line at the ICS phosphate plant approximately 28 km south of the MSP site. A dedicated access road is being considered to deliver product by truck to this point.

Zircon (zirconium silicate) is the other significant product of the Grande Côte Project with a significantly higher value per unit than the ilmenite. Additionally, smaller quantities of rutile (titanium dioxide) and leucoxene (an alteration product of ilmenite, mainly titanium dioxide) will also be produced.

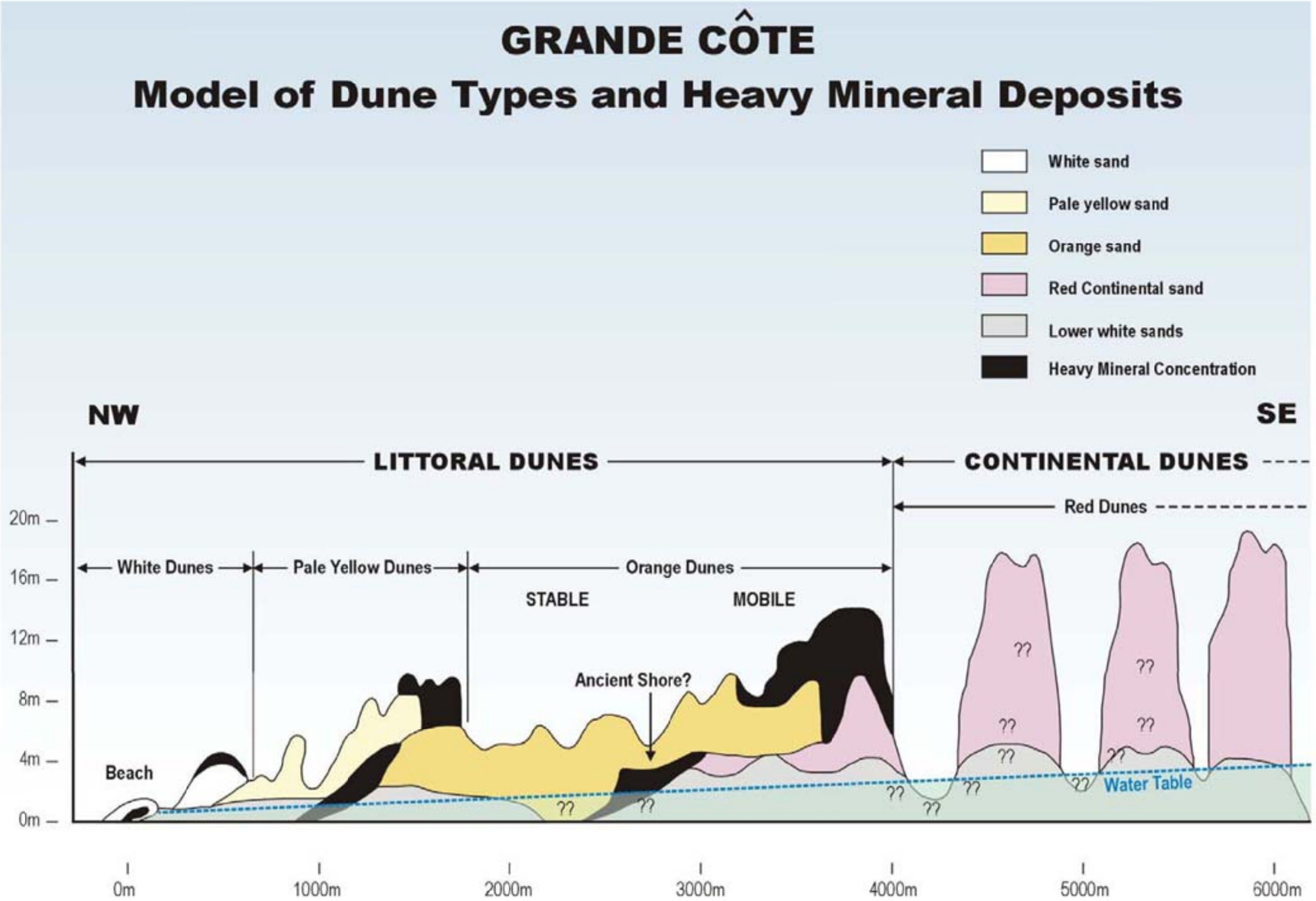
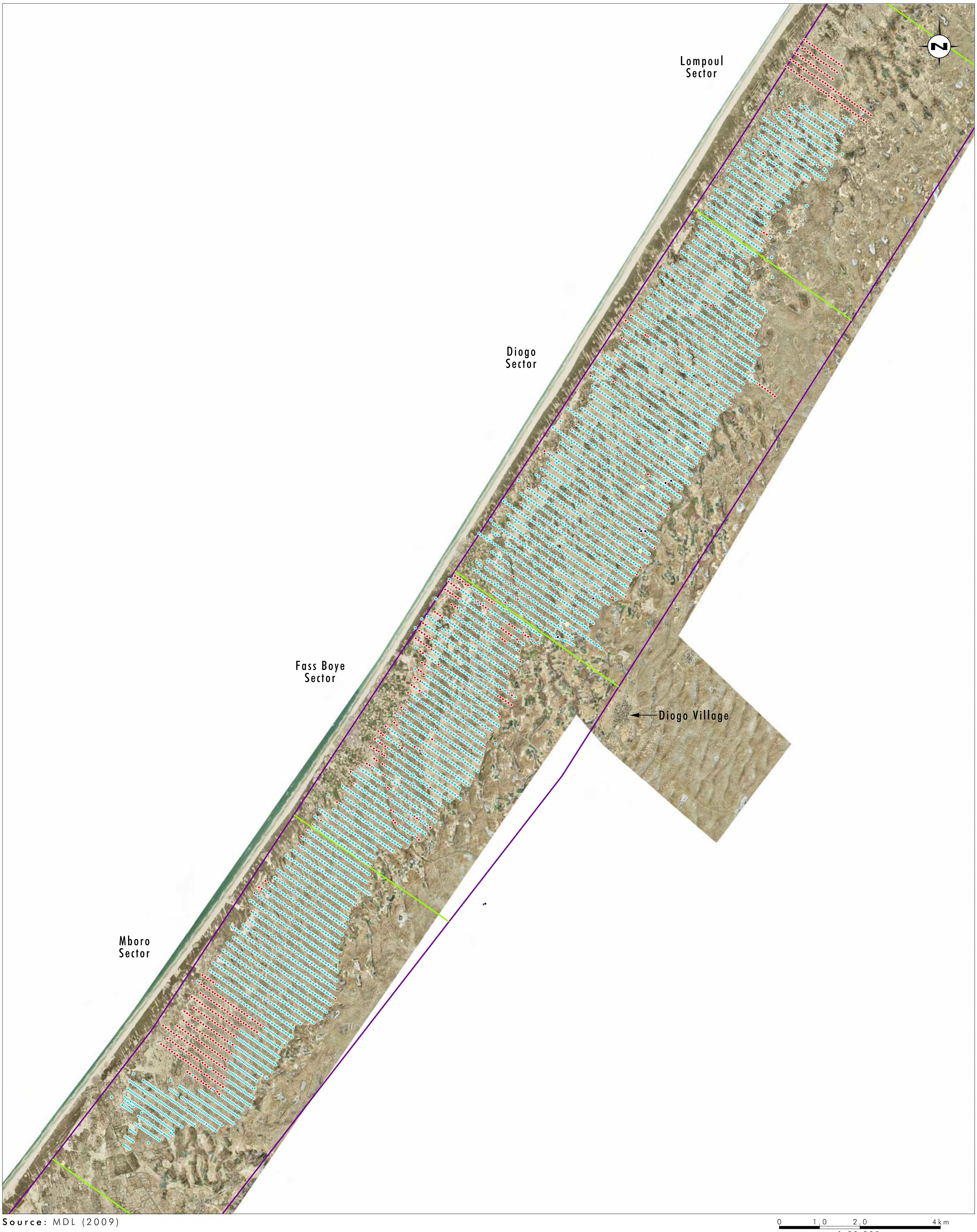


FIGURE 2.4

Schematic Model of Dune Types and Heavy Mineral Deposits on Grande Cote

Source: Mineral Deposits Limited (May 2007)

Umwelt
Environmental Consultants



Source: MDL (2009)

Legend

- Tenement Boundary
- Prospect Division
- Drill Hole (Auger)
- Drill Hole (Reverse Circulation)
- Shaft
- Standard Penetration Test

FIGURE 2.5

Exploration Drilling in Grand Cote Project Area

Copy 3

Approximately 10% to 17% of the heavy mineral concentrate stream is composed of waste heavy minerals, which will be returned to the dune system after processing. These waste minerals include monazite (cerium lanthanum phosphate), staurolite (hydrated iron aluminium silicate), kyanite/sillimanite (aluminium silicate), corundum (aluminium oxide), tourmaline (a complex borosilicate of sodium, lithium, magnesium, iron and aluminium), and others. Together these waste minerals constitute l<0.004% of the sand mass.

In exploration undertaken by MDL two types of drilling, air core reverse circulation (RC) and hand auger have been employed. All holes were vertical with samples collected at 1 m intervals from both the RC and hand auger drilling. To the end April 2010, MDL had completed 7,750 RC holes for 150,665 m and 4,569 hand auger holes for 45,203 m for a combined total of 195,868 m.

From drilling and the establishment of a piezometer network, the Measured and Indicated Mineral Resources were estimated from the block model developed by AMC (May 2010) by accumulating the averaging grade in 20 mE x 25 mN columns of sand (based on grades estimated into 20 m x 100 m x 1 m blocks) above a surface that is 6 m below the modelled water table (based on the average piezometer readings from 31 March 2009 to 31 March 2010).

The Measured and Indicated Mineral Resource at a cut-off grade of 1.25% HM accumulated to 6 m below the water table is shown in Table 2.2.

Table 2.2 Resource Estimate above A Surface 6 m below the Water Table at 1.25% HM Cut-off Grade

Resource Category	Tonnage (Mt)	HM (%)
Measured	980	1.7
Indicated	50	1.7
Measured + Indicated	**1,030**	**1.7**

2.5 Mine Construction

2.5.1 Dredge Construction Site

The dredge pond, dredge plant and floating concentrator will be constructed at a site located approximately 2 km north of Diogo. The site will be located in a depression (niaye) adjacent to the proposed dredge path and it will occupy approximately 8 ha. Constructing the dredge pond in a topographic depression minimises the amount of soil/sand that needs to be excavated to access the water table. Prior to construction, topsoil will be carefully removed and stockpiled on site for later redistribution over the area when the site is rehabilitated. A portion of the site and the adjacent valley will be permanently buried by sand from the first dredge workings.

The initial dredge pond will be approximately 250 m long x 200 m wide; i.e. approximately 5 ha in area. It will be dug down to within 0.5 m of the natural water table level and the entire pond will be lined with plastic, which will be protected by a layer of lateritic material during construction; i.e. the dredge and associated infrastructure will ideally be constructed dry although the more conservative from cost point of view wet approach has been included at this point in time in the capital estimate. At the commencement of commissioning, the pond will be filled with water provided from bores into the deeper Maestrichtian aquifer. Overburden from the dredge construction site will be placed near an adjacent dune, where it will remain.

Once the dredge is operational, it will commence mining northward along a dredge path located entirely within the dunes. The manner in which the dredge operates means that a sand volume equivalent to the material excavated to create the dredge pond will remain most likely in a valley adjacent to the starter pond area. The final dredge pond will remain at the end of the dredge path if desired as part of the closure planning.

A Rehabilitation and Closure Plan for the dredge construction site will be developed prior to construction. The hardstand area beside the initial dredge pond will be rehabilitated when it is no longer required.

Construction of the dredge and dredge pond is expected to take approximately 18 months. Initially, construction hours will be 7 am to 5 pm. Two 10-hour shifts, operating over 24 hours at peak periods, may be required to complete the construction phase in a reasonable time frame if deemed necessary by construction personnel.

2.5.2 Mineral Separation Plant Construction Site

The mineral separation plant (MSP), power station and fuel storage area will be constructed approximately 1.3 km east-south-east of Diogo within a 354.5 ha site (Figure 2.1).

The MSP will consist of three modules: a wet mill; a zircon dry mill; and a water table plant. There will also be heavy mineral concentrate stockpiles, a process water pond, product storage bins and a reject tailings stockpile. Offices, stores and workshops, an ablution block, laboratory, water treatment plant, container storage and fuel farm will be constructed in the vicinity of the MSP.

A 28 MW power station will be constructed adjacent to the MSP to provide power for the entire mining operation (Figure 2.1). The average load is expected to be 22 MW. The facility will be self-contained and will comprise an engine hall with five dual-fuel-powered generator sets (heavy fuel oil and natural gas), a workshop, control room and fuel farm.

The installation of a natural gas compatible power station will provide opportunity for utilisation of a local energy source with the added benefit of potential carbon credits under the clean development mechanism (CDM). Natural gas would be supplied by pipeline to a filtering and pressure balancing unit at the MSP site.

The fuel farm will include unloading facilities and storage for approximately 1M litres (12 days consumption) of heavy fuel oil if natural gas is not used for power generation, as well as a quantity of diesel and lube oil. All liquid fuels and lubricants will be stored in a concrete bunded storage facility. An unloading bay will be constructed beside the tanks to contain any accidental spillage of fuel while it is being transferred from fuel tankers to storage tanks or from the tanks to vehicles.

During construction, power will be supplied by mobile generators established on site within bunded impermeable areas. Locating the generators within bunded impermeable areas will minimise the risk of hydrocarbon contamination of the soil.

Water demand for this construction phase will be primarily for the construction workers. An estimated 800 workers will be employed during construction of the dredge, dredge pond, MSP, power station and associated buildings. At 100 litres per person per day, the estimated water demand will be 80,000 litres per day. This will most likely be supplied by a deep bore.

2.6 Operations Phase

2.6.1 Dredge Path and Mining Sequence

The dredge path will be confined to the semi-fixed yellow dunes and orange dunes west of the niayes. It will avoid directly affecting the niayes. Progress along the dredge path will be approximately parallel to the coast. The proposed dredge path for the first 14 years is shown on Figure 2.1.

Power for the dredge and wet concentrator will be supplied by power lines from the power station constructed at the MSP.

The dredge will progress along the dredge path at a rate of approximately 7 km pa, or approximately 130 m per week. Clearing of vegetation along the dredge path will be limited to approximately 200 m ahead of the dredge at any time (or approximately 6 ha), to minimise the area exposed to wind erosion. A maximum of the top 10 cm of surface material will be scraped aside and stockpiled for later re-spreading over the re-formed dunes in applicable areas. As the landscape is re-formed behind the dredge, the surface will be prepared for revegetation and planting will take place progressively as soon as conditions are suitable, as described in Section 5.6.5.

2.6.2 Mining Method

Mining will be conducted using conventional dredging techniques. The dredge pond will be between 0 m and 6 m above the natural water table and will be approximately 250 m long x 270 m wide. The dredge will be maintained in position within the dredge pond by heavy-duty bulldozers with widened blades located on the margins of the dredge path. Winches mounted on the dredge will be used to adjust its position. The cutter-suction dredge will mine the deposit at the front of the advancing pond and pump the excavated material to the floating wet concentrator.

The floating wet concentrator will separate the heavy minerals (approximately 2%) from the sand as a concentrate. The concentrate will be pumped to the MSP and further separated into a magnetic (ilmenite) stream and a non-magnetic (zircon, rutile, leucoxene) stream. The remainder of the sand will be stacked at the rear of the dredge pond to approximate the original topography.

2.6.3 Mineral Separation Plant, Power Station and Fuel Storage

The MSP will operate 24 hours per day, seven days per week, year round. It is envisaged that the MSP will remain in one location for the life of the mine.

The MSP will consist of four components: a WHIMS (wet high-intensity magnetic separator) module, wet mill, dry mill and Ilmenite Plant. The WHIMS module will receive the entire heavy mineral concentrate from the floating plant and separate this into two streams; i.e. a magnetic (ilmenite) concentrate stream and a non-magnetic (zircon, rutile, leucoxene) concentrate stream.

The magnetic concentrate stream will be stockpiled adjacent to the MSP facility for processing in the ilmenite processing plant.

The wet mill will receive the non-magnetic concentrate stream through a loading hopper, feeder and feed bin. This non-magnetic concentrate stream will be slurried and processed through a wet gravity circuit, including multiple stages of spiral separators followed by wet shaking tables.

Two concentrate sub-streams will be recovered from the wet shaking tables. The concentrate sub-streams will have either low or medium levels of Al_2O_3 and will be segregated for batch processing. The concentrate sub-streams will be dewatered and stockpiled through cyclone stackers and allowed to drain and partially air dry. A waste stream will be returned to the dredge tailings via an overland pipeline.

The dry mill will be batch fed alternately with the two concentrate sub-streams from the wet mill, which will be conveyed into a rotary kiln dryer to remove any residual moisture. The dryer will either use a fuel (diesel gas) although a preferred option of recycled heat from power station exhaust gases will be pursued as part of the power station tendering process. The first stage of dry milling is to pass the concentrate over a series of high-tension roll separators to commence the segregation of non-conducting minerals (e.g. zircon, kyanite) from conducting minerals (e.g. rutile, leucoxene). The zircon (non-conducting) sub-stream is then passed over a series of electrostatic and mineral separators to progressively ensure that all rutile and leucoxene have been segregated. The zircon sub-stream is finally treated on air tables to remove as much kyanite as possible.

The conducting minerals sub-stream is passed over a series of magnetic separators to segregate the rutile (a non-magnetic conductor) from the leucoxene (a magnetic conductor). The resulting three sales products – zircon, rutile and leucoxene – will be transferred to covered bulk storage stockpiles and then packed into containers for transfer to the port.

Minerals will be transported to Dakar port in containers lined with plastic. Because of the density of the minerals, the containers will be only partly filled. Transport of approximately 80,000 t each year of these mineral products by road will require 2,000 loads at 2 x 20 t per trip. This is 40 loads per week or eight loads per day over five days or seven loads per day over six days. These mineral products may be transported by rail in the future.

A separate facility will be required for processing the magnetic (ilmenite) stream from the WHIMS module to create saleable ilmenite product. Equipment and processing is similar in nature and scale to that detailed for zircon and will produce approximately 575,000 tpa of ilmenite. Rail transport of this product will occur, with ship load-out from a bulk materials handling facility at the Dakar port.

The power station will generate electricity to run the MSP, dredge and wet concentrator, and provide power requirements for the associated buildings. Although a fuel farm will be constructed, the primary fuel is envisaged as being natural gas; however in the event HFO is required, transport of fuel at a rate of three to four tankers per day will be necessary.

2.6.4 Waste Minerals Management

Waste minerals or reject tailings will be mostly quartz sand tailings from the various separation processes. Tailings will be returned back to the mine site by a dedicated pumping system and incorporated in the restored landscape.

2.6.5 Water Management

Water demand for the MSP will be approximately 50 m^3ph, which will include processing losses and a small amount of evaporation from the process water pond. This demand will be serviced by a deep water bore into the Maestrichtian aquifer, which will also be used to supply potable water for the MSP site and potentially the water for the revegetation nursery.

Process water will be a mixture of raw water supplied from a groundwater bore, and process water stored in the process water pond.

Potable water will be supplied to all emergency eyewash/shower stations located throughout the MSP site.

Groundwater currently used for potable water at the nearby exploration camp and in Diogo Village has a pH around 6, low salinity, electrical conductivity around 130 to 270 µS/cm and iron approximately 4 to 10 mg/L. Only the iron levels exceed the recommended drinking water level of 0.3 mg/L, which is based on aesthetic values. Elevated iron levels commonly occur in coastal sand aquifers and are not considered a health hazard. However, a non-chemical iron removal plant in conjunction with regular chemical dosing has been successfully installed and used for the past two years at the exploration camp to produce potable-quality water.

2.6.6 Infrastructure and Services

The following buildings are planned for the MSP site:

- Mine office.
- Mine ablution block.
- MSP and administration office.
- MSP laboratory.
- Kitchen and mess.
- MSP store and workshop.
- Power station engine hall and associated support buildings.

Ongoing exploration facilities and facilities for contractors may be provided but at this stage the intent is to remove the existing construction camp after completion of construction.

The following services will be provided at the mine and the MSP:

- PABX with telephone and facsimile connections.
- Mobile phones or VHF radio links as appropriate.
- Computer server with internal and external high-speed data links and internet.
- Video conferencing facilities.
- Potable water.
- Portable sewage treatment system at the mine site and sewage treatment system at the MSP site.
- Refuse disposal.

- Removal and disposal of hydrocarbon waste; i.e. oily waste including rags, used filters, waste oil and sludge will be in line with procedures established at MDL's Sabodala operation in conjunction with partners Shell and Sococim.

Roads and fencing to provide access to buildings and work areas with appropriate security and safety will be constructed. Visitor and public safety will be carefully considered.

2.7 Transport

Road access to the mine construction site and MSP site will follow the existing sealed highway N1 from Dakar to Thiès, sealed highway N2 from Thiès to Tivaouane, sealed road from Tivaouane to Darou Khoudoss, then gravel road from Darou Khoudoss to Diogo. This route involves approximately 100 km of sealed road and 25 km of gravel road. The gravel section passes through several villages between Diogo and Darou Khoudoss. Government funding is in place and work is currently well advanced to repair and seal the entire road during the second quarter of 2010. The road through Diogo and nearby villages is often congested with traffic due to loading of market-garden produce onto trucks for transport to markets. In addition, local markets occur along the road, adding to traffic congestion. In order to alleviate the traffic congestion and maintain a high level of safety for villagers, GCO is considering several options for transport associated with the construction and mining operations at Diogo, including:

- Construction of a bypass (approximately 25 km long) for Diogo and adjacent villages, which is the most likely option and which will bypass the closest villages to the MSP site. This road will also be used to transport mineral products, particularly ilmenite to the ICS (Industries Chimiques du Senegal) rail head for rail transport to Dakar.
- Education and training for drivers.
- Raising awareness of villagers.
- Installation of speed humps.
- Establishment of signal persons/traffic guardians.
- Provision of a hardstand area adjacent to the road system for delivery of garden produce by carts and loading of trucks for transport to market.

The maintenance records and driver competency of transport vehicles for GCP product and bulk fuel transport will be closely monitored to reduce the transport risks to local villages and risks of vehicle accidents/bulk spillage.

At this stage, transport of product and supplies will be by road between Dakar and the MSP site. The preferred route will be via Thiès, Tivaouane and Darou Khoudoss. All products, with the exception of the ilmenite, will be transported in lined containers. Ilmenite will be transported as a bulk product by rail to load-out facilities at the Dakar port.

Containerised product will be stored at or near the port of Dakar. Dakar port is large and has more than adequate capacity to handle and store the proposed containerised zircon, rutile and leucoxene production from the GCP.

2.8 Rehabilitation and Closure

2.8.1 Rehabilitation of Dredge Path

GCO is committed to restoring the landscape following mining to approximately the original topography. GCO will rehabilitate and revegetate the mined areas with native vegetation and fast-growing species as required (in areas that were vegetated prior to mining). A Rehabilitation and Closure Plan will be developed in consultation with stakeholders, based on pre-mining mapping of dredge path vegetation. The Rehabilitation and Closure Plan will be developed to cover a three to five-year time frame and will be updated annually. Rehabilitation success criteria (based on vegetation species diversity and density) will be developed in consultation with stakeholders.

2.8.2 Conceptual Closure Plan for Dredge and Dredge Pond

At the end of mining, which is expected to be at least 20 years time, the dredge will be dismantled and removed from the site. The final dredge pond will be filled with sand from adjacent dunes or left as a lake in accordance with closure criteria to be agreed. All power transmission lines, fencing, pipelines and any other infrastructure will be removed from the landscape, unless an alternative use for this infrastructure is agreed with authorities.

A Conceptual Closure Plan for the dredge and dredge pond will be developed within three years of the commencement of mining operations. Consultation with stakeholders will be undertaken as part of the plan development. Information in the plan will be considered when updating Mining Plans and Rehabilitation and Closure Plans. The Conceptual Closure Plan will be formally reviewed and updated every three years.

The Final Decommissioning and Closure Plan will be developed within five years of mine closure to facilitate efficient decommissioning.

2.8.3 Conceptual Closure Plan for Mineral Separation Plant Facility

A Conceptual Closure Plan for the MSP will be developed within three years of the commencement of operations. Consultation with stakeholders will be undertaken as part of the Plan development. Agreed criteria for site rehabilitation will be established in consultation with stakeholders. The Conceptual Closure Plan will be formally reviewed and updated every three years.

The Final Closure Plan will be developed within five years of MSP closure to facilitate efficient decommissioning.

When the MSP is no longer required, all buildings and infrastructure will be dismantled and removed from the site so that the original landscape is generally restored.

An inspection of the site will be conducted to determine whether any hydrocarbon contamination of the soil has occurred. Remediation of any hydrocarbon-contaminated soil will be arranged. Throughout operations at the MSP site, a groundwater monitoring bore located beside the hydrocarbon storage area will be sampled every year and analysed for hydrocarbons to provide early warning of any hydrocarbon contamination of the groundwater. If hydrocarbon contamination is detected, remediation measures to clean up the groundwater and prevent further contamination will be implemented.

The heavy mineral concentrate from the Grand Côte Project will contain extremely small amounts of the radioactive mineral monazite. It is expected to constitute less than 1% of the magnetic concentrate stream, which is 1.5% to 3% of the total sand mined; i.e. the monazite is 0.00015% to 0.0003% of the sand being mined.

At these levels the monazite will not pose any radiation hazard. Monazite and other waste minerals will be returned to the mine site via a pipeline, for incorporation in the tailings at a concentration similar to that which existed prior to mining. The low concentration of monazite and the proposed processing and handling protocols will ensure that no increase in radiation levels will occur at the MSP site.

Revegetation of the site will be required for final rehabilitation, in accordance with agreed rehabilitation success criteria.

3 ENVIRONMENTAL AND SOCIAL MANAGEMENT SYSTEM OVERVIEW

The environmental and social management system (ESMS) being developed for the GCP broadly follows the structure outlined in International Standard ISO 14001. It is based on the identification of environmental and social issues through the environmental and social impact assessment process (Tropica 2005), the assessment of land use and community development (Earth Systems 2010B), and the development of mitigation measures to manage known environmental and social impacts.

The main objectives are:

- To implement a fully functional and effective ESMS to improve environmental and social performance and to reduce environmental and social risk.
- To ensure ownership of the ESMS at all managerial levels and that employee knowledge and use of the system remains high.
- To prioritise staff and financial resources on the basis of environmental and social risk.
- To continuously improve the environmental and social performance of the GCP through annual improvement plans, audits and inspection processes, training programs and effective corrective action systems.

The Environmental and Social Management and Monitoring Plan (ESMMP) (Appendix 2.1) describes the monitoring, mitigation and management measures required during the construction, operation, decommissioning and rehabilitation phases of the project. It is based on commitments made in the EIES and on requirements of the GRS and financial institutions involved in the project. The ESMMP provides a framework for ongoing environmental and social management and sets guidelines for development of management plans and standard operating procedures that will be developed as part of the ESMS. A list of plans and procedures to be developed is provided in Table 3.1.

Table 3.1 List of Plans and Standard Operating Procedures Required for the GCP ESMS

Section of the ESMMP	Management Plan	Time Frame
3.6.1	Rehabilitation and Closure Plan	Prior to mining
3.6.2	Conceptual Closure Plan for Dredge and Dredge Pond	Within three years of commencement of mining operations
3.6.2	Final Decommissioning and Closure Plan for Dredge and Dredge Pond	Within five years of mine closure
3.6.3	Conceptual Closure Plan for the MSP	Within three years of commencement of mining operations
3.6.3	Final Decommissioning and Closure Plan for the MSP	Within five years of closure of the MSP
5.2	Acid Sulphate Soil Management Plan	Prior to commencement of mining, if necessary
5.2	Remediation Plan for Arsenic in Groundwater	Prior to commencement of mining, if necessary
6.4	Acid Sulphate Soil Contingency Management Plan for Mine Site Tailings	Prior to commencement of mining, if necessary
6.4	Tailings Management Plan for MSP	Prior to operations

Section of the ESMMP	Management Plan	Time Frame
6.5	Topographic Plan of Proposed Dredge Path	Prior to mining
7.4	Plan for monitoring wind erosion of dune sand in proximity to market gardens	Prior to mining
8.4	Waste Management Plan	Prior to operations
10.4	Compensation Plan for Protected Species Disturbed by Mining	Prior to operations
11.0	Rehabilitation and Closure Plan	Prior to operations
11.2	Logging Plan	Prior to clearing of plantations
11.2	Revegetation Procedures Plan	Prior to mining
11.4.9 & 11.6	Rehabilitation Monitoring Plan	Prior to operations
17.5	Community Relations and Development Plan	Prior to operations
17.5	Public Consultation and Disclosure Plan	Prior to operations
17.5	Resettlement Action Plan	Prior to operations
17.5	Social Development Plan	Prior to operations
18.0	Radiation Management Plan	Prior to operations
	Standard Operating Procedures	
7.4.6	Maintenance and repair of erosion and sediment control structures	Prior to operations
11.4.4 & 11.4.8	Seed collection, seed propagation, seedling planting, vegetation monitoring, weed control	Prior to operations

The ESMMP is a dynamic document subject to updating and adjustment following biennial review. Continuous improvement of environmental and social management will be achieved through progress towards targets that are included at the end of each section of the ESMMP.

4 PLANNING

This section identifies the legal and other requirements that are applicable to environmental and social aspects of the project, discusses the environmental and social context, and lists the environmental and social aspects identified in the EIES for the project.

4.1 Legal and Other Requirements

This section outlines the specific consents and permits granted by the Senegal government that allow mining to proceed (Section 4.1.1). It also identifies the Senegal legislation relevant to the GCP, the international conventions ratified by Senegal that are relevant to the GCP, the Equator Principles and relevant IFC guidelines and performance standards.

4.1.1 Project Consent

4.1.1.1 Mining Convention

The Mining Convention between MDL and the GRS was executed on 9 September 2004, formally decreed on 10 September 2004 by Ministerial Arrête 7474, and recorded in the *Government Gazette* (*Journal Officiel*) of 30 October 2004. Through the Mining Convention an official exploration licence (*permis de recherché*) was obtained to explore for zircon, rutile, ilmenite, leucoxene and other associated minerals in a 445.7 km^2 rectangular exploration area on the Grande Côte. Following approval of the EIES for the GCP, a Mining Concession was granted in November 2007, covering the same area (see Section 4.1.1.3).

The Mining Convention stipulates commitments and requirements relevant to the management of environmental and social issues associated with exploration and mining at the GCP. These commitments are summarised as follows:

- The deposit will be mined in such a manner as to protect the environment (Article 23).
- Preference in employment will be given to Senegal nationals where qualifications, skills and experience are equivalent (Article 31.3).
- Local labour will be used for positions that do not require any special professional qualifications (or prior experience) (Article 31.3).
- A program for basic and continuous training and promotion of Senegal personnel will be implemented to ensure the use of Senegal personnel in all phases of the mining activities (Article 31.3).
- MDL will contribute to the basic and further training of officers responsible for the management and promotion of the Senegal mining sector, on the basis of a protocol for convention to be concluded with the Minister for Mines (Article 31.3).
- Housing for workers employed on site, if provided, will be in accordance with regulations for hygiene and cleanliness (Article 31.3).
- MDL will contribute to the construction or, where applicable, the improvement or extension of health, educational and leisure infrastructure for workers and members of their immediate families, taking into account the economic situation of the society and complying with local standards (Article 31.4).
- MDL will comply with Senegal standards for safety, hygiene and cleanliness and the protection of the environment (Article 31.7).
- MDL is required to indemnify the State or any physical person or corporation for damages or financial losses that it causes (Article 31.12).

- MDL will be required to pay compensation to residents or land users for losses, privations of use or damages resulting from mining activities (Article 32.6).
- Mining titles must respect the provisions of the Forestry Code, particularly those of Article L44, concerning mining in Classified Forests (Article 33.2).
- MDL will establish a trust account to cover costs of rehabilitation of the mining site (Article 33.4).
- MDL is required to take necessary measures to protect the environment (Article 33.6), including:
  - Regular monitoring of soil, water and air quality in the project area and surrounding areas.
  - Disposal of excavated material in such a way as to be able to control, within acceptable limits, landslides and earth movements, deviation and sedimentation of water courses, formation of sites of contaminated water retention and deterioration of neighbouring soils and vegetation.
  - Discharging wastewater that meets international standards.
  - Avoiding discharge of toxic chemical solutions, products and dangerous substances on to the earth or into the air.
  - Effectively neutralising and controlling waste products so as not to significantly and unfavourably affect climatic conditions, the soil, vegetation or water resources of the project area.
- MDL will reinstate the mined area so that the contour of the land blends reasonably with the local topography (Article 33.6).
- If objects of national cultural significance are discovered during exploration and mining, MDL will inform the relevant government authorities and will not disturb the objects for a period specified by the relevant authorities (but not exceeding one month). MDL will contribute to the costs of transferring such objects; within reasonable limits (refer to Articles 33.7 and 33.8).

4.1.1.2 Addendum to the Mining Convention

Article 25 of the Addendum to the Mining Convention (Avenant No 1 à la Convention Minière) between MDL and the GRS was signed on 24 September 2007. This document notes that MDL should, if practical, carry out replanting of each mined site within six weeks after processing the dunes. Article 25 notes that an area of 15 ha per month, on average, will be returned to the State. It also raises the possibility of alternative final land use options such as ornamental lakes, fish farm ponds, parks and entertainment areas on the rehabilitated mine path.

4.1.1.3 Mining Concession

A Mining Concession (Concession Minière) was granted to MDL Senegal on 2 November 2007. This document refers to the Mining Convention and the Addendum to the Mining Convention as defining the conditions under which mining will be carried out. It provides coordinates defining the limits of the Mining Concession area, which covers 445.7 km^2. The Mining Concession is valid for 25 years and is renewable.

4.1.1.4 Certificate of Environmental Compliance

In February 2008, the Ministry for the Environment, Protection of Nature, Water Retention Basins and Artificial Lakes (Department of the Environment and Classified Establishments) issued the Certificate of Environmental Compliance for the GCP, which applies to the Environmental and Social Impact Study (EIES – Etude d'impact environnemental et social), and its management plan (PGES – Plan de gestion environnementale et sociale) (Tropica 2005). This certificate requires implementation of the management plan, including consultation with committees specified for each section of the management plan.

The Certificate of Environmental Compliance also requires that the "further studies recommended by the consultancy firm in the EIS (EIE in French) report must be completed in order to clarify the Environmental and Social Management Plan (ESMP) (PGES in French)".

The outstanding studies concern the environmental and social impacts of:

- The power plant and fuel storage facility.
- The tracks and roads to be used for access and transport.
- The mineral separation plant and ancillary structures.

The locations of these features were unknown at the time of the original EIES, but have now been identified. Qualitative assessment of the environmental and social impacts of these parts of the project has been completed. However, potential impacts such as noise and visual impact will be further assessed, so that appropriate mitigation measures can be included in the final design.

4.1.2 National Legislation, Regulations, Policies and Guidelines

Laws and regulations of GRS that are relevant to the environmental and social management of the GCP are listed in Table 4.1. The relevance of these documents will be reviewed periodically to determine if there has been any change of status, or if any laws should be added to or removed from this list (ESMMP Section 1.6.4).

Table 4.1 National Policy, Legislation and Regulations Applicable to the GCP

English Title	French Title	Date Decreed
National Action Plan for the Environment	Plan National d'Action pour l'Environnement (PNAE)	1993
Environment Code	La loi no. 2001-01 du 15 janvier 2001 portant Code de l'Environnement	1983, updated 2001
Decree no. 2001-282 (12 April 2001) – Application of the Environment Code	Le décret no. 2001-282 du 12 avril 2001 portant application du Code de l'Environnement	2001
Mining Code	La loi no. 2003-36 du 24 novembre 2003 portant Code Minier	2003
Decree no. 2004-647 (17 May 2004) – Application of the Mining Code	Le décret no. 2004-647 du 17 mai 2004 portant application du Code Minier	2004
Forestry Code	La loi no. 98-03 du 8 janvier 1998 portant Code Forestier	1998
Hunting and Fauna Protection Code	La loi no. 86-04 du 24 janvier 1986 portant Code de la Chasse and de la Protection de la Faune	1986

English Title	French Title	Date Decreed
Decree no. 86-844 (14 July 1986) to fix basis for fauna protection and management, supplemented by decree of application on 25 June 1998	Le décret d'application no. 86-844 du 14 juillet 1986 et les décrets d'application du 25 juin 1998	1986, updated 1998
National Anti-Deforestation Action Program	La Programme d'Action National de Lutte Contre la Désertification (PAN/LCD)	1998
National Monograph on Biodiversity in Senegal	La Monographie Nationale de la Biodiversité au Senegal	1998
National Strategy and National Plan of Action for the Preservation of Biodiversity	La Stratégie Nationale et le Plan National d'Actions pour la Conservation de la Biodiversité	1998
National Strategy of Implementation on Climatic Change	La Stratégie Nationale de Mise en œuvre de la convention cadre des Nations Unies sur les changements climatiques	1999
National Strategy for Sustainable Development	La Stratégie Nationale de Développement Durable	2005
Water Code	La loi no. 81-13 de 4 mars 1981 portant Code de l'Eau	1981
Wastewater Discharge Standard	La norme sur les rejets des eaux usées (NS 05-061)	2001
Interministerial decree no. 1555 (15 March 2002) applying wastewater discharge standard NS 05-061	L'arrêté interministériel no. 1555 de 15 mars 2002 portant application de la norme NS 05-061 sur les rejets des eaux usées	2002
Land Use Legislation:	La Législation foncière:	
Law no. 64-46 (17 June 1964) concerning the national domain	La loi no. 64-46 du 17 juin 1964 relative au domaine national	1964
Law no. 72-75 (19 April 1972), establishing rural institutions for managing public lands	La loi no. 72-75 du 18 avril 1972 relative aux communautés rurales	1972
Law no. 76-66 (2 July 1976) pertaining to the State Code	La loi no. 76-66 du 2 juillet 1976 portant Code du Domaine de l'Etat	1976
Civil Code and the Decree of 26 July 1932	Le Code civil et le décret de 26 juillet 1932	1932
Public Health Code	La loi coloniale no. 54-418 du 15 avril 1954 portant Code de la Santé publique	1954
Reproductive Health Law	La loi no. 2005-18 du 5 août 2005 relative à la santé de la reproduction	2005
Hygiene Code	La loi no. 83-71 de 5 juillet 1983 portant Code de l'Hygiène	1983
Fair Labour Standards Act	La loi No. 97-17 du 1 décembre 1997 portant Code du Travail	1997
Agro-forestry-pastoral Orientation Law	La loi no. 2004-16 du 4 juin 2004 portant loi d'orientation agro-sylvo-pastorale	2004
Cattle-Run Regulation	Le décret no. 80-268 du 10 mars 1980 portant organisation du parcours de bétail	1980
National Emergency Organisation Plan	Plan national d'organisation des secours	1999
Monument and Site Preservation Law	La loi no.71-12 du 25 janvier 1971 fixé le regime des monuments historiques et celui des fouilles et découvertes	1971
Decree no. 73-746 (8 August 1973) on the application of the Monument and Site Preservation Law	Le décret no. 73-746 du 8 août 1973 portant application de la loi no.71-12	1973
Law no. 96-06 (22 March 1996) on the Code of the Local Communities	La loi no. 96-06 du 22 mars 1996 portant Code des Collectivités Locales	1996

English Title	French Title	Date Decreed
Law no. 96-07 (22 March 1996) transferring environmental jurisdiction to local communities	La loi no. 96-07 du 22 mars 1996 portant transfert des competences environnementales aux collectivités locales	1996
Decree no. 96-1134 (27 December 1996) on the application of the law transferring jurisdiction of environmental matters and management to regions, communes and rural communities	Le décret no. 96-1134 du 27 décembre 1996 portant application de la loi portent transfert de compétences aux régions, aux communes et aux communautés rurales, en matière d'environnement et de gestion des ressources naturelles	1996
National Action Plan for Hazardous Waste Management	Plan National d'Action pour la gestion des déchets dangereux au Senegal	1999
Atmospheric Pollution Standard NS 05-062	La Norme de rejets NS 05-062 – pollution atmosphérique	2004
Draft Standard on Management of Solid Waste	Projet de Norme relative à la Gestion des Déchets Solides	In preparation in 2005

4.1.2.1 National Action Plan for the Environment

The *National Action Plan for the Environment* (1993) (PNAE) provides a strategic framework for environmental planning. The PNAE evaluates the state of the environment, identifying the principal problems and stakeholders for key economic, industrial, social and environmental areas. It offers solutions and strategies for managing these issues.

Relevant sections of the PNAE include Chapter 1.1.7 – Mines, Energy and Industry. As stated in the subsection on 'Appraisal: Mines and Geology':

- The principal environmental impacts resulting from the mining industry include soil erosion, deforestation and atmospheric pollution.
- Future environmental strategies should be based upon the rehabilitation of degraded areas and the use of technologies focussed upon preserving the current surroundings and natural resources.

The PNAE also presents actions for protection of the littoral belts and the area of the Niayes, including stabilising the dunes and protection of the basins from sand encroachment. The Plan aims to establish 45,000 ha of stabilised dunes between 1994 and 2015. Only 1,016 ha are estimated to have been revegetated to date within the project area.

4.1.2.2 Environment Code

The *Environment Code* (2001), Senegal's principal environment law, aims to establish a set of fundamental principles designed to manage and protect the environment against all possible forms of degradation arising from the economic, social and cultural development of Senegal. The code defines procedures for environmental impact assessment, including community consultation. The code also defines key environmental terms and sets out the government's environmental policies for four key areas: classified installations (any source, mobile or fixed, capable of posing a threat to the environment); water pollution; noise pollution; and air pollution and unpleasant odours. The following sections are particularly relevant to the mining industry:

- Title I, Chapter 3 'Instruments for the Protection of the Environment' – Specifies the plans that are integrated into the environmental policy, including the National Action Plan for the Environment, and the National Management Plan for Hazardous Waste.
- Title II, 'Prevention and Fight against Pollution and Noise' – Outlines the measures for preventing and taking action against an environmental incident for such areas as in

Chapter I 'Classified Installations', Chapter 3 'Managing Waste', Chapter 4 'Harmful and Dangerous Chemical Substances', and Chapter 6 'Implementing an Emergency Plan'.

- Title III, 'Protection and Enhancement of Receiving Environments' – Outlines the regulations surrounding discharging of waste into different environments, including water (Chapter I), the atmosphere (Chapter II) and soil and the sub-strata (Chapter III), as well as noise pollution regulations (Chapter IV).
- Title IV, Chapter I 'Penal Sanctions' – Outlines the penalties imposed for non-compliance with the Environment Code.

Decree No. 2001-282 (2001) details the application of the Environment Code and specifies the allowable amount of discharge for different types of pollution. Article R84 sets the maximum levels of noise pollution at the nearest residence between 55 and 60 decibels during the day and 40 decibels at night. For air pollution, Article R72 requires all installations to apply all possible methods to prevent and reduce emissions to air, as outlined in the Atmospheric Pollution Standard NS 05-062.

4.1.2.3 Mining Code

The *Mining Code* (2003) is the primary legislation regulating the mining industry in Senegal, covering both exploration and mining activities. Sections of the code that are relevant to environmental and social management of the GCP include:

- Title IX, Chapter 5 'Environmental Protection' – Specifies the requirement for an environmental impact study; for setting funds aside for rehabilitation and closure and compliance with the Forestry Code (Art. L44).
- Title VIII, Article 55, 'Equalisation and Support' – Ensures that a portion of income from a mining operation is set aside as a fund for the local communities (Community Equalization Fund).
- Article 76 of the Mining Code requires the holder of a mining title to compensate owners or occupants of land occupied by the mining title holder.
- Article 82 states that a mining title holder is obliged to rehabilitate mine sites at the expiry of each mining title.
- Article 84 requires a Mine Site Rehabilitation Fund to be established with terms and conditions fixed by decree.

4.1.2.4 Water Quality, Air Quality and Noise Guidelines

In order to develop an environmental and social management and monitoring program for the GCP, it is necessary to consider the:

- Emission guidelines for off-site release of airborne contaminants.
- Discharge guidelines for off-site release of water-borne contaminants.
- Ambient guidelines for the protection of beneficial uses and environmental values, such as drinking water, air quality and noise.

The potentially applicable guidelines for the GCP are listed in Table 4.2.

Table 4.2 Potentially Applicable Water, Air Quality and Noise Standards and Guidelines

Issue	Source	Potential Guidelines
Discharge to water	Senegal	Interministerial Decree No 1555 Discharge Water Guidelines (2002) Waste Water Discharge Standard, NS 05-061
Air emissions	Senegal	Emission Limits for Stationary Combustion Engines (2004)
Air emissions	Senegal	Atmospheric Pollution Standard, NS 05-062 (2004)
Water quality	World Health Organization (WHO)	Guidelines for Drinking Water Quality (2008)
Noise	Senegal	Environment Code Application Decree of the Environment Code

4.1.3 Land Ownership and Administration

Land legislation consists of a series of legal texts and regulations based upon the 1964 National Domain Law (64-46) and the 1972 Rural Communities Act (72-75). Decentralisation increased during the 1990s enabling the transfer of powers in the fields of land management, environment, natural resource management and spatial planning to regions, departments and rural communities.

State lands fall into four categories: i) urban areas; ii) classified forests, national parks, etc.; iii) community land; and iv) pioneer zones. Land can be accessed through occupation, authorisation, ordinary lease, long-term lease and concession. Locally elected officials in rural communities can allocate land according to customary practices as long as lands are productively used (*mises en valeur*). Note, the 1964 law does not recognise pastoralism as a viable form of land use although a decree passed in 1980 provided for the reservation of certain grazing areas for herders (SWAC Secretariat 2006).

Principal community land use activities within the project area include horticulture, agro-pastoralism, and timber forest-product harvesting. Local people have the right to use the land according to customary practices under the jurisdiction of the Rural Community of Darou Khoudoss.

In practice the influence of the Rural Community on land administration has been limited to the niayes and has yet to extend to land on the littoral dune or in hinterland areas. The Rural Community reported that much of the agricultural land in the niayes had been formally titled – an indication of the higher value of the land and the potential for land-related conflicts. Agricultural land on the littoral dune, however, is currently held under traditional title, although in the future there is the potential for this land to be formally titled by the Rural Community.

Under law, traditional right of use extends for a period of five years following the cessation of use, after which the Rural Community has the authority to reallocate the land to another user.

Under customary land allocation practices a farmer wishing to exploit land will need to gain approval from either:

i. The previous user of the land, who will normally permit access if they have no immediate plan for exploitation but may want to retain their traditional title, i.e. a tenancy arrangement for the period of exploitation. If traditional title is exchanged this will normally be done in consultation with the village chief.
ii. The village chief in cases where the land of interest has not been previously exploited for agriculture. The village chief is responsible for confirming that no other family has a traditional claim and will provide access to this or another area accordingly.

In situations where the village chief realises the potential for land ownership conflict he may bring the matter to the attention of the Rural Community for their consideration.

Land ownership in the project area is principally patrilineal – resulting in the increasing fragmentation of land with population growth as it is inherited by all the sons and subdivided. Women can hold land tenure, however traditionally this is not common and their tenure rights are likely to be less secure with the potential to be dispossessed of land by other members of the family in periods of hardship (Grigsby 2004).

Under Article 73 of the Mining Code, GCO as a holder of a mining title can occupy lands that are required for their mining operations without acquiring the property. The right of land occupation is also stated in Article 32.3 of the Grande Côte Mining Convention, which stipulates that the State gives the right for GCO to have access, possess and use all lands that are located either inside or outside their Mining Concession necessary for prospecting and exploitation. Under Article 76 of the Mining Code the holder of the mining title is required to compensate other land users for any loss or damage sustained by the occupation of land.

Note, the GCP development area comprises numerous forest plantations administered by the National Forestry Commission. The first plantations commenced in 1925 and were intensified with subsequent investments in 1948, 1975 to 1991, and more recently from 2002 with the assistance of Japan International Cooperation Agency (JICA). Work undertaken in the area by the JICA ceased at the end of 2005.

Recent significant plantations undertaken by the National Forestry Commission within the GCO mining lease area include those in the northern area, north of Lompoul in 2003 to 2004 (EMRC 2009). Further north, 120 ha of eucalypts were established in August 2009.

The principal objectives of the plantations were to fix the mobile littoral dunes and thus minimise the loss of valuable agricultural land in the niayes. Use of the plantation as a source of timber is permitted under the control of the National Forestry Commission.

4.1.4 International Conventions

International conventions ratified by Senegal relevant to the mining project were identified in the EIES (Tropica 2005). They are listed in Table 4.3 along with comments on the implications of these conventions for the GCP and potential requirements for project operations.

Table 4.3 International Conventions Ratified by Senegal and Relevant to the GCP

Convention	Implications for GCP	Project Requirements
Convention on International Trade in Endangered Species (CITES)	Avoidance of trade in endangered species.	No trade in endangered species will be undertaken as part of this Project.
United Nations Convention on Biological Diversity (CBD)	Vegetation mapping prior to disturbance to ensure that existing biodiversity is recorded and appropriate revegetation measures can be implemented. Revegetation of mined areas will endeavour to restore pre-existing vegetation to maintain existing biodiversity.	Pre-mining mapping of vegetation; development of a Rehabilitation and Closure Plan in conjunction with Forestry Commission to address appropriate mitigation measures for any impacts on threatened species.

Convention	Implications for GCP	Project Requirements
United Nations Framework Convention on Climate Change and the Kyoto Protocol	Under the Kyoto Protocol, Senegal has no restrictions on its greenhouse gas emissions because it is a Non-Annex 1 country. It is possible for Senegal to trade in carbon credits with Annex 1 countries.	Greenhouse gas (GHG) emissions from the proposed power station will be approximately 90,000 t of CO_2e pa if heavy fuel oil is used or approximately 66,000 tpa if natural gas is used. If the project produces more than 100,000 t CO_2e pa, then annual quantification and monitoring of GHG emissions will be necessary to satisfy IFC Performance Standard 3, Clauses 10 and 11.
Convention on the Protection of World Cultural and Natural Heritage	World Cultural and Natural Heritage refers to cultural and natural heritage sites of outstanding universal value. Five sites have been identified in Senegal: the Island of Goree; the Djoudj Bird Sanctuary; Niokol-Koba National Park; Island of Saint-Louis; and Stone Circles of Senegambia.	None of the five sites of World Cultural and Natural Heritage value identified in Senegal is located within the GCP Mining Concession area.
Convention on Protection of Wetlands of International Importance (RAMSAR Convention)	Four wetlands in Senegal are listed under the Ramsar Convention, but none is located within or near the project area.	The project will not affect Ramsar-listed wetlands.
Montreal Protocol on substances that deplete the ozone layer	The Montreal Protocol stipulates that the production and consumption of compounds that deplete ozone in the stratosphere – chlorofluorocarbons (CFCs), halons, carbon tetrachloride, and methyl chloroform – are to be phased out by 2000 (2005 for methyl chloroform).	No substances listed on the Montreal Protocol will be used in the operation of this project.
United Nations Convention to Combat Desertification	Desertification is the degradation of land in arid, semi-arid and dry sub-humid areas. It is caused primarily by human activities and climatic variations. The convention provides criteria for developing action programs to combat desertification, through enabling local people to reverse land degradation.	Revegetation undertaken as part of the rehabilitation of the mined dunes will assist in local efforts to combat desertification. Local expertise will be involved in developing and implementing the Rehabilitation and Closure Plan.
Convention Concerning Basic Aims and Standards of Social Policy (International Labour Organization Convention)	Protection of rights for workers including: fair treatment, non-discrimination, equal opportunity, safe and healthy working conditions.	GCO will respect workers' rights and provide a safe and healthy working environment, in accordance with IFC Performance Standard 2 on Labour and Working Conditions.
International Atomic Energy Agency standards for transport of radioactive materials	The radioactivity of the mineral products zircon, rutile and leucoxene, plus the waste stream is below the threshold requiring special consideration.	The radioactivity of the mineral products and monazite-bearing waste stream from the GCP has been assessed by the Australian Nuclear Science and Technology Organisation (ANSTO). Monazite-bearing material from the mineral separation plant will be continuously mixed with other tailings and pumped back to the dredge pond.

4.1.5 World Bank/IFC Guidelines and Performance Standards

GCO has committed to designing, operating, decommissioning and rehabilitating the GCP in a manner consistent with high standards of environmental practice, including relevant World Bank/IFC policies and guidelines and in accordance with GRS legislation and guidelines.

World Bank Environmental Health and Safety (EHS) Guidelines are technical reference documents that address IFC's expectations regarding the industrial pollution management performance of projects financed by the IFC. Banks subscribing to the Equator Principles also apply these guidelines to projects they finance. The guidelines are designed to assist managers and decision makers with relevant technical information to support actions aimed at avoiding, minimising and controlling EHS impacts during the life of a project.

IFC Performance Standards that are potentially relevant to the environmental and social management of the GCP are described in Table 4.4.

Table 4.4 Description of Current IFC Performance Standards on Social and Environmental Sustainability (IFC 2006)

Performance Standard (PS)	Content
PS 1: Social and Environmental Assessment and Management System	This Standard underscores the importance of managing social and environmental performance throughout the life of a project. It requires a social and environmental management system incorporating: social and environmental assessment; management program; organisational capacity; training; community engagement; monitoring; and reporting.
PS 2: Labour and Working Conditions	This Standard recognises that the pursuit of economic growth through employment creation and income generation should be balanced with protection for basic rights of workers. It underscores the importance of establishing and fostering a sound worker–management relationship. It requires safe and healthy working conditions with fair treatment, non-discrimination and equal opportunity for workers. This Standard also addresses issues of child labour and forced labour in order to protect the workforce.
PS 3: Pollution Prevention and Abatement	This Standard outlines a project approach to pollution prevention and abatement, in line with internationally disseminated pollution prevention and control technologies and practices that are technically and financially feasible and cost-effective. It requires consideration of ambient conditions and application of suitable technologies and practices during the project life-cycle.
PS 4: Community Health, Safety and Security	This Standard requires evaluation of the risks and impacts to the health, safety and security of the affected community during the design, construction, operation and decommissioning of the project. It addresses the responsibility of companies to avoid or minimise such risks and impacts caused by project activities.
PS 5: Land Acquisition and Involuntary Resettlement	This Standard is applied wherever land, housing or other resources are taken involuntarily from people. It requires the consideration of feasible alternative project designs to avoid or minimise physical or economic displacement, while balancing environmental, social and financial costs and benefits. It outlines compensation and benefits for displaced persons and guidance on resettlement planning and implementation. It also covers economic displacement where the project causes loss of income or livelihood without physically displacing people.
PS 6: Biodiversity Conservation and Sustainable Natural Resource Management	This Standard provides guidelines on protecting and conserving biodiversity, and management of renewable resources. It requires an assessment of the significance of project impacts on biodiversity, as well as mitigation measures to avoid or minimise the impacts. It also requires companies to demonstrate sustainable management of natural resources.

Performance Standard (PS)	**Content**
PS 7: Indigenous Peoples	This Standard aims to develop and maintain a positive and ongoing relationship with indigenous people. It generally requires the avoidance of adverse impacts, and information disclosure, consultation and participation. In addition, it sets forth the special requirements and procedures to be carried out where the project causes impacts on traditional or customary lands under use by indigenous peoples.
PS 8: Cultural Heritage	This Standard provides guidelines on protecting cultural heritage discovered during the course of project activities. Besides relevant national laws, internationally recognised practices for protecting cultural heritage need to be undertaken. It requires protection of known cultural heritage from adverse impacts of project activities, through consultation with national or local regulatory agencies. It also requires development of a chance find procedure when the project is located in an area where cultural heritage is expected to be found.

In addition to the Performance Standards described in Table 4.4, there are a number of guideline documents prepared by the IFC that may be applicable to the GCP (see Section 1.6.7 in ESMMP).

4.1.6 Equator Principles

The Equator Principles provide a framework for financial institutions to determine, assess and manage environmental and social risk in project financing. Adherence to the principles ensures that projects are developed in a manner that is socially responsible and reflects sound environmental practices. In order to keep all options open with respect to financial backing for this project, GCO has elected to comply with the Equator Principles.

The aims of the 10 Equator Principles (July 2006) are summarised below. A complete statement of the principles is available from http://www.equator-principles.com.

Principle 1: Review and Categorisation – Categorise the project based on the magnitude of its potential impacts and risks. *Financiers have assessed this Project as being a Category A project – a project with 'potential significant adverse social or environmental impacts that are diverse, irreversible or unprecedented.'*

Principle 2: Social and Environmental Assessment – Complete a Social and Environmental Assessment to satisfaction of financial institution; propose mitigation measures. *Tropica's (2005) EIES and this Environmental Management Strategy fulfil this requirement.*

Principle 3: Applicable Social and Environmental Standards – Assess compliance with host country laws, regulations, permits, IFC Performance Standards and World Bank Pollution Prevention and Abatement Handbook. *This Environmental Management Strategy and the Environmental and Social Management and Monitoring Plan (ESMMP) identify relevant laws and regulations and provide strategies to achieve compliance with these laws and guidelines; the Environmental and Social Monitoring Manual (ESMM) outlines management and monitoring procedures that will allow assessment of compliance with those laws and regulations.*

Principle 4: Action Plan and Management System – Prepare an Action Plan to describe and prioritise actions needed to implement mitigation measures; establish a social and environmental management system. *This Environmental Management Strategy and the ESMMP identify environmental and social management issues and proposed mitigation measures. Environmental and social management procedures and plans will be developed to* *address these issues and they will be incorporated in an environmental and social management system.*

Principle 5: Consultation and Disclosure – Consult with project-affected communities in a culturally appropriate manner; incorporate communities' concerns into project management. *Tropica's (2005) EIES and ongoing GCO consultation fulfil this requirement*.

Principle 6: Grievance Mechanism – Establish appropriate procedures to receive and address concerns or grievances raised by individuals or groups from project-affected communities. *Proposed procedures are described in Appendix 2.1.*

Principle 7: Independent Review – An independent social or environmental expert will review the EIES, Action Plan and consultation process documentation to assess Equator Principles compliance. *GCO organised an independent review of a draft version of the ESMMP developed in 2007*.

Principle 8: Covenants – Incorporate covenants linked to compliance with all relevant laws, regulations and permits; comply with Action Plan; provide regular reports on compliance; and decommission the facilities in accordance with an agreed Decommissioning Plan. *This Environmental Management Strategy identifies relevant laws, regulations and permits and provides the background and framework for monitoring compliance with these laws and regulations. A Conceptual Closure Plan will be developed prior to operations.*

Principle 9: Independent Monitoring and Reporting – Financial Institution will require appointment of independent environmental and/or social expert to verify monitoring information and to ensure ongoing monitoring and reporting.

Principle 10: Equator Principles Financial Institution (EPFI) Reporting – Each EPFI commits to periodically report publicly about its Equator Principles implementation processes and experience.

4.1.7 African Development Bank Safeguard Policies

The African Development Bank Group Involuntary Resettlement Policy (November 2003) has been developed to cover involuntary displacement and resettlement of people as a result of a Bank-financed project. It applies when a project results in relocation or loss of shelter by the persons residing in the project area, assets being lost or livelihoods being affected.

The overall goal of the Bank's Involuntary Resettlement Policy is to ensure that when people must be displaced, they are treated equitably, and that they share in the benefits of the project that involves their resettlement.

Details of the guiding principles are provided in Appendix 2.2 – *Land, Asset and Livelihood Baseline Study.*

4.2 Environmental and Social Context

Senegal is located on the western margin of northern Africa, with an area of approximately 196,190 km^2 and an estimated population of approximately 12 million people (July 2006) (www.cia.gov). Most of the population are Muslim (94%) with a small Christian minority (5%) (mostly Roman Catholic) and the remainder following indigenous beliefs.

The GCP is located on a coastal dune system that starts about 25 km north of the capital, Dakar, and extends northward for more than 140 km. The mining concession area is 90 km long x 5 km wide and extends from near Kayar in the south to near Sag in the north (Figure 1.1). The project lies within the Thiès and Louga regions of Senegal, which are governed by Regional Councils. Within these administrative regions are several Rural Communities (*Communauté Rurale*) governed by Rural Councils, including: Darou Khoudoss, Cab Gueye, Thieppe and Diokoul Diawrigne. Although most villages in these Rural Communities lie outside the mining concession area, many hamlets and some villages are located inside the area, and some are located within the proposed dredge path (exploitation area) (Figure 4.1). The Commune of Mboro, which is governed by a city council with a mayor as leader, is the closest town to the proposed mine site.

Mining will commence approximately 2 km north of Diogo village, which is located within Darou Khoudoss Rural Community, some 125 km by road from Dakar. The first 10 years of mining will be conducted in a 32 km-long strip on the eastern margin of the littoral dunes, as shown in Figure 2.1.

The landscape of Senegal is generally low, rolling plains rising to foothills in the south-east, with the only significant hills being in Senegal's far south-east corner and along the border with Mali. The highest land is the coastal terrain mobile sand dunes, where average height above the base of the swales is about 5 m. The height of the mobile dune profile increases gradually, moving inland from the fore-dune area with an RL of 10 m to an average RL of 25 m at the most inland mobile dune. Further inland dunes are lower in relief from 3 m to 5 m. The countryside as a whole rises in elevation away from the coast, with an average RL of 60 m approximately 15 km inland.

The project lies within the area of the niayes, an area of sand dunes with arable inter-dune depressions known as 'niayes'. The niayes are situated mainly on the eastern side of the dunes in the hinterland areas and will generally not be impacted directly by the proposed mining operation, except during construction of the initial dredge pond. However, during the first year of operation, while the dredge moves along the eastern margin of the littoral sand dunes adjacent to the niayes, temporary changes to the water table in the vicinity of the dredge pond may occur. These changes might lead to temporary flooding of the niayes or to temporary lowering of the local groundwater table while the dredge pond is nearby. However, every effort is being made to limit these effects by the inclusion of a lateral borefield adjacent to the active mining area. Some of the agricultural areas on the littoral dunes, which are also in depressions and often more marginal than those in niayes, are likely to be impacted under the current 10-year mine plan.Three types of soils are present in the project area (Figure 2.4):

- Soils of white dune depressions (locally called *dioukis*).
- Soils of yellow dune depressions.
- Soils of red dune depressions (locally called *dior* soils).

These sandy soils are essentially young, rough mineral soils with very little differentiation and weak fertility. They have minimal organic matter and very low nitrogen content. To farm these soils it is generally necessary to enrich the soil with animal manure and/or organic and chemical fertilisers. This practice of fertilisation may already be causing nitrate pollution of groundwater.

Vegetation in the dunes within the proposed mining area is generally sparse. Several areas have been planted with eucalyptus and filao (casuarinas) in an effort to stabilise the dunes and protect market gardens from encroachment by mobile sand dunes. Various endemic species and species on the IUCN Red List of Threatened Species occur in the general mining concession area; however, no threatened species are known to occur on the proposed GCO mine path.

Copy 3

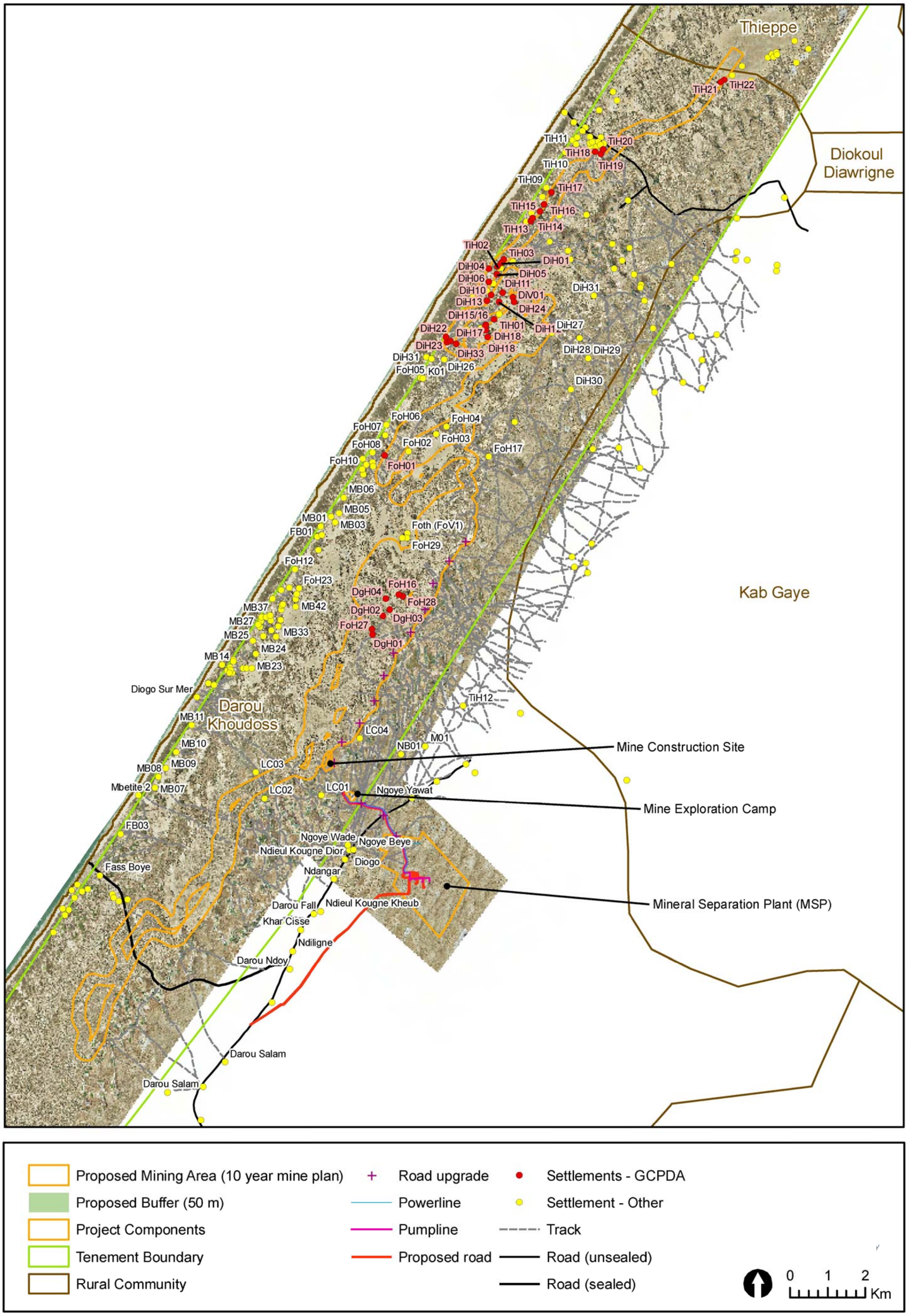


FIGURE 4.1

Settlements in Vicinity of Proposed Dredge Path

Copy 3

Source: Earth Systems Pty Ltd, Melbourne (2010)

There are no major surface drainage lines within the project area, since most rainfall infiltrates the sand dunes and recharges the groundwater. Some depressions between the dunes become swampy during the wet season due to rising water tables. Over the past 30 years rainfall has generally decreased and rainfall at the levels required to adequately replenish the groundwater system in the sand sheet aquifer has not occurred for many years. In an effort to manage the available groundwater sustainably, the PAEP (Program of Support for Farmers' Entrepreneurship) has recommended a maximum pumping rate of 15 m^3/hr for groundwater from the sand sheet aquifer.

Initial mining is proposed near Diogo, in the Rural Community of Darou Khoudoss. In 2003 the population of the Rural Community was 39,684 people, with an average density of 76 people per km^2. Migratory movements are widespread in the Rural Community, contributing to ethnic diversity. Principal ethnic groups are Wolof (70%) and Peul (20%). Others include Serer, Diola and Bambara.

The main occupation in the region is agriculture, with 65% of the population involved in market gardening. Animal husbandry occupies 15% of the working population, while 10% are engaged in fishing. Crafts, trading and road haulage are additional occupations. Low schooling rates and poor health infrastructure characterises the Rural Community, which relies on wells and bores for water supplies. Use of groundwater and lack of adequate sewage systems promotes propagation of diseases. Lack of water in schools, lack of teaching supplies and lack of teachers combine to reduce the availability of schooling, which is limited to the primary level. Health centres are similarly under-resourced, with only three health stations in the Rural Community of Darou Khoudoss, located in Darou Khoudoss, Darou Fall and Fass Boye.

4.2.1 Climate

Senegal is located in the Sahel, the arid semi-desert or savannah region that forms a broad band across Africa between the Sahara desert to the north and forested areas to the south. The Grande Côte has a tropical climate with distinct wet and dry seasons. The wet season is from June to October, with most rain falling in August and September. However, the wet season is shorter and rainfall is lower in the north than in the south. In Dakar, average annual rainfall is approximately 600 mm; however, in the southern end of the mining concession area around Mboro, average annual rainfall is approximately 425 mm. Further north, around the Lompoul area, average annual rainfall is approximately 350 mm. In Dakar, average maximum daytime temperatures are around 24°C from January to March and between 25°C and 27°C in April, May and December. From June to October, temperatures rise to around 30°C. Northerly maritime winds moderate temperatures along the coast for most of the year. However, the hot dry wind known as the Harmattan may raise the temperature in May and June.

4.2.2 Site Geology and Geomorphology (from MDL 2006)

Along the Grande Côte, the Quaternary sand sheet is characterised by four geomorphological units, which are aligned approximately parallel to the coast (Figure 2.4). From west to east the units are:

- White dunes.
- Pale yellow dunes.
- Orange dunes.
- Red dunes (Ogolien).

The Recent pale yellow dunes overlie older late Quaternary lower white marine sands that were deposited during a time when lagoons, bars, spits and deltas formed along the coast together with the development of minor peat in lagoons and estuaries. The interface between these two layers is generally a 0.5 m humic horizon. Both the light yellow dunes and the underlying white marine sands contain heavy minerals, principally ilmenite with accessory zircon, rutile and leucoxene. Zircon is the main commodity of interest.

The mobile dune system is typically asymmetric, rising from about 10 m immediately inland from the fore-dune area to an average of 20 m before terminating at a high and steep-faced inland dune. Heights are variable and may reach more than 35 m. The average height of the dunes is 5.6 m. The average width of the dune field is 2 km and reaches up to 4.5 km inland. The dunes and the sand mass in general appear to increase in size and height north-eastwards from Mboro to Lompoul.

The underlying white marine sands are generally 30 m to 40 m thick and contain thinly bedded heavy mineral concentrations reworked as lag deposits in the mobile dunes (strandlines).

An extensive older back dune system of north-east trending Aeolian red or orange coloured sands (rouges) was formed during an Ogolien age (20,000 to 11,000 years before present) regression when the desert sands of Mauritania spread to this region. The mobile dunes may also be a reworked part of these back dunes. Drilling data indicates the mobile dunes intermittently overlie the back dune sands in the more inland parts of the deposits.

Based on work by the Geological Survey and DuPont, a model of the mineral sand deposits was constructed that suggests three Aeolian phases, with the greatest amount of heavy minerals in the oldest phase, which is now the most inland part of the mobile dune system.

The **white dunes** (latest Holocene age) are located between the sandy ocean beach and the pale yellow dunes and may also overlie the pale yellow dunes (Figure 2.4). Apart from areas stabilised by filao (casuarina) plantations, the white dunes are mobile. The dunes are fed by sand blown from the beach by trade winds and may contain heavy minerals. These dunes are not a target for this mining project.

The **pale yellow dunes**, which contain heavy minerals, are located in an irregular strip between the coastal white dunes and the more inland orange dunes. They are both mobile and semi-fixed and are a target of this mining project. In general, the pale yellow dunes overlie white marine sands of Nouakchottien age, with the boundary generally marked by a thin (0.5 m) humic horizon. The marine sand contains some heavy minerals (possible old strandlines). Reworking of these older marine sands may have contributed heavy minerals to the overlying pale yellow dune sands.

The **orange dunes** constitute an irregular, discontinuous belt along the Grande Côte, between the mobile pale yellow dunes and the inner red dunes. Most of the Grande Côte heavy mineral sand deposits are contained in these dunes, which range between 5 m and 30 m above sea level and extend up to 4.5 km inland. The dunes are semi-fixed by vegetation and plantations, but are mobile in some areas. Drilling data indicates that towards the east, orange dunes directly overlie the red dunes and the inter-dune depressions (known as niayes). In some cases, orange dunes have migrated over the niayes at a rate of approximately 3 mpa (BRGM 1983, p. 15). Reworking of the older red dunes may have contributed to the overlying orange dune system. The orange dunes are a target of this mining project, along with the pale yellow dunes.

The **red dunes,** of Ogolien age, form a continuous belt inland of the orange dunes. They are aligned in a north-north-west to south-south-east direction in the northern part of the Grande Côte and in a north-south direction between Mboro and Potou, in the direction of the continental trade winds (dominant dry season winds). These dunes formed during a regression, when sea level fell and the desert of Mauritania spread to this region.

Topographic depressions between the dunes, known as niayes, occur along the western margin of the red dune system. Niayes are flooded by fluctuations of the water table, which periodically emerges at the surface, causing the formation of temporary or permanent marshes. Peat deposits occur in the niayes and are likely to extend beneath the orange dunes. The morphology of the niayes indicates that they occupy old fluvial valleys, some aligned perpendicular, and others at an angle, to the coast.

4.2.3 Surface Water

The only surface water present in the project area occurs in niayes, which may be flooded by fluctuations in the water table, forming temporary or permanent marshes. Under the present climate because rainfall is generally lower on average now compared to the pre-1970 period, flooding of niayes due to rising water tables is unlikely. Water currently present in niayes is generally contained in small ponds, where trenches have been dug by farmers to intersect the groundwater table (groundwater trenches) and to provide water for irrigation. No flowing streams are found in the GCP area.

4.2.4 Groundwater

Groundwater is the only source of water within the proposed mining area. Groundwater for local use is obtained from the sand deposits, which extend as a ‘sand sheet’ for some 100 km along the coast and from 10 to 15 km inland (Pells Sullivan Meynink – PSM 2004). Groundwater is accessed from wells and pits, which vary from a few metres to over 20 m deep. It is used for potable water, farm irrigation and watering stock. Groundwater bores tapping this resource have a recommended maximum pumping rate of 15 m^3ph (4 litres per second or 131 MLpa) to minimise drawdown and maintain a sustainable water supply. The groundwater table is approximately 11 m above sea level at Diogo, grading to 1 m above sea level close to the coast (PSM 2006) (Figure 2.3).

The unconsolidated sand sheet aquifer is recharged by rainfall. Average rainfall in the vicinity of Diogo, where the MSP and initial mine site will be constructed, is approximately 410 mm pa, most of which falls between mid-June and mid-October. Further south it is wetter and further north it is drier. Available records indicate a declining trend in rainfall (and therefore groundwater recharge) since the 1950s (PSM 2006). Mean open water evaporation potential at Thiès, approximately 65 km south of Diogo, is 2,109 mm pa. Average annual recharge in 1981–1982 was estimated to range between 40 mm/yr north of Mboro and 29 mmpa south of Lompoul (PSM 2004). The piezometric divide that separates landward and coastward groundwater movement appears to be more or less parallel to the coast and 5 to 10 km inland (Figure 2.3).

GCO has established an extensive piezometer field (in excess of 330 piezometers as of April 2010) across the entire exploration drilling area and commenced monitoring groundwater levels in April 2006. Results to date indicate a declining trend in groundwater levels in many piezometers, confirming the declining trends identified in earlier studies of the groundwater in this area (BRGM 1983).

In addition GCO has completed groundwater modelling for the project area using a MODFLOW model to represent the regional groundwater flow and a proprietary hydraulic model of the impacts of dredging on local groundwater flow (PSM 2010).

Basement for the sand sheet aquifer is Eocene limestone. Basement contours define a basement divide approximately parallel to the coast and located between 9 km and 15 km inland (PSM 2004). In the Diogo sector, basement contours slope to the west, from approximately 20 m below sea level at Diogo to approximately 40 m below sea level at the coast (Figure 2.3).

Underlying the Eocene limestone, at depths of more than 400 m, is an aquifer of Maestrichtian age that will be used to supply water for mining, mineral processing and for potable applications.

4.2.5 Terrestrial Vegetation and Fauna

The GCP is located within the Niayes region, which is known as an area for 'reforestation or restoration' under the Forest Code. Although often sparse, vegetation is present over most of the mining concession area, with only 2% mapped as mobile dunes. Since the 1940s, exotic vegetation has been planted on the mobile dunes to try to prevent wind erosion and transport of sand onto the farming areas. The plantations also provide wood for local communities. filao (*Casuarina equisetifolia*) and eucalypt have been planted by the Senegal government in conjunction with various overseas aid projects. A program of tree planting financed by Japan was completed in 2005 on several large dunes along the Grande Côte.

Native vegetation in the Niayes region contains a mix of species, including relicts of Guinean flora coexisting with Sahel steppe species. The composition and distribution of the flora are determined by the nature of the substratum and hydrological conditions. Savannah is developed on the dunes and in the inter-dune depressions. In the inter-dune depressions, the vegetation is denser and the trees are higher than in the more exposed locations. Sub-Guinean species are preserved in these sheltered sites.

Pseudo-steppe vegetation is also developed on the dunes, consisting mainly of *Parinari macrophylla, Fagara xanthoxyloides, Aphania senegalensis, Commisphora africana and Annonaa senegalensis.* Towards the eastern side of the mining concession area, *Faidherbia albida* and *Acacia raddiana* are the dominant species. Several native species, including cashews and *Parinari macrophylla,* provide forest fruits for local communities.

Eleven threatened flora species and eight endemic flora species have been identified in the mining concession area (Tropica 2005, Table 10.1). Detailed vegetation mapping will be conducted on the mine path and on the areas to be disturbed for infrastructure development prior to construction, to determine whether threatened, endemic or significant flora species are present.

The Niayes area is considered poor in wildlife, especially terrestrial animals. The only endangered species recorded for the area by Tropica (2005) are marine turtles, which use the beaches of the Grande Côte for nesting. No mining will take place in their nesting habitat.

4.2.6 Socio-economic Environment

4.2.6.1 Regional Economic Context

The project lies within the area of the Niayes, a narrow coastal area from Dakar to Saint-Louis characterised by interdunal depressions where coastal aquifers outcrop. Roughly 80% of Senegal's vegetable production comes from the Niayes. Due to the proximity of the highway and major population centres, farmers in the Niayes have few problems marketing vegetables. Dakar, Thiès, Louga and Saint-Louis are the main rural and urban marketing centres. As such, horticulture forms the principal livelihood of communities in the project region, supplemented by cereal and leguminous cropping, fisheries, and small-scale animal husbandry.

The importance of vegetable crops has been increasing in Senegal since the 1970s (De Bon et al. 1997). There has been a significant trend away from subsistence rain-fed cropping to year-round irrigated market gardening. In 2002 the annual vegetable production in the niayes was estimated to be about 155,000 t, 36.5% coming from the Thiès region and 27.7% from the Dakar region (Global Environment Facility 2002).

Most of the vegetables produced are consumed on the domestic market, but regional trade among West African countries has increased. Senegal also exports vegetables and fruits to Europe in winter by air.

In value, the four most important vegetables in Senegal are onions, potatoes, tomatoes and cabbages. While some vegetables are grown all year, the bulk of production is in the dry season when there are fewer problems with pests and diseases. Staples such as millet, maize, and groundnuts are grown in the rainy season.

However, the ecosystem in the Niayes is fragile. Market gardening activities are threatened by drought, which has led to a lowering of the water table and stress on the vegetation, as well as by the landwards migration of littoral dunes by wind erosion.

The use of chemicals and organic inputs for horticulture has the potential to adversely affect groundwater and public health. The mineral and organic manures used in the area contribute to the pollution of the ground water of Quaternary sands by nitrates, which can create various pathologies in animals and people. Beyond the problems raised by the fertilisers, pesticides also have negative consequences on the Niayes farming system – it is estimated that 10% of pesticides used in the region are persistent.

4.2.6.2 Settlement

Thiès, with an estimated population of 1.36M people is one of the most populated regions (Ministere de l'Economie et Finances 2005). Nationally, the population density is 50 people per km^2. Thiès is the most densely populated of all Senegal's regions with 208 people per km^2. The Region of Louga has an estimated population of 743,973 people, with a population density of approximately 25 people per km^2 (2006 estimate; ANSD 2006).

In 2003, the population of the Rural Community of Darou Khoudoss was 39,683 with an average population of density 76 people per km^2 (Rural Community of Darou Khoudoss 2004). For the Rural Community of Thieppe, the 2006 population was 13,857 with an average population density of 32 people per km^2 (Alizés 2006).

Settlements within the project area can be broadly clustered into three zones: i) settlements located on the littoral dune including: Foth, Diourmel, some Diogo hamlets; ii) coastal settlements located adjacent to the proposed dredge path; and iii) hinterland settlements located east of the littoral dune.

The littoral dune has significant influence on the movement of people within the Rural Community of Darou Khoudoss and Thieppe, and hence their socio-economic and political associations. The dune settlements of Foth and Diogo tend to be closely associated with the township of Diogo, while the dune settlements of Diourmel tend to be associated with the north-eastern townships of Khonk Yoye and Lompoul. Note, Khonk Yoye and Lompoul are under the administrative control of the Kébémer Rural Community and the sous-prefecture of Ndande. The coastal settlements located south of Diogo Sur Mer tend to be associated with the township of Fass Boye, while the coastal settlements of Diourmel and Thiakmat are more strongly associated with the township of Lompoul Sur Mer.

Family structure is patrilineal. An extended family typically comprises more than one household and is represented by a chief (chef de concession) who is typically the eldest male. Households within the same extended family normally live within a common compound (or concession). Resources such as food, access to land, equipment and cash income can be shared by households within the concession. This interdependency strengthens individual resource security, especially in times of hardship. Polygamy (or more specifically polygyny) is common; almost 40% of adult men in the 2007 baseline survey villages have more than one wife.

For the settlements located within the proposed dredge path, the average household size is approximately 6 to 8 persons. Upwards of 50% of the population within the 2007 baseline survey area is below the age of 16 years and less than 10% is above the age of 50.

4.2.6.3 Ethnicity

The project is inhabited by populations of the Peul and Wolof ethnicities. The dune settlements of Foth, Diourmel and the Diogo hamlets, are entirely inhabited by Peul people. The hinterland villages comprise a majority who are Wolof (86%) and a minority Peul (13%). The coastal settlements comprise distinct Wolof and Peul communities. Wolof settlements include Diogo Sur Mer, Fass Boye, and Litte. Peul settlements include Mbetite 2, Thiakmat and Theni Naar.

Both the Wolof and Peul have inhabited the land within the broader project area for at least 100 years. Traditionally the Wolof have practised rain-fed agriculture in the hinterland areas to the east of the littoral dune and in more recent times, over the last 30 to 40 years, have migrated west to the Niayes where they have been able to exploit ground water for market gardening.

The Wolof is the politically dominant group in Senegal. The Wolof controlled the Senegal region prior to the French military conquest in the late 18th century. Thereafter, they were recruited by the French colonial regime as the administrators and later inherited this influence once Senegal gained independence in the 1960s.

The Peuls (also known as Fula Julon) are a large ethnic group located in the West African nations of Guinea, Mali, Sierra Leone and Senegal. Peul herdsmen settled in the Fouta Djalon region, a mountainous area of central Guinea, over 200 years ago, and have since spread throughout western Africa. In the project area, Peul settlements are characterised as being small, remote and highly dispersed.

Although the Wolof and Peul in the project area share similar livelihood and social structures, the Peul are a comparatively marginalised group. The Peul have less secure access to land, less access to community facilities (schools, health centres and roads), speak a minority language, and are likely to have less representation in political structures.

4.2.6.4 Employment and Economic Status

The main occupation in the project area is agriculture, with most adult men (92%) and women (58%) in the 2007 baseline survey area identifying agriculture as their principal occupation (see Appendix 2.2). The communities on the dune recorded the highest percentage of adults involved in farming compared to hinterland and coastal communities. Farm labourers are mostly unpaid family members (women, children, nephews, etc.) who are financially dependent on the head of their household.

The 2007 baseline study identified that:

- Most women (79%) in the dune settlements identified farming rather than housekeeping as their primary occupation. This compared to just 25% of women in the hinterland and coastal settlements.
- Few people in the 2007 baseline survey area are engaged in private sector employment with the exception of 2% from hinterland settlements. Hinterland settlements also have the highest incidence of people engaged as labourers and trades people.
- Sixteen per cent (16%) of men in coastal settlements identified fishing as their primary occupation. This is particularly the case in the Wolof settlements of Fass Boye, Litte and Diogo Sur Mer.
- Fish processing was identified as the primary occupation for 4% of women from Diogo hamlets and 5% of women from coastal settlements.
- Just one percent (1%) of men identified themselves as being unemployed or retired.

Households within the project area are heavily reliant on cash income sourced from horticultural activities for the purchase of staple foods, supplementary foodstuffs, household items, and to manage emergencies such as medical expenses. Average annual household cash income for the settlement clusters on the littoral dune varied from 3M FCFA (~US$6,833) in Foth to 4.2M FCFA (~US$9,567) in Diourmel hamlets. There are few opportunities for inhabitants of the 2007 baseline study villages to be involved in any form of off-farm employment, with the exception of supply chain services for the horticultural sector, i.e. packaging, transportation and the supply of farming inputs. Lower-income households are large, have a greater number of dependants, and lack access to education.

Households from hinterland settlements reported higher mean income levels at 6.2M FCFA, presumably a consequence of their relative proximity to markets and access to larger agricultural land area in the Niayes, compared to settlements on the littoral dune. Some households reported substantially higher incomes, which could be contributed to either greater access to agricultural land areas or by non-agricultural sourced income. For example a number of households recorded income in excess of 10M FCFA from "servicing" – this is likely to be the provision of supply chain services for the horticultural sector i.e. fertilisers, transport, etc.

The highest mean household incomes of 15.3M FCFA were recorded in the coastal settlements, and specifically those engaged in coastal fisheries, e.g. Fass Boye, Litte and Diogo Sur Mer.

Households whose members identified fishing as their occupation consistently recorded substantially higher incomes than households reliant on agriculture. Some boat owners and fish traders declared incomes up to 100M FCFA.

Food, and in particular rice, represents the single most important cash expenditure item for rural households. After food, households devote the largest portion of income to farming inputs (seeds, fertilisers, pesticides, animal fodder), followed by clothing, medical treatment, and transport.

4.2.6.5 Health and Education

Life expectancy in Senegal is relatively low at 56 years. Infant mortality and under-five mortality rates are 78 and 137 per 1,000 live births respectively (UNDP 2006).

Access to health facilities is a major constraint to the population of the Rural Community of Darou Khoudoss. Within the project area, health posts were identified in Darou Fall, Fass Boye and Lompoul (Rural Community of Darou Khoudoss 2004). All of these facilities are located more than 10 km from the dune settlements of Foth and Diourmel. Settlements such as Diourmel located at the northern extent of the proposed dredge path access health facilities located in Lompoul, Louga and Kebemer to the north. Hinterland communities access the facility in Darou Fall and coastal communities the facility in Fass Boye. The closest hospital to the project area is in Mboro, a further 17 km south of Diogo. Local communities are forced to rely heavily on traditional forms of medicine and may consult a recognised “healer” in times of need who would prescribe various herbal and spiritual remedies.

Health facilities in the Rural Community of Thieppe consist of 13 health huts and one health post/station (Alizés 2006).

Common health issues in the project area include malaria, dysentery, diarrhoea, parasites, malnutrition and tuberculosis (Rural Community of Darou Khoudoss 2004). The incidence of HIV/AIDS is relatively low in Senegal (0.9% of adults) compared to other African nations, and is estimated to be 0.1% in the Thiès Region (Ministere de l’Economie et Finances 2005).

There is potential for the escalation of local health problems associated with the inflow of migratory labour during the construction phase of the GCP.

In 2006 the overall French language illiteracy rate in Senegal was 41%; 32% for males and 50% for females (ANSD 2006). Based on interviews with heads of household from the project area, 28% of males and 42% of females described themselves as illiterate. This is lower than expected given only 10% of men and 8% of women have attended primary school.

As per health facilities, access to French language schools is a major constraint to the population of the Rural Community of Darou Khoudoss. Within the project area, French language primary schools are located in Darou Fall, Fass Boye and Lompoul (Rural Community of Darou Khoudoss 2004). All of these facilities are located more than 10 km from the dune settlements of Foth and Diourmel. The closest secondary school to the project area is in Mboro, a further 17 km south of Diogo. GCO has recently constructed a kindergarten in the village of Diogo. A total of 21 elementary schools are located within the Rural Community of Thieppe (Alizés 2006).

As expected, attendance rates at primary school are low as children are required to help their family in the fields. Girls in particular are denied opportunities for education because they are burdened with the responsibility of domestic work; are married at a young age; and will provide little or no wealth to their parental family when they become members of their husband's concession.

4.2.7 Land and Water Use

4.2.7.1 Land Use

Local people have the right to use the land according to customary practices under the jurisdiction of the Rural Community. Most of the land in the project area is held under traditional forms of title, with the exception of some land parcels in the Niayes that are formally registered with the Rural Council.

The principal land use activities within the broader project area include horticulture, agro-pastoralism, and timber forest-product harvesting. Horticulture is the principal agricultural activity in the project area, which is practised in the depressions of the littoral dunes and the Niayes where groundwater is more readily accessible for irrigation (Plate 4.1). Horticulture is the main dry season activity and it is meant both for family consumption and income production. Effectively all households in the 2007 baseline survey area are engaged in market gardening.

Limited access to water, and secondly land and labour, are the principal drivers for the intensification of market garden production systems. To overcome these constraints farmers are:

- Adopting mechanised methods for extracting groundwater and irrigating crops. In recent years some of the wealthier farmers in the Niayes have installed boreholes fitted with pumps that distribute water via a network of pipes and hoses to their crops. The use of pipes and hoses compared to manual water distribution methods greatly increases the area of land that can be exploited from a single water source. At the time of the 2007 baseline study these methods had not been adopted by farmers exploiting the littoral dunes. The high cost of fuel and the construction of a suitable well are most likely limiting the further expansion of this approach.
- Recruiting labour to increase household farm production, whereby the labourers share in the profits of the production cycle.
- Increasing the use of chemical fertilisers and pesticides.

Inefficiency in the transport of production from farm gate to market is also a significant constraint. Most of the produce is perishable and the farmers are not equipped with appropriate storage facilities, which can result in significant loss.

Diversification of the agricultural sector between crops and livestock helps to provide an important form of livelihood security. More than 75% of the households in the 2007 baseline survey area raise cows, small ruminants (goats and sheep) or poultry. Market gardening has enabled the intensification of animal raising in the form of waste crops providing a valuable source of animal feed, and manure as a source of fertiliser. Horses and donkeys are mainly used for animal traction and transportation.

Vegetation cover within the project area is generally characterised by scrub, widely dispersed, small-leafed trees, revegetation plantations and open sand areas with little to no vegetative cover. Although often sparse, vegetation is present over most of the proposed

PLATE 4.1
Typical horticultural practice in the dune depressions
Source: Earth Systems Pty Ltd, Melbourne (2010)

PLATE 4.2
Typical private well with holding and distribution vessel in background
Source: Earth Systems Pty Ltd, Melbourne (2010)

mining area and buffer zone. This vegetation provides local communities with a valuable source of timber and non-timber forest products, and grazing land to support their livelihood. Several species provide forest fruits for local populations.

In the 2007 baseline survey area, no arboriculture was identified on the littoral dunes and minimal activity in the Niayes. In the Niayes it was common for farmers to maintain a range of fruit trees adjacent to their market gardens, but in general the orchards are small and subsidiary to the vegetable production. The most common fruit trees include mango, orange, guava, lemon, coconut palm, papaya, banana and date palm.

4.2.7.2 Water Use

Groundwater is of vital importance to the livelihood of the local communities within the GCP development area. A comparison of studies conducted in 1975 and 1994 suggests that the groundwater level has been steadily dropping. Consultation with village representatives confirmed this trend. Several anthropogenic activities are potentially associated with this trend, including: increased exploitation for town use; agriculture[1]; and plantation development. Long-term drought is also likely to have reduced the recharge potential of groundwater sources.

The recent climate is marked by a change that occurred between 1966 and 1970 characterised by a diminution of precipitations varying between 20% and 40% and determining a southwards migration of the isohyets (Global Environment Facility 2002). The mean annual rainfall in the 2007 baseline survey area has fallen from approximately 600 mm to 400 mm over the last 50 years.

For settlements on the littoral dune, groundwater is the key source of water. Groundwater harvested from shallow wells is used by settlements for agriculture, household consumption (e.g. washing, cooking), and stock watering (Plates 4.2 and 4.3). Groundwater is usually transported by hand to irrigate adjacent agricultural areas. Groundwater is also commonly stored in cemented holding basins, which are located adjacent to the wells or further afield and connected via a PVC conduit system. These basins act as a labour-saving device and in turn improve irrigation efficiency. Mechanically driven boreholes, varying in depth from a few metres to over 20 m can also be found in niayes areas.

Household investment for a well or borehole varies according to depth but is typically in the order of 70,000 FCFA or 700,000 FCFA respectively. The number of water sources owned by the household is a reflection of their agricultural production potential and hence wealth. Based on interpretation of aerial photography and 2007 baseline study data, there are an estimated 609 water sources within the proposed mining area, of which six are trenches and the remainder wells. A further 283 water sources were identified within the buffer zone. Note, that some of these wells may be ‘dry’ where the water table is below the base of the well. However, the exact numbers of dry and active wells could not be determined from visual interpretation of aerial photography.

[1] It is estimated that 1 ha of vegetables requires 50,000 litres of water daily (Bielenberg and Allen 1995).

PLATE 4.3
Typical trench and pump configuration located in the Niayes
Source: Earth Systems Pty Ltd, Melbourne (2010)

PLATE 4.4
Mosque in Foth main village (FoV1)
Source: Earth Systems Pty Ltd, Melbourne (2010)

4.2.8 Archaeology and Cultural Heritage

Islam is the dominant religion in the Rural Community of Darou Khoudoss and Thieppe, with a minority adherent to Christianity or animism. A number of religious leaders (marabous) maintain significant social influence over Wolof communities surrounding the project area – particularly from the mosque located in the hinterland village of Darou Salam. Some religious leaders, including those from religious centres such as Touba, own large areas of land within the Niayes where their students manage market gardens. For example, four camps under the authority of Touba Islamic religious leaders are near the project development area.

A small number of cultural sites have been identified inside the proposed mining area under the first six years of project development. These include two cemeteries and one mosque associated with Diogo hamlets.

Nearly all the settlements in the project area have either a mosque or a place of prayer – sites that are highly valued by the community.

There is also potential for other cultural sites including abandoned cemeteries to be present in the project area in addition to those identified in the baseline study (Appendix 2.2).

A detailed site assessment of archaeology values in the vicinity of the project area has not yet been conducted. “Shelly heap” is the only known potential archaeological site mapped within the Mining Concession (Tropica 2005). It occurs close to the coast in the approximate vicinity of Fass Boye and is located outside of the proposed mining area.

Archaeological findings throughout West Africa indicate that Senegal was inhabited since prehistoric times. The following briefly describes the archaeological findings in the Thiès region (The Museum of Thiès 2009).

Human settlement in Senegal dates back at least to the Lower Palaeolithic period (early Stone Age, 2.7 million to 200,000 years ago). Several artefacts belonging to Lower Palaeolithic inhabitants have been discovered in the peninsula of Cape Verde and in Eastern Senegal. Bifaces (two-sided stone tools) of this age were found in the peninsula of Cape Verde and small axes were found in south-eastern Senegal (Djita, Sare). Lower Palaeolithic artefacts have not been found in the region of Thiès.

Many scrapers and cores with circular lights (short fragments) belonging to an industry called "moustéroïde" from the Middle Palaeolithic period (approximately 60,000 to 30,000 years ago) have been uncovered near the Thiès region (around Ndiaye, Cap des Biches, Diokoul, Pout, Bargny West and Bargny East) as well as in middle and lower valley of the Senegal River.

Evidence of an advanced form of "moustéroïde" industry was discovered in Tiemassas (south-east of Mbour), and Somone (north-west of Sebikhotane) dating back to an “evolved Palaeolithic” era (approximately 30,000 to 13,000 years ago) in the Thiès region. These artefacts include many bifaces, heads of spears, arrows and javelins. Microlithic tools (small blades made from flaked stone) and various ceramic pottery belonging to the Neolithic era were found in the Thiès region and Cape Verde.

The mineral sand ore body to be mined in the Grande Cote Project has accumulated in the last 10,000 years; consequently, the potential for archaeological deposits occurring within the sand body is limited to the last 10,000 years.

The vestiges of protohistoric civilisations (AD 1450–1650) are also numerous in Senegal. The most remarkable sites are represented by the tumuli, sepulchral mounds made of earth, shells, or may be entirely composed of stones. Thousands of mounds (tumuli) of various sizes, presumed to be funerary monuments, occur throughout Senegal. Of these, the Senegambian Stone Circles located in central Senegal (south-east of Thiès) and just north of Gambia (Senegambia) were listed as a World Heritage site in 2006 by the UNESCO. Several gold, silver and copper artefacts and pottery in association with the human bones were discovered in the tumuli. The sites of the protohistoric era are poorly preserved in the Thiès region.

4.3 Environmental and Social Aspects and Impacts

In this section the environmental impacts and social impacts likely to occur from the GCP are summarised.

4.3.1 EIES Environmental and Social Management Plan

The Environmental and Social Impact Assessment for the GCP (Etude d'Impact Environnemental et Social – EIES) was completed by Tropica Environmental Consultants in November 2005, prior to final decisions on the locations of various road works, power station, mineral separation plant and mine path. At the time of writing the EIES, the proposed mine path extended for approximately 10 km north of Diogo (see Figure 29 in Tropica 2005). The current proposed mine path (Figure 2.1) extends further north than the originally proposed mine path. The environmental and social impacts for the current mine path are expected to be similar to those identified in the EIES in 2005.

The EIES included an environmental and social management program (Plan de Gestion Environmentale et Sociale [PGES]), which proposed measures to mitigate the potential impacts of the GCP, as well as a system for supervising the implementation of the mitigation and monitoring measures. The PGES consisted of three plans:

- A Natural Resources Management Plan (Plan de Gestion des Ressources Naturelles [PGRN]).
- A Social Management Plan (Plan de Gestion Sociale [PGS]).
- A Hygiene–Health–Safety Plan (Plan Hygiène–Santé–Sécurité [PHSS]).

The EIES proposed that GCO would undertake consultation on each plan with an external technical committee. The external technical committees will be informed of the likely mitigation measures to be implemented and will be asked to advise on the impacts of the mitigation measures being implemented.

The environmental and social management programs proposed in the EIES have been updated and are summarised in Tables 4.5 to 4.13.

Table 4.5 Natural Resources Management Plan - Flora and Fauna

Potential Negative Impacts	Mitigation Measures	Implementation Methods	Time Frame for Implementation	People Involved	Key Performance Indicators
Loss of vegetation (both local species and plantation species) in the dredging path, around MSP	Replace recent plantations	Define clearing program	Before the start of operations	GCO, Forestry Commission	Mapping
	Revegetate degraded land and older plantations	Undertake planting trials	Before the start of operations	PRL	Success of planting trials
	Revegetate around MSP on closure	Prepare a rehabilitation program	Before the start of operations	CR	Complete Logging Plan Complete Rehabilitation Plan
	Give cleared vegetation to local people via defined process/procedure	Scale up production at local tree nurseries Produce seedlings Plant and maintain	Before the start of operations At the start of operations During operations	Committee of local people (Forest Union, GIE intercompany management syndicate, men, women, etc.)	Progress in planting program
Removal of individual trees of local species	Replace removed trees	Set up a Logging Plan and a process to identify key examples of local trees to be specifically replaced Awareness	Before mining starts	GCO Forestry Commission	Numbers of removed/replaced trees
Habitat destruction	Rehabilitation process for mined areas Community Conservation Zones Managed faunal reintroduction	Prevention measures Identify appropriate habitats Long-term faunal reintroduction program	Following mining	GCO Forestry Commission CR Local people	Habitat condition
Encroachment on the Community Nature Reserves (Réserves Naturelles Communautaire – RNC)	There are no RNCs within the project area				
Loss of vegetation outside dredge path (e.g. around tracks)	Use existing tracks and roads where possible to minimise vegetation loss	Identify and use existing tracks and roads	Before the start of operations	GCO	Mapping of tracks and roads

Potential Negative Impacts	Mitigation Measures	Implementation Methods	Time Frame for Implementation	People Involved	Key Performance Indicators
Illegal logging	Surveillance of clearing Anti-poaching measures	Signs prohibiting tree clearance/logging Anti-clearing regulations for project site Verbal briefings on anti-clearing regulations	At the start of operations During operations	GCO Forestry Commission CR	Regulations handbook Conduct verbal briefings on regulations
Risks of delay in the process of rehabilitation (depending on the season, by comparison with the speed of mining)	Careful timing of rehabilitation	Prepare a Rehabilitation and Closure Plan (tree nurseries, planting, etc.)	At the start of operations	GCO Forestry Commission CR Local people Heads of villages	Project plan Observation
Risk that best adapted local species are excluded	Nurseries use known local species	Good control of sylviculture (tree farming) for targeted species	Before the start of operations	Forestry Commission Local people Heads of villages	Condition of nurseries
Lack of maintenance of plantations	Produce an integrated planting and maintenance plan	Implement maintenance regime, identifying participants and their roles	At the start of operations	GCO National Forestry Commission CR Heads of villages	Report plantation maintenance activities Monitor development and outcomes for plantations

Table 4.6 Natural Resources Management Plan – Landscapes

Potential Negative Impacts	Mitigation Measures	Implementation Methods	Time Frame for Implementation	Person(s) in Charge	Key Performance Indicator
Visual impact of introduced buildings/infrastructure	Remove infrastructure at the end of the project	Dismantle and remove introduced buildings/infrastructure at end of project	End of the project	GCO/local community	All introduced buildings/infrastructure removed from project site
	Construct camp using easily removed buildings/infrastructure	Consider these issues in project specifications	At the start of the project	GCO	Include in project specifications
Waste discharge	See Hygiene–Health–Safety Plan				
Risk of disturbance of archaeological sites	Train dredge operators to recognise shelly masses on the surface Raise awareness with dredge operators of the possibility of finding shelly masses Inform the authorities when possible archaeological sites discovered	Train dredge operators to recognise shelly masses on the surface	Before start of mining activities	GCO	Numbers of training sessions for mine operators to recognise shelly masses
Soil compaction and subsidence	Establish direct transport routes and avoid productive land (avoid multiple tracks)	Research land use and the role of local authorities	At the start of the project	GCO and the local authorities	Project site layout plan
Existing land uses within the mining area will be halted temporarily while mining proceeds (agriculture, forestry, tourism, etc.)	Mined areas will be rehabilitated to pre-existing uses at the end of the project, or will be planned in a suitable manner for specific uses	Dialogue with appropriate authorities/grower representatives/GCO	At the start of the project	GCO and the local authorities	Agreed Rehabilitation and Closure Plan

Potential Negative Impacts	Mitigation Measures	Implementation Methods	Time Frame for Implementation	Person(s) in Charge	Key Performance Indicator
Destruction of soil structure and reduction in fertility	Drivers trained to use designated tracks	Driver training courses	At the start of the project	GCO	Number of driver training courses providing information and raising awareness
Risk of dune erosion being increased by the wind	Minimise the time between clearing and rehabilitation of the dunes in the mine path	Immediate rehabilitation of the mined dunes	For whole project life	GCO	Constant rate of rehabilitation
Risk of accidental or systemic hydrocarbon contamination of the soil	Secure hydrocarbon storage	Impermeable retention system	At the start of the project	GCO	Layout plan for production site
Risk of soil contamination from accidental or systemic discharge of liquid or solid wastes from domestic or mechanical sources	See Hygiene–Health–Safety Plan				

Table 4.7 Natural Resources Management Plan – Groundwater

Potential Negative Impacts	Mitigation Measures	Implementation Methods	Time Frame for Implementation	Person(s) in Charge	Key Performance Indicator
The MSP will use groundwater for domestic and production purposes	Groundwater for project use will be extracted from the deeper aquifer. Water used temporarily from the sand sheet aquifer will be recirculated back to the sand sheet aquifer.	Inform pumping personnel about pump discharge limits	From the start of project	GCO DGPRE	Pump meter readings
Liquid effluents from MSP may contaminate groundwater	See Hygiene–Health–Safety Plan				
Accidental or systemic pollution of groundwater by hydrocarbons	Store hydrocarbons in accordance with standard practice Train and raise awareness among personnel responsible for refuelling machines Conduct refuelling in impermeable areas using trained personnel, aware of the risks	Establish impermeable retention system Organise training courses Monthly sampling of the groundwater for laboratory analysis	Before the start of project	GCO Specialised company for disposal of hydrocarbon contaminated wastes	Enter into contract with hydrocarbon specialist Number of training and awareness sessions for targeted personnel Monthly hydrochemical analysis
Risk of groundwater drawdown in the project area due to: • Dredge pond intake • Evaporation • Pumping	Install piezometer network to monitor water table fluctuations on a three-monthly basis	Undertake subsequent work to plot three-monthly water table fluctuations	Throughout the project	GCO DGPRE	Quarterly report on water table variations

Potential Negative Impacts	Mitigation Measures	Implementation Methods	Time Frame for Implementation	Person(s) in Charge	Key Performance Indicator
If water table in dredge pond was lowered, the cone of depression could potentially affect other activities using groundwater (agriculture areas, etc.). This could reduce groundwater available in nearby wells.	Operate dredge pond at an elevated level by providing make-up water	Make-up water provided from deep bore	Throughout the mining operation	GCO DGPRE	Groundwater levels
The dredge pond exposes the water table, making it vulnerable to various sources of pollution, for example lubricants and hydrocarbons from the dredge motors	Daily visual checking of potential sources of hydrocarbon or oil discharges from motors in the dredge pond The project will not use any chemical products	Regular inspection of tank integrity where potential pollutants are found in motors, including gear-case, tanks, etc.	Every week	GCO	Motor inspection reports
The dredging activities could accidentally damage the impermeable substrate of the layer	None required. The depth to the impermeable substrate is known to be below the maximum dredging depth	None required			
Working through the sand unit and removing of fines could potentially modify the hydraulic parameters of the aquifer (permeability, coefficient of storage, transmissivity)	The hydraulic parameters of the aquifer will be recalculated following mining. If the assumptions about aquifer modification are confirmed, a new appropriate discharge limit for the groundwater will be calculated and the DGPRE will be informed	Conduct pumping tests	At halfway At the end of the project	GCO DGPRE	Hydraulic parameters updated

Table 4.8 Social Management Plan

Potential Negative Impacts	Mitigation Measures	Implementation Methods	Time Frame for Implementation	Person(s) in Charge	Key Performance Indicator
Encroaching on fields	Government mandated compensation provided	Agreed compensation rate based on consultation with all relevant parties and precedence in the region	Before the beginning of the activity that will affect people	Local communities GCO Administration Affected people	Number of cases settled Level of satisfaction of affected people
Conflicts with community concerning their lack of involvement	Favour local labour Tell the local population about the project and its activities	Continuous consultation	Before the start of activity	Local communities GCO Populations	Number and percentage of the local people employed
Occupancy of the pasture zones	Government mandated compensation provided to affected livestock producers	Map land use Provide support for domestic animals by providing new grazing or by providing animal feed	Before the beginning of activities that will affect people	Local communities GCO Technical services of State Affected people	Number of settled cases Level of satisfaction of the affected people
Disruption of commerce and trade (weekly markets)	New road to be constructed to bypass the village	Support the market by providing a parking area Construct new road	Before the start of activity	Head of the village Local communities assisted by GCO	Status of market organisation Level of satisfaction of affected people
Moving of occupants or activities	Government mandated compensation provided	Agreed compensation rate based on consultation with all relevant parties and precedence in the region	Before the start of activities that are a source of impact	Local communities GCO Administration Affected people	Number of settled compensation cases Level of satisfaction of the affected people

Potential Negative Impacts	Mitigation Measures	Implementation Methods	Time Frame for Implementation	Person(s) in Charge	Key Performance Indicator
Risk of market gardening activities being disturbed	Government mandated compensation provided	Agreed compensation rate based on consultation with all relevant parties and precedence in the region	Before the start of all the activities that are a source of impact	Local communities GCO Technical services of State Concerned people	Number of settled compensation cases Level of satisfaction of the affected people

Table 4.9 Hygiene-Health-Safety Plan – Risk of Impacts on Hygiene, Health and Living Environment

Potential Negative Impacts	Mitigation Measures	Implementation Methods	Time Frame for Implementation	Person(s) in Charge	Key Performance Indicators
Discharge of solid waste	Effective management: collection, treatment, and removal Organising and regulating land use around the MSP to ensure a healthy living environment Raise awareness among workers and MSP operators	Composting and/or burning of organic waste Removal of the remainder to landfill Separation and recycling of inorganic waste Raise awareness among workers about sorting wastes Make a person within GCO responsible for maintaining hygiene Establish rules for the management of waste and provide these for workers and MSP operators	At commencement of construction	GCO, through the person responsible for hygiene Recycling organisations (local crafts for instance)	State of living environment
Discharge of liquid wastes: sewage	A sewage treatment plant is being installed	Secure septic tank for toilets. Drain and close when decommissioned Install portable toilets on the dredge	At setting up	GCO with the help of a sanitation specialist	Operational condition of sanitation system
Discharge of waste oil	Collection of waste oil and delivery to a centre specialising in the disposal of these products	Seek advice and support from a fuel and lubricant supplier	At the start	GCO with support of a specialist	Quantity of used oils collected and treated compared to that used (proportion collected and treated)

Table 4.10 Hygiene–Health–Safety Plan – Sanitary Impacts

Potential Negative Impacts	Mitigation Measures	Implementation Methods	Time Frame for Implementation	Person(s) in Charge	Key Performance Indicators
Respiratory diseases caused by dust inhalation	Wear masks (workers) Raise awareness among communities Plant trees, where necessary, along major roads and tracks used by mine vehicles Support for local health systems Road watering	Include these diseases in workplace disease prevention planning Design and implement tree plantings Collaborate with local health agencies	Design at the start Implement immediately	GCO With support of DEFCCS and with the collaboration of local people	Occurrence of respiratory disease Assessment of local communities
Potential spread of STDs/AIDS (MST/SIDA)	Raise awareness among staff and local communities about the risks of STDs/AIDS Organise and regulate the MSP surroundings to reduce risky social behaviour Raise awareness among workers and MSP operators	Collaborate with the local Health District (DS) in which the site is situated	At the start and throughout the entire project	GCO Affected Health District (DS)	Number of awareness-raising meetings
Other diseases (for example, malaria where standing water is found)	Monitor vectors Raise awareness of workers and local communities about these diseases and measures for their prevention	Implement prevention and control measures if necessary	When dredge pond established	GCO Affected Health District (DS)	Occurrence of disease

Table 4.11 Hygiene–Health–Safety Plan – Safety Risks

Potential Negative Impacts	Mitigation Measures	Implementation Methods	Time Frame for Implementation	Person(s) in Charge	Key Performance Indicators
Risks of accidents involving local people	Road/track markings Implement speed bumps Raise awareness among drivers Provide alternative/dedicated roads for site access	Define rules/standards to be followed by all drivers working on the project Bypass for markets	At the start	GCO	Number of accidents
Fire hazard or explosion	Implement a functional fire management system where hydrocarbons are handled and stored	Design and implement a fire risk management system Include safety clauses in contractor specifications	At the start	GCO with the assistance of a specialist when needed Contractors	Number of incidents
Risk of industrial accident	Wear life jackets when on the dredge pond Specific safety plan for each part of the project	Develop and implement a comprehensive safety plan for workers Adopt safe working practices in the various work places	At the start	GCO	Number of industrial accidents

Table 4.12 Hygiene–Health–Safety Plan – Risk of Impacts on Hygiene, Health and Living Environment

Potential Impacts on the Environment	Mitigation Measures	Implementation Methods	Time Frame for Implementation	Persons in Charge	Key Performance Indicators
Air pollution	Choose generators with low emission levels Conform to current accepted Senegal emission standards Burn natural gas as fuel	Assess generators, considering their impacts on the environment Monitor pollution and air quality Identify remedial measures and implement when necessary		GCO with the support of a specialist	Levels of the following parameters (CO_2, NOx, SOx, etc.)
Nuisance caused by sand raised by vehicles	Limit vehicle speed through villages Protect dwellings Collaborate with local health agencies Contribute to the treatment of respiratory illnesses	Raise awareness and direct drivers if needed Design and implement tree planting along tracks/roads in very exposed villages Collaborate with local health agencies	Design at the start Implement immediately	GCO with the support of DEFCCS in collaboration with local communities	Occurrence Assessment of local communities
Noise pollution (noise from vehicles and motors)	Prevent through vehicle choice Attenuate through traffic schedules	Apply this principle within GCO and require contractors to undertake as well Reduce traffic during resting hours	At the start	GCO	Assessment of local communities

4.3.2 Cross-references to Environmental and Social Issues

The various aspects and impacts identified in the EIES are listed in Table 4.13 along with the relevant sections of this report where these issues are addressed.

Table 4.13 Summary of Environmental and Social Issues Identified in the EIES

Environmental Issues	Section	Social Issues	Section
Revegetation	**5.6.5**	Archaeological sites and cultural heritage	**5.6.16** **5.7.7**
Biodiversity and conservation	**5.6.15**	Land use conflicts and compensation	**5.7.15.7.9**
Rehabilitation and closure	**5.6.20**	Markets and transport	**5.6.14**
Erosion	**5.6.4**	Human health	**5.7.6**
Groundwater quality	**5.6.1**	Noise	**5.6.8**
Groundwater quantity	**5.6.2**	Dust	**5.6.9**
Noise	**5.6.8**	Visual	**5.6.18**
Dust	**5.6.9**		
Air quality	**5.6.10**		

4.3.3 Risk Assessment

Full project risk assessment is covered in Volume 1, Section 21.

4.4 Environmental and Community Objectives and Targets

Environmental objectives and targets provided in Table 4.14 are summarised from the ESMMP (Appendix 2.1).

Table 4.14 Environmental objectives and targets for the Grande Côte Project

Aspect	Objectives	Targets
Groundwater	Ensure that the quality of water discharged from the MSP site complies with legislative, licensing and financing commitments	Install drainage management structures for all facilities and bunding for hydrocarbon storage facilities
	Minimise impacts on neighbouring groundwater users and environmental values	Establish baseline groundwater monitoring bores and commence monitoring of groundwater levels and quality
	Minimise groundwater extraction by efficient water use and by recycling water within the MSP where possible	Review water demand estimates for MSP to verify design estimates and minimise raw water demand
	Minimise impacts on groundwater levels and quality adjacent to the mine site	Monitor and review water demand and effect on local groundwater table and quality as mining proceeds to ensure that impacts on adjacent groundwater users are minimised
	Minimise impacts on neighbouring groundwater users and environmental values	Develop and implement an Acid Sulphate Soil Management Plan, if necessary
	Avoid penetrating the impermeable basement of the sand sheet aquifer	No penetration of impermeable basement
	Ensure that mining activities do not induce saline intrusion into the sand sheet aquifer	No saline intrusion into the sand sheet aquifer
	Assess the hydrological parameters of the sand sheet aquifer before and after mining	Hydrological parameters assessed before mining and after mining

Aspect	Objectives	Targets
Tailings management	To re-form the landscape following mining to approximately the same pre-mining topography	Prepare topographic plan of proposed dredge path as a guide for reshaping tailings within reason, i.e. the capacity of the tailings discharge system
	To re-form the mined landscape in such a way as to minimise the potential for sand encroachment onto market gardens	Prepare landscape re-formation plan in vicinity of market gardens
	To monitor the acid-generating potential of tailings at the dredge pond	Prepare Acid Sulphate Soil Contingency Management Plan for mine-site tailings, if necessary
	To ensure that tailings with radioactivity levels higher than background are returned to the mine site and incorporated in the re-formed dunes in a manner that poses no threat to human health or the environment	Prepare Tailings Management Plan for MSP
	To maximise the return of water from the tailings to the dredge pond	Design tailings dewatering system
Erosion and sediment management	Minimise movement of sediment by wind	Rehabilitate re-formed mined dunes as soon as practicable following mining
	Minimise loss of sediment from areas disturbed by the GCP	Ensure drains and sediment traps at MSP site are operational prior to the first wet season
		Establish quantitative key performance indicators for sediment control structures at MSP site
		Establish land disturbance and rehabilitation database
		Establish monitoring system for sand encroachment from mined areas onto market gardens
		Minimise quantity of topsoil stockpiled from areas disturbed by mining
General Waste Management	Reduce potential health and environmental risks associated with waste generation and disposal	Install colour-coded bins and appropriate signage at designated locations around the project area for segregation of waste
	Promote the efficient use and conservation of resources, reduce the need for waste treatment facilities, and reduce the requirement for raw materials	Conduct inspection of major waste types and quantities generated on site, and develop waste inventory
	Maximise recycling of solid and liquid waste materials generated on site	Conduct an education campaign among the project workforce to assist with suitable waste disposal practices
	Minimise the use of hazardous materials on site and seek safer alternatives where possible	
Hazardous materials management	Reduce potential health and environmental risks associated with handling and use of hazardous materials	Develop and implement Standard Operating Procedures for hydrocarbon transportation, unloading, transfer, storage, handling, use and disposal
		Completion of qualitative risk assessments by transport contractors
		Establish proper hazardous material signage at all storage facilities
		Provide hazardous materials training to process operators

Aspect	Objectives	Targets
Hazardous materials management (cont)		Ensure suitable protective equipment is on site for all employees authorised to handle hazardous materials
		Develop an inventory of hazardous materials on site
		Conduct a hazardous material use and storage audit
Biodiversity and conservation	Minimise project impacts on flora and fauna within the mining and mineral processing areas	Develop a Biodiversity Action Plan in accordance with IFC requirements
Revegetation and rehabilitation	Develop a comprehensive Rehabilitation and Closure Plan to ensure that: • rehabilitation and closure considerations are integrated into mine planning decisions • progressive rehabilitation and revegetation are undertaken in a systematic, efficient and timely manner • progressive rehabilitation and revegetation are consistent with closure objectives and designated post-closure land uses • both the socio-economic and biophysical closure objectives are integrated and achieved • adequate funds are allocated to provide for the rehabilitation and closure activities. Establish criteria to measure rehabilitation success and achieve those criteria	Develop a Rehabilitation and Closure Plan based on post-mining land use
	Minimise potential impacts on threatened species by mapping the vegetation pre-mining, avoiding direct impacts on threatened species where possible and ensuring replanting of threatened species in areas where direct impacts on these species are unavoidable	Stabilise areas affected during construction that can be rehabilitated prior to the onset of the wet season
	Replant local species using seeds collected from mature plants in the local area	Implement revegetation trials
	Ensure alternative sites are available for collection of village wood, if clearing of the mine path removes vegetation currently used for this purpose	Alternative village wood collection area defined, if necessary
	Facilitate distribution of village wood cleared from the mine path in consultation with concerned parties (including Forestry Commission, local community)	Establish a database of topsoil locations and volumes, source locations, soil properties, etc.
	Preserve topsoil and contained seed bank by removal prior to mining for temporary stockpiling or respreading immediately on land restored after mining	Plant ground-stabilisation species and implement erosion and sediment controls for any existing topsoil stockpiles
	Restore and enhance topsoil in suitable depressions within the restored dune topography following mining	Conduct flora reconnaissance survey to identify local species suitable for revegetation

Aspect	Objectives	Targets
Revegetation and rehabilitation (cont)		Develop a Rehabilitation Monitoring Plan to record areas of revegetation, monitoring procedures, monitoring schedules, maps indicating revegetation areas and monitoring sites, rehabilitation objectives and success criteria
		Review results of rehabilitation monitoring and modify environmental controls as required to improve rehabilitation outcomes
Noise	To prevent nuisance and ensure that noise generated by the GCP does not adversely affect the health and safety of the community	Assess noise emissions from the MSP, power plant, construction equipment, and dredge
		Establish noise monitoring equipment if indicated as necessary by the model
Air quality	To prevent nuisance and ensure that air emissions generated by the GCP do not adversely affect the health and safety of the community	Conduct baseline air quality assessment for emissions of sulphur dioxide from power plant to impact significantly on local ambient air quality
	To minimise impacts from air emissions on the natural environment	Develop and implement a planned maintenance schedule for the bag house at the MSP
		Develop and implement a planned maintenance schedule for the power station
Archaeology and cultural heritage	To protect any archaeological or cultural heritage items from adverse project impacts and support their preservation	In future, develop and implement a chance find procedure in accordance with IFC requirements
	To avoid disturbing significant sites, or if unavoidable, minimise any impacts and appropriately relocate cultural heritage items	Provide specialist training to the Environment and Community Relations Departments so that the chance find procedure can be successfully implemented
	To ensure that artefacts uncovered during project activities are appropriately recorded, documented and reported to the appropriate GRS Department, such as the Ministry of Culture and Historical Heritage, for a decision on preservation	Record, document and report any uncovered artefacts
Traffic management	To minimise the impact of mine traffic on local communities, particularly along the transport route to the port of Dakar	Complete suitable risk assessment/audits of licensed carriers
		Develop and present a Traffic Safety Awareness Program to local villagers
		Install speed limit, crossing and road feature signs
		Provide safety training for drivers
		Develop a vehicle maintenance program and log
		Develop a road incident log and reporting protocol
Community Relations and Development	Preserve and improve the quality of life and the environment to benefit the local people in the vicinity of the GCP operations	Conduct household surveys to establish a detailed socio-economic baseline for the local community
	Improve basic social infrastructure, particularly in regards to education, health and water availability	Conduct a baseline land/asset survey of all land and assets that may be affected by Project activities in the Diogo mining sector
	Promote and facilitate income-generating activities	

Aspect	Objectives	Targets
Community Relations and Development (cont)	Reinforce skills and abilities	
	Provide employment opportunities	Develop and implement a feedback/community grievance register
	Actively seek community input and engage in community consultation regarding mine activities, environmental performance and community initiatives	Provide cultural awareness workshops and training
	Provide information and training to ensure that community members understand mine activities, and are fully informed of potential impacts and their mitigation measures	Establish a system for recording employment statistics
	Implement mitigation measures to address community concerns or grievances, or if there are no feasible measures, provide appropriate compensation to affected community members	Any required mitigation measures are implemented
Radiation	To ensure that the health of employees and the local community is not adversely affected by radiation	Establish a system for monitoring workers' exposure to radiation
		Submit product and tailings samples to ANSTO for assay of radioactivity on an appropriate basis
		Ensure adequate mixing of MSP tailings into re-formed dunes to prevent elevated radioactivity at surface of re-formed landscape

4.5 Environmental and Community Programs and Management Plans

The following environmental and community programs and management plans will be developed for the Grande Côte Project:

- Rehabilitation and Closure Plan, including:
  - Topsoil Recovery, Stockpiling and Re-spreading Plan.
  - Seed Sourcing and Growing Plan.
- Revegetation Maintenance and Monitoring Plan.
- Acid Sulphate Soil Management Plan (if necessary).
- Groundwater Quality Monitoring Plan (proposal developed by Umwelt 2010).
- Groundwater Table Monitoring Plan.
- Wind Erosion Monitoring Plan.
- General Waste Management Plan.
- Conceptual Closure Plan.
- Logging Plan.
- Radiation Management Plan.
- Public Consultation and Disclosure Plan.
- Resettlement Action Plan.
- Social Development Plan.

5 IMPLEMENTATION AND OPERATION

In this section, the objectives of an environmental management system, its structure and the responsibility for its implementation and operation are outlined.

5.1 Objectives

As outlined in Section 3, GCO will develop an environmental management system (EMS) that is broadly consistent with an international standard of management. The EMS will be incorporated into a comprehensive system that includes all management activities associated with the GCP.

5.2 Structure and Responsibilities

The structure of the environmental management system (EMS) and its associated supporting documents is shown in Figure 5.1. The Environmental and Social Impact Assessment (EIES) (Appendix 2.3), the Environmental and Social Management and Monitoring Plan (ESMMP) (Appendix 2.1), the Environmental and Social Monitoring Manual (ESMM) (Appendix 2.4), the Emergency Response Plan – Environment (ERP-E) (Appendix 2.5) and the Conceptual Closure Plan (to be developed) are all essential parts of the EMS. As environmental procedures and plans are developed to manage or mitigate potential environmental impacts, they will be incorporated into the environmental management system.

The implementation, day-to-day management and continued improvement of the EMS for the GCP will be the responsibility of the environmental superintendent, who will report directly to the general manager. The environmental superintendent will also be responsible for maintenance of the risk register for the GCP, which will be used to prioritise allocation of staff and financial resources in line with the site operational and business plans.

The specific duties of the environmental superintendent include:

- Ensuring compliance is achieved with relevant legislation and company policy by establishing and maintaining appropriate management and monitoring systems.
- Ensuring the management practices described in the ESMMP are implemented effectively.
- Ensuring that contractors fulfil their contractual obligations (detailed environmental and social management requirements).
- Providing specialist advice on ESMMP strategies, as required, to departmental managers, contractors and other project personnel.
- Monitoring the performance of ESMMP strategies.
- Regular liaison (as required) with the government, community and other stakeholders.
- Implementing environmental/social induction procedures and appropriate training for GCO personnel and contractors.
- Reporting.

It is the responsibility of all mine staff and contractors to comply with the regulations and procedures defined in the ESMMP, and to carry out their work in a way that minimises the social and the environmental impacts.

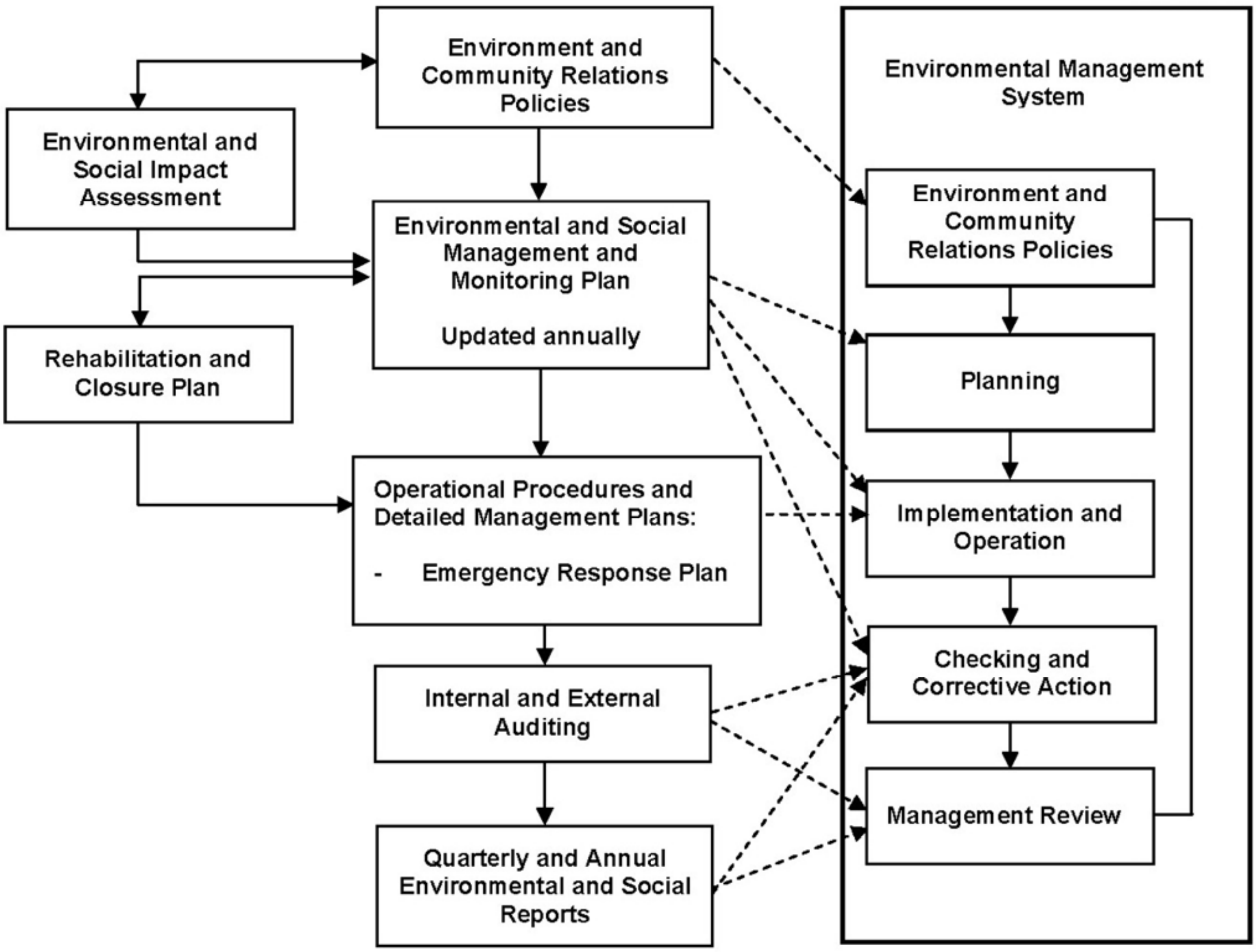


FIGURE 5.1

Schematic Diagram of the Environmental Management System

5.3 Training, Awareness and Competence

GCO will recruit appropriately experienced and qualified personnel to ensure that the requisite knowledge and skills are available on site to achieve environmental and community relations policies, objectives and targets.

For the GCP, GCO will employ as many Senegalese personnel as is feasible. GCO will develop and implement a training program to further increase the proportion of Senegalese staff working for the company. A competency-based training scheme will be implemented and used as the benchmark for local people to progress and work towards higher levels of competency in their field.

All new employees and contractors will be required to complete a structured site induction. The scope of the induction will include:

- Legislative requirements.
- Site layout and environmental sensitivities.
- Standard operating procedures.
- Incident reporting.
- Community sensitivities and cultural awareness.
- Health and social awareness.
- Safe work and emergency response procedures.

Additionally, all staff will receive an Induction Manual, which summarises the site induction program.

Training will be ongoing to improve the environmental and social understanding, capabilities and performance of personnel and contractors. In addition, specific training will be provided to personnel involved in:

- Maintaining and operating pollution control and radiation monitoring equipment.
- Storing and handling hydrocarbons and other hazardous materials.
- Responding to environmental incidents and emergencies.
- Work that involves potential or actual significant environmental risk.

Cross-cultural awareness will be a key emphasis of induction and training programs.

Records will be retained of all persons inducted. All employees and contractors will be required to undertake a re-induction every two years.

5.4 Communication

Project communication includes internal communication with the GCP workforce and external communication with the community, with local government and with national government.

5.4.1 Internal Communication

Effective internal communication aims to raise general awareness of environmental and social issues in the workforce, and to ensure that proper work procedures are used in all areas with potential for environmental and/or social impact so that potential impacts are minimised or controlled. As required, toolbox talks and noticeboards will be used to raise awareness of specific issues.

Approximately 80% of the Senegal population speak Wolof as a first or second language. About 20% of men and about 2% of women understand French. In Senegal about 50% of men and 30% of women are literate.

Internal communication on GCP sites will take place in Wolof, in French and in English. Written notices placed on noticeboards will be in English. Verbal notices will be used in Wolof and in French to ensure illiterate employees can also receive information.

GCO will employ the following environmental and community relations reporting systems at the GCP:

- Incident reporting (Section 5.4.1.1).
- Weekly, monthly and quarterly reporting (Section 5.4.1.2).
- Annual reporting (Section 5.4.1.3).

Results from the environmental and social monitoring program will be presented internally at monthly or quarterly management meetings, unless there is cause for more rapid consultation.

5.4.1.1 Incident Reporting

An environmental or social incident is defined as any uncontrolled event that impacts on, or may potentially impact on the environment or community, or any activity resulting in regulatory non-compliance or the breach of company policies, standards or commitments. It also includes community complaints.

The following situations may constitute environmental and/or social incidents:

- All spills of fuel or oil greater than 20 litres, for example, within unbunded workshop areas and pits.
- All spills of fuel or oil greater than 20 litres outside of workshop areas and pits.
- All non-contained fires within operational areas.
- All chemical spills greater than 20 litres.
- Any unauthorised clearing of vegetation.
- Any accident involving native fauna.
- All project-related grievances expressed by local employees and/or community members.
- All confrontations involving local employees and/or community members.
- All near-miss environmental/social incidents.

Environmental and social incidents will be reported verbally to the relevant departmental manager immediately following their occurrence. Incidents will be risk assessed and ranked and then classified according to their environmental/social impact (see Table 2.1 in Appendix 2.5). A written Environmental and Social Incident Report will be submitted to the mining superintendent within 24 hours of the incident occurring, and presented to the mine operations manager at the first management meeting following the incident, unless the severity of the incident (as determined using the assessment criteria outlined in Table 2.1 of Appendix 2.5) requires immediate notification.

Immediate notification is required for major and critical incidents. These incidents require external help to resolve and require suspension of activity in the area immediately surrounding the incident. Such incidents must be reported to government authorities within 48 hours of the occurrence (see Section 2.4 in Appendix 2.5).

Information to be included in the Incident Report is listed in the ESMMP (Section 4.6.1) (Appendix 2.1).

5.4.1.2 Weekly, Monthly and Quarterly Reporting

The environmental superintendent will report on the progress of ESMMP implementation and performance against the Continuous Improvement Targets as part of routine reporting to the mining superintendent.

Monthly reports will include a summary of the events and activities carried out during the preceding month and list tasks for the following month. Safety issues or concerns and any incidents will also be addressed in the monthly report. Annual reports will compile and summarise the information in the monthly reports to provide an indication of progress and any issues or concerns that need to be addressed.

Formal reporting to external authorities will be on a quarterly basis (see Section 5.4.2).

5.4.1.3 Annual Reporting

At the end of every calendar year, GCO will prepare an Annual Environmental and Social Report for the GCP. This report will include:

- Results from all relevant monitoring activities carried out during the year, including a comparison with relevant guidelines (e.g. World Bank and national water quality guidelines).
- An explanation of any breach of compliance requirements, including the cause of the breach, and the corresponding corrective measures planned or underway to prevent future occurrences.
- A record and analysis of all significant environmental and social incidents.
- Results from relevant social surveys.
- Key findings of audits and facility inspections.
- A review of rehabilitation work undertaken and the results of any new rehabilitation investigations and trials.
- Any changes to the ESMMP.
- A review of the effectiveness of the ESMMP and recommended improvements to the ESMMP and environmental/social management procedures.

The Annual Environmental and Social Report will be submitted to the Board of Directors and copied to relevant external authorities.

5.4.2 External Communication

Communication with local authorities is necessary to share information, identify problems and work out solutions. Monthly meetings for this purpose are held and will continue to be held between GCO and key marabouts, village chiefs, president of Rural Council, and sous prefect. These meetings will continue throughout the life of the GCP.

Quarterly reports on environmental management will be submitted to the Department of Mines and Geology (Direction des Mines et de la Géologie), within the Ministry of Energy and Mines (Ministère de l'Energie et des Mines) in Dakar and the Department of Environment (Direction de l'Environnement et des Etablissements Classés), within the Ministry of Environment and Nature Conservation (Ministère de l'Environnement et de la Protection de la Nature).

Quarterly reports will include:

- Any significant environmental/social incidents or events that have occurred in the preceding three months.
- Progress against the Continuous Improvement Targets.
- Preventative measures implemented.
- Any process or operational changes/improvements.
- Results of the monitoring program.

For the first two years of mining, a six-monthly report on groundwater quality and groundwater levels will be submitted to the Division of Management and Planning of Water Resources (Division de Gestion et de Planification des Resources en Eaux). If, after two years, the division is satisfied with the results for groundwater quality and groundwater levels, then GCO will provide subsequent reports on an annual basis.

5.5 Operational Control

As part of its EMS, GCO will develop and document procedures to deal with significant environmental aspects of its operations. These procedures will aim to ensure that the operations are conducted in a manner that will control or reduce the adverse environmental impacts associated with them.

5.6 Environmental Issues and Mitigation Measures

Environmental issues likely to be of significance for the project were identified in the Environmental and Social Impact Study (Etude d'Impact Environnemental et Social – EIES, in French) in 2005 (Tropica 2005) and are listed in Table 4.9.

Additional environmental issues have been identified since the production of the EIES. The complete list of environmental issues identified is outlined in Table 5.1, along with the relevant section of this report.

Table 5.1 Environmental Issues Identified for Grande Côte Project

Relevant Section	Environmental Issue	Relevant Section	Environmental Issue
5.6.1	Groundwater Quality	5.6.11	General Waste Management
5.6.2	Groundwater Quantity	5.6.12	Hazardous Materials Management
5.6.3	Surface Water	5.6.13	Radiation
5.6.4	Erosion and Land Stability	5.6.14	Transport and Traffic Safety
5.6.5	Revegetation and Rehabilitation	5.6.15	Biodiversity and Conservation
5.6.6	Mine Path Tailings	5.6.16	Archaeology and Cultural Heritage
5.6.7	Mineral Separation Plant Tailings	5.6.17	Energy and Emissions
5.6.8	Noise	5.6.18	Visual Aspects
5.6.9	Wind-Blown Dust and Sand	5.6.19	Cumulative Impacts
5.6.10	Air Quality	5.6.20	Rehabilitation and Closure

Each environmental issue is discussed below and the mitigation measures proposed to manage its impacts are outlined.

5.6.1 Groundwater Quality

Groundwater quality in the sand sheet aquifer may potentially be affected through discharge from point sources such as fuel tanks, lubricant stores or human waste disposal systems, as well as through diffuse discharge from agrochemicals and fertilisers used in revegetation. A special issue for consideration is the potential impact of acid sulphate soil oxidation.

Existing groundwater quality has been measured at wells and bores in the Diogo area. The existing quality of the groundwater includes several parameters that exceed WHO guidelines for drinking water. These are outlined in Table 5.2 below.

Table 5.2 Existing Groundwater Quality Values Equalling or Exceeding WHO Guidelines for Drinking Water in Wells and Bores in the Diogo Area MDL2006 and GCO 2009

Parameter	Units	Extreme Value	WHO (2008) Guideline
pH		3.1	6.5–9.5[a]
Chloride	mg/L	1,790	250[b]
Nitrate	mg/L	228	50[b]
Sulphate	mg/L	489	250[b]
Sodium	mg/L	780	200[b]
Iron (total)	mg/L	17.6	0.3[b]
Manganese (total)	mg/L	2.32	0.4
Lead (total)	mg/L	0.01	0.01
Nickel (total)	mg/L	0.11	0.07
Cadmium (total)	mg/L	0.003	0.003
Aluminium (total)	mg/L	16.3	0.2[b]

[a] No health-based pH guideline is recommended in WHO (2008), but optimum pH for operation conditions is the value range noted.

[b] Aesthetic/taste levels of concern (WHO 2008).

The high nitrate values are likely to be the result of existing fertiliser use on gardens in the Niayes (Sall and Vanclooster 2009). The high iron, manganese, lead, nickel, cadmium and aluminium values are likely to be caused by existing acidic groundwater leaching the metals (see the highly acid extreme pH value and high sulphate value).

Groundwater quality will be monitored as part of the Groundwater Monitoring Program (see Appendix 2.7).

5.6.1.1 Fuel, Lubricants and Reagents

Fuels and lubricants will be used by the power station, by the dredge (lubricants only), by vehicles used as part of the project and as part of the mineral separation plant processes.

- Natural gas is considered as one of the potential fuels for the dual-fuel power station. In addition to the natural gas a stock of liquid heavy fuel oil will be stored in a tank farm at the power station.
- Gasoil for plant processes and vehicles will be stored at the MSP site.
- Gasoil for vehicles will be stored in tanks at the exploration camp during construction.
- Lubricants used for the vehicles, for the power station and for the dredge will be stored at the power station and at the exploration camp during construction.

Existing refuelling of vehicles may have contaminated the ground, and possibly groundwater, around locations where refuelling is undertaken in local villages. The background level of hydrocarbons in groundwater will be monitored prior to the project commencing.

Fuel tanks will be established in an impermeable and bunded retention system to provide secure hydrocarbon storage. Lubricants will be stored in sheds constructed with a sealed and bunded floor.

Hydrocarbons and reagents will be handled according to industry leading practice guidelines. Vehicle and plant operators will be trained in refuelling procedures and in spills management.

The use of hydrocarbons on the dredge will occur directly over the groundwater body. To minimise the potential for hydrocarbon contamination, potential sources of contamination on the dredge will be checked regularly.

The concentration of hydrocarbons will be monitored in groundwater sampling undertaken around substantial fuel stores, around fuel handling areas and in the dredge pond water.

5.6.1.2 Fertiliser, Agrochemicals

During the revegetation phase of the project, agricultural fertilisers and agrochemicals will be used to encourage the re-establishment of trees and other vegetation following the passing of the dredge.

Existing fertiliser and agrochemical use is likely to be found around the project site. The background level of nitrates (a derivative of fertilisers) and organophosphates will be monitored prior to the project commencing.

Fertilisers and agrochemicals (if used) will be applied at a rate that minimises their discharge to groundwater.

The concentration of nitrates and the concentration of organophosphates in groundwater will be monitored as part of the groundwater monitoring program (see Appendix 2.7).

5.6.1.3 Sewage Systems, Pit Toilets

Sewage disposal systems will be established at the exploration camp and at the MSP site to provide facilities for project employees. The sewage system will collect, transfer and treat human waste in a manner that minimises discharges to groundwater and minimises impacts on the environment.

Existing private toilets and animal dung are likely to have contaminated groundwater, particularly around niayes, where the water table is close to the surface. The background level of faecal coliforms will be monitored prior to the project commencing.

The concentration of faecal coliforms in groundwater will be monitored as part of the groundwater monitoring program.

5.6.1.4 Potential Acid Sulphate Soil

An issue for consideration is the potential impact of acid sulphate soil oxidation. Although the Grande Côte ore body is a very low sulphur system, and no evidence of pyrite has been noted in the sands or the humic material (peat), any potential acid sulphate soil identified in the dredge path will be treated as detailed below.

If there is potential for acid sulphate to be generated, it may occur when humic or acid-forming material is excavated during dredging and placed in a position where it can be oxidised, e.g. in the tailings.

Preliminary testing of samples from the project site indicates that there is potential for acid sulphate generation to occur (see Appendix 2.1 – Section 5.2).

If it takes place, acid sulphate generation is most likely to occur within the dredge tailings pile in the months following dredging. The maximum rate of acid sulphate generation, if it occurs, is likely to occur within a few years of the tailings being stacked in air. The rate of acid sulphate generation is likely to decline in the years following the maximum generation rate as the material remaining to be oxidised decreases in volume.

The potential for any acid sulphate generation will be minimised by identifying, where feasible, high humic content materials and placing them below the water table as the dredge moves forward. This will prevent oxidation of any sulphides present and reduce the volume of any acid sulphate that is produced.

Where, despite this mitigation measure, there is a significant potential for acid sulphate drainage to be generated, it may be mitigated by incorporating lime into the tailings as they are stacked.

If acid sulphate is generated despite these mitigation measures, it will be detected by the groundwater quality monitoring program. In this situation, mitigation measures will be developed to prevent groundwater of inadequate quality being used for irrigation, for stock watering or for human consumption.

5.6.2 Groundwater Quantity

Tailings stacked behind the dredge will incorporate water from the dredge pond and from the local groundwater body. This water will drain into the groundwater body underneath the dredge tailings pile, elevating the local water table. To prevent this elevated water table from detrimentally affecting neighbouring niayes and land, for example by flooding, the groundwater mound will be intercepted by two lines of lateral containment bores situated at the margins of the dredging zone. Water will be pumped back from the containment bores to the dredge pond to make up for water lost when tailings are removed.

The two temporary lines of lateral containment bores will extend 1,300 m on each side of the dredge path. Behind the dredge operation, as the water table returns to seasonal levels that existed prior to the dredge passing through the landscape, the bores no longer required will be removed and new bores will be installed in front of the dredge operation. The containment bores will be spaced at 50 m intervals.

The 52 temporary containment bores will each be pumped at an average rate of 9.7 L/s (35 m^3/hr). Pumped groundwater will be immediately returned to the dredge pond. The groundwater is recirculated to the shallow aquifer.

About 10% of the total groundwater being recirculated from the groundwater body requires replacement due to evaporation and process losses (about 1,000 m^3 net per day). Any replacement groundwater required will be obtained from the deeper Maestrichtian aquifer. The Maestrichtian aquifer is not connected to the surficial sand aquifer in which the dredge will be operating.

Processing at the mineral separation plant (MSP) will require water at a rate of approximately 50 m^3/hr. Following processing, wet tailings will be returned to the dredge pond from the MSP by pipeline.

A deep water bore adjacent to the MSP will be used to supply process water and potable water for the MSP and water for rehabilitation nurseries. Several deep water bores spaced along the dredge path will be used to supply make-up water for the dredge pond.

Existing water table levels are being monitored prior to the commencement of the project, to establish medium-term and short-term trends. During the project, water table levels will be monitored around the dredge pond and throughout the mining concession area.

During most of the first years of the project as the dredge passes along the eastern side of the project area, the dredge pond will be maintained at the same level as the surrounding groundwater to minimise any changes in the groundwater table that may have adverse impacts on the Niayes. Pumping of water from the temporary containment bores will minimise changes in the local groundwater table.

A variety of groundwater management methods will be used to review and mitigate impacts on groundwater quantity. Water supply and water demand estimates for the various components of the operation will be continuously reviewed once the plant is in operation. Actions will be taken to minimise any potential temporary adverse flooding of niayes and to minimise water loss, hence minimising operationally expensive additional make-up water from the deep aquifer. Section 8 of Volume 1 details project water management and hydrology requirements and controls.

5.6.3 Surface Water

The only surface water present in the project area is the water contained in small ponds in the niayes, where trenches have been dug by farmers to intersect the groundwater body (groundwater trenches) and to provide water for irrigation. No flowing streams are found in the GCP area.

During the first years of the project as the dredge passes along the eastern side of the project area, where the dredge pond is close to niayes, if the groundwater is raised, this has the potential to temporarily flood the niayes.

This flooding will be short-lived, subsiding as soon as the dredge has passed by. The impacts of this flooding will be mitigated by the measures outlined in Section 5.6.2 and by provision of compensation for individuals farming those niayes for the period that their crops are affected.

5.6.4 Erosion and Land Stability

The issues surrounding erosion and land stability include sand dune stabilisation and revegetation and the impacts of road construction and MSP activities.

5.6.4.1 Dune Stabilisation

The stabilisation of sand dunes to restrict any increase in rates of wind-blown sand movement due to the project is discussed below in Section 5.6.5 on Rehabilitation and Revegetation.

5.6.4.2 Road Construction

Erosion associated with road construction activities includes the disturbance of sand that may be blown by the wind. It is not expected that road run-off will require management, since little run-off will occur on the highly permeable sand.

Vegetation will be left intact on road verges and batters where possible and silt fences may be installed where wind-blown sand is obstructing the road.

Any erosion and sediment control structures will be inspected following major rainfall events (>50 mm in a day), following maintenance and repairs and at the end of each wet season.

Documented procedures will be developed for maintaining and repairing erosion and sediment control structures as appropriate.

5.6.5 Rehabilitation and Revegetation

As the dredge passes through the dunes, it will be working through both vegetated and unvegetated dunes. Any existing vegetation will be cleared prior to mining. The sand tailings from the mineral concentrator will be discharged at the rear of the dredge pond to create landforms that will approximate the shape and size of the original dunes. The bare sand will then be rehabilitated and revegetated to an appropriate land cover.

5.6.5.1 Objectives

The overall objective of the GCP rehabilitation and revegetation program is to restore the land to be suitable for activities that existed prior to mining.

Where bare sand existed prior to mining, the landscape will be restored to bare sand, although potential wind erosion and the risk of increased dune mobility may necessitate stabilisation of some form, even on previously bare sand.

Dune revegetation will take place where vegetation existed previously. Initial revegetation may be undertaken with species such as oats or sorghum as soon as practicable after mining. It is estimated that 24 months will be required after the passage of the dredge for shrub and tree plantings to be established. This time frame will be reviewed and revised over the life of the operation and will be considered in compensation agreements.

Where threatened species exist prior to mining, their distributions will be mapped, they will be avoided where possible, and threatened species will be replanted in areas where impacts on these species are unavoidable.

Where feasible, local species will be replanted using seeds collected from mature plants in the local area.

If clearing of the mine path removes areas currently used for collecting wood, GCO will ensure that cleared wood is made available via a pre-established equitable process.

Topsoil (where it exists) and the seed it contains will be preserved where feasible by removing the topsoil prior to mining and stockpiling it or respreading it immediately on land restored after mining.

Topsoil removed from depressions between dunes will be returned to suitable depressions within the re-formed dune topography following mining.

The previously vegetated sections of the restored landscape will be revegetated as soon as possible after mining, to reduce the risk of wind erosion and to maintain the viability of the natural seed bank in the soil.

5.6.5.2 Environmental and Social Context

The GCP will operate through a series of sand dunes. Sand dunes move through wind entrainment of the sand and wind-blown sediment movement. Market gardens in low-lying depressions on the landward side of the dunes already experience sand encroachment. No other mass movement or erosion processes are expected to occur in the project area.

About 10% of the existing dunes within the 10-year dredge path are active and unvegetated (Table 5.3). The remaining 90% of dunes currently vegetated have a range of different land covers, including gardens, scrubland, savannah, woodland and plantation forest. The vegetation will be cleared prior to the dredge moving through the area. Only bare sand will remain immediately after the dredge has worked through the area.

Table 5.3 Land Cover Types in the 10-Year Dredge Path

Dune Land Cover Type in 10-Year Dredge Path and Buffer Zone, Excluding Settlements *(from Earth Systems (2010A) Data and Dredge Path at 19 May 2010)*	**Area (ha)**	**Proportion (%)**
Active (unvegetated) dunes	55.5	2.0%
Agricultural land	169.9	6.2%
Littoral dune scrub and herbaceous species	278.5	10.2%
Littoral dune scrub and woodland	307.4	11.2%
Littoral dune scrubland	804.0	29.4%
Plantations	1,197.4	43.8%
Terrestrial dune depression	37.2	1.4%
Terrestrial dune scrub savannah	52.6	1.9%
Total	**2,732.6**	**100%**

The EIES listed 11 threatened plant species in the Niayes area. It is understood that these species occur in the depressions, not on the dunes, and therefore, not in the mine path. However, threatened plant species may occur at the dredge construction site. Baseline vegetation surveys will be conducted in proposed construction and mining areas to identify threatened plant species and to assist in planning revegetation strategies.

Some of the sand dunes in which the mine will operate have previously been the focus of dune stabilisation works. Revegetation of dune sand in the Grande Côte area is challenging because the low rainfall occurs mainly during the wet season and strong winds occur during the dry season.

Despite these difficulties, plantations of filao (casuarina) and eucalypt have been established successfully on parts of the dunes, particularly by a Japan International Cooperation Agency (JICA) project.

GCO intends to consult with local communities on vegetation clearance. This consultation will include consideration of how to manage the disposal of firewood and timber from areas cleared of vegetation in a manner that benefits local populations.

GCO will develop and maintain a database to record the consultation undertaken on vegetation clearing. This will be part of the Revegetation Procedures Plan to be developed as part of the EMS.

Consultation with local communities who farm small areas on top of the dunes will be necessary to ensure that they are fully informed of the proposed mining and potential impacts on their farms. Communities identified within the proposed mine path during the Land Asset and Livelihood Baseline Survey (Earth Systems 2010A) will be consulted further once the final mine path is determined. Their system of organic enrichment of topsoil within dune depressions will be implemented following mining, where possible, to restore land suitable for future farming purposes.

5.6.5.3 Rehabilitation and Revegetation Strategy

In consultation with stakeholders, GCO will develop a rehabilitation strategy for the GCP, which will define the final site rehabilitation objectives, and establish quantifiable criteria to help determine rehabilitation success.

As part of the Annual Mining Operations Plan, a vegetation survey of the proposed dredge path will be conducted and authorisation sought from the Forestry Commission for clearing. Impacts on protected species will be managed by avoiding them, by replacement planting, or by offset planting.

Rehabilitation trials will be conducted prior to the start of mining. The rehabilitation trials will assess the effectiveness of various rehabilitation methods on the reconstructed dunes. Rehabilitation trials and baseline surveys will be used to determine what general categories of land use will be rehabilitated and where this rehabilitation will take place. The categories of land use most likely to be used are plantation, native ecosystem, agriculture and possibly bare dunes.

The winds in Senegal are from the northern quadrants, with north-easterly and north-westerly components dominating. Wind speeds at Thiès, 80 km south-west of Diogo, vary from 1.8 m/s to 3.5 m/s, with an average of 2.6 m/s. At Louga, 54 km to the north-east of the northern end of the project area, the wind blows predominantly from the north-east with average velocities in excess of 2.7 m/s all year round.

The highest wind speeds occur in the period February to May. Dry sand grains move along the surface of a dune (by hopping) when wind speeds reach about 0.8 m/s. When wind speeds reach about 2 m/s, medium size sand can be carried in suspension in the wind. The sand dunes at the project site are naturally migrating towards the south-west.

Wet sand is not as readily entrained by the wind as dry sand. Sand is not expected to be blown by the wind during the period when the sand dunes are being re-formed with the tailings stacker.

Following dredging, the bare tailings sand has the potential to be entrained and transported by wind. In areas where vegetation has been removed, tailings sand has the potential to be transported at rates higher than occurred prior to the dredge's passing.

To restrict wind erosion of the tailings, long-term dune stabilisation methods will be required. In areas where dune erosion will not affect any surrounding land, it may be appropriate to allow wind erosion to continue for a short period, allowing some flexibility in the timing of dune stabilisation. However, where dune erosion has the potential to affect market gardens or settlements, and the area was vegetated prior to mining, dune stabilisation by revegetation should begin shortly after the dredge has passed through the area.

The dunes may need to be stabilised in the short term to allow plants adequate time to grow. Methods available for dune stabilisation include windbreaks made from natural materials, as is the current practice of the Senegalese Forestry Department, and/or options such as planting of a cover crop such as oats or sorghum, the use of Terolas (bitumen emulsion), the placement of mulch, or installing brush matting.

Installing windbreaks and stabilising the dune surface will reduce the volume of sand being blown away from the newly formed dune surface, particularly into niayes or into previously rehabilitated areas. Dune stabilisation may only be required for long-term rehabilitation on steep slopes (e.g. more than 15%). However, prior to vegetation re-establishing, dune stabilisation may be required on all slopes if sand is blown at a significant rate from the bare dunes.

The area of sand to be stabilised will be approximately 14 ha per month, at the normal speed of dredge operation. The typical width of the dredge path will be 240 m, although this will vary between 130 m and 270 m.

The dredge tailings will be shaped mostly by the tailings elevator into landforms that approximate the original dune landforms. Where necessary, the tailings may also be shaped mechanically.

Any soil or surface humic material present in the dune systems will be retained separately as the dredge passes through the dunes. This material will be replaced on the rehabilitated dunes, to offer a seed and nutrient source for replanting.

At the MSP site, disturbed areas will be stabilised with vegetation or other materials as soon as practicable after final surface preparation. The perimeter of buildings associated with the project will be planted with local plant species to establish a visual barrier and to assist in stabilising the area.

The revegetation program will require the successful establishment of a variety of plant species to ensure that the aims of site rehabilitation and closure planning are met. Plant types may include:

- Rapid growth species to ensure rapid stabilisation and colonisation of disturbed areas.
- Indigenous vegetation to ensure restoration of pre-mining indigenous and protected vegetation.
- Species of agricultural or cultural significance.

There are two main existing types of vegetation cover that may be recreated by revegetation:

- Plantations of exotic species such as filao (casuarinas) or eucalyptus. These fast-growing species have been successfully established on the dunes in the Projet de Reboisement de la zone du Littoral (PRL) and could be expected to provide stabilising vegetation in a relatively short period of time. However, these species do not encourage local biodiversity, as they inhibit understorey development. In addition, eucalypts consume significant quantities of water to sustain their rapid growth. This rate of water consumption could be detrimental to the availability of groundwater for other uses. However, hundreds of hectares are now being actively planted by the Forestry Department using locally cultured eucalyptus.
- Revegetation with native species may provide a more sustainable alternative if local forest fruit species (Parinari, Aphania, Chrysobalanus), fodder species, species of pharmaceutical interest and species capable of fertilising the soil (*Acacia (Faidherbia) albida*) could be planted. Local pioneer species (such as acacias) need to be identified for initial planting to assist in dune stabilisation and soil improvement.

Native and plantation plant production will be undertaken at either a nursery established for the purpose at the mineral separation plant site or via a partnership with the community and/or the Forestry Department's nursery at Lompoul.

GCO will develop a Rehabilitation and Closure Plan and release criteria in consultation with appropriate government and community organisations.

Further details of the revegetation strategy are provided in Section 11.4 of the ESMMP (Appendix 2.1).

5.6.6 Mine Path Tailings

As the dredge mines through the sand dunes, the heavy minerals are separated into a concentrate stream that is pumped to the mineral separation plant (MSP) via a pipeline. Approximately 2% of the sand mass will be removed as concentrate, leaving approximately 98% of the original sand mass to be restacked as tailings behind the dredge. Tailings minerals are predominantly quartz sand, which is inert. A minor amount of humic material occurs as lenses within the sand body. Mining of humic materials from below the water table may lead to oxidation of organic sulphur and generation of acid in the tailings following mining (see Section 5.6.1.4).

An acid-sulphate soil contingency management plan will be developed prior to mining if tests indicate there is potential for acid generation. Further details of this strategy are provided in Section 6.4 of the ESMMP (Appendix 2.1).

The tailings produced by the wet plant at the mine site will be returned directly by high-pressure pumping to re-form the dune system behind the plant, to approximate the former topography. A detailed topographic plan of the mine path is available to guide post-mining landforms. Groundwater entrained in the tailings will gradually percolate downwards to the groundwater table.

Revegetation will be undertaken on those mined areas that were vegetated prior to mining (see Section 5.6.5.3). Where dunes were stable and not subject to significant erosion prior to mining, dune stabilisation measures will be established to reduce wind erosion of the mined dunes, prior to revegetation. According to the EIS no stabilisation measures are required to be carried out on dunes that were bare and inherently unstable prior to mining.

5.6.7 Mineral Separation Plant Tailings

A single heavy mineral concentrate (HMC) stream will be produced at the mine site, containing zircon, rutile, leucoxene, ilmenite and extremely small volumes of monazite and other minerals. The HMC will be pumped to the mineral separation plant (MSP), where it will be separated into two fractions at the WHIMS (wet high-intensity magnetic separation) module: a magnetic (‘mags’) fraction and a non-magnetic (‘non-mags’) fraction. The mags concentrate is predominantly ilmenite, which will be stockpiled adjacent to the MSP site and batch processed. Approximately 575,000 tpa of ilmenite will be produced from this concentrate.

Processing of the non-magnetic mineral concentrate (containing rutile and zircon) at the MSP will produce approximately 90,000 tpa of tailings, which will be pumped continuously back to the current dredge location and incorporated in the re-formed dunes as a tailings stream. Continuous return of the tailings stream will avoid stockpiling of tailings at the MSP site.

All mineral sands are considered to be naturally occurring radioactive materials (NORM), due to the presence of thorium and uranium in the mineral grains. As a rule, the elements of the ^{232}Th and ^{238}U decay chains are present in the minerals in a state of secular equilibrium (Calytrix Consulting 2008). Analyses of the radioactivity of tailings produced at the MSP will be conducted to establish likely dose rates for workers exposed to the tailings. Those process streams considered as having the potential for exceeding the recommended dose limits will be shielded for protection and personnel working in those locations will be required to wear a personal radiation exposure badge to measure their annual exposure rate. Exposure is expected to be negligible, given that tailings will not be stored at the MSP but will be pumped back continuously to the mine site for incorporation in the re-formed dunes. The discharge line at the mine will be configured to ensure that the rejects are intermixed with tailings from the wet concentrator modules. This will result in all tailings being returned to the mined sand dunes and deposited in a manner that ensures that there is no detectable change in background radiation levels at the ground surface (See Section 6.4.2 of Volume 2, Appendix 2.1).

Dust suppression measures will be implemented whenever necessary in the MSP to minimise inhalation of tailings or products. Further details on radiation exposure monitoring are provided in Section 18.4 of the ESMMP (Appendix 2.1).

5.6.8 Noise

Noise emissions are expected to be generated during both construction and operation phases of the GCP. Construction of the initial mine site, dredge and MSP will involve power generation and operation of graders, bulldozers, trucks, cranes and other vehicles. Transport of materials and equipment to the construction sites will be through several villages north of Darou Khoudoss.

Operation of the GCP will involve power generation at the MSP site, operation of the MSP (which will include front-end loaders, conveyors, pumps, vibrating tables, etc.), pipeline transport of concentrate from the mine site to the MSP, pipeline transport of tailings back to the mine site from the MSP, transport of mineral products to Dakar via road and railway, operation of the dredge, and transport of supplies and equipment to the MSP site.

The MSP and associated power plant will be constructed approximately 1.3 km east-south-east of Diogo (Figure 2.1), while the initial mine site will be constructed approximately 2 km north-west of Diogo. The closest dwelling to the proposed power plant is 1.25 km away, on the outskirts of Diogo village. The closest dwelling to the proposed dredge construction site is a farming labour camp, some 780 m away to the south (Figure 4.1).

It is anticipated that the distance from the power plant to the closest dwelling will not change during the project. The MSP site is not expected to attract settlement close by as there is no water supply on this sand dune area. The MSP site will be fenced and security will be provided. GCO will maintain close liaison with the village chief and the sous prefect in regard to dealing with the possibility of people settling close to the MSP site.

Noise emissions will be managed to meet established site-specific environmental noise quality objectives. Article R84 of the Environment Code's Application Decree states that maximum noise levels should be 55 decibels during the day and 40 decibels during the night at the nearest residential receiver.

After commissioning of the MSP and in conjunction with consultation with all relevant stakeholders per the EMS, a noise model may be developed to determine what, if any, additional noise control measures are required to ensure compliance with the Environment Code noise levels

In accordance with the noise assessments, the following noise control measures may need to be implemented to reduce noise emissions from the sites:

- Noise generated from reversing alarms may need to be regulated to reduce intrusiveness, particularly at night. For example, alarms may be set at 10 dB(A) above the ambient noise level.
- If necessary, vehicles operating at the MSP may be fitted with smart reversing alarms rather than tonal reversing alarms.

- Where appropriate, sound barriers, such as bund walls, will be used to minimise noise transmission from operational areas.
- Temporary acoustic shielding may be necessary to shield machinery noise during construction of the initial mine site and MSP.

The following steps will be taken to minimise noise emissions from mine traffic:

- Truck exhaust systems will be maintained regularly to minimise noise.
- Exhaust braking within the vicinity of villages will be limited.
- Truck movements through villages south of Diogo may be restricted to daylight hours to minimise potential noise impacts and avoid sleep disturbance. This may, however, cause greater traffic congestion and increased travel times and this measure will be reviewed once operations commence. It is likely that a parallel by-pass road will be constructed by GCO to provide an alternative transport route between the MSP site and Darou Khoudoss, thereby avoiding approximately 16 villages.

Construction of a dedicated road from the ICS rail head some 25 km south of the MSP is being considered and will provide an alternative system for transporting products to Dakar and for bringing fuel and other supplies to the MSP site. It will be essential for transporting the large volumes of ilmenite that will be produced annually. Noise generated during construction and operation of the road will be assessed prior to construction commencing so that noise attenuation strategies can be implemented where necessary.

Noise produced by the ongoing operation of the dredge may impact on residents living within close proximity to the proposed mine path. The potential for noise disturbance will be assessed once the sound power levels of all equipment on the dredge are known. GCO will develop a compensation assessment program and will provide temporary disturbance compensation if required.

5.6.9 Wind-blown Dust and Sand

Wind-blown dust and sand may be generated around the project site by moving machinery, such as truck movements and from strong winds blowing sand stockpiles and the worked dunes.

High levels of wind-blown dust and sand occur naturally in Senegal. Strong Harmattan winds frequently blow dust from the Sahara and sub-Saharan regions as far west as North America.

Generally, wind-blown dust and sand generated from the project will generate only a minor contribution to the overall levels of naturally occurring dust and sand in the region. However, where mining activities such as truck movements pass close to settlements, there is potential for locally generated dust to affect residents. In addition, sand blown from dunes that have been cleared prior to mining or newly re-formed following mining may potentially be blown by the wind until they are stabilised.

The GCP will minimise nuisance from wind-blown dust and sand generated by the project, ensure the health and safety of the community and minimise impacts on the natural environment.

The two generally dominant wind directions in the Grande Côte are north-easterlies during November to April and westerlies/north-westerlies from May to October. The north-easterlies may bring fine dust from the Sahara. Winds capable of moving larger sand particles can be experienced at any time of year but are more likely during the dry season from January to April.

The potential for dust generation will be reduced during the wet season from July to October. However, dust generation may be a significant issue during the dry season, when dust suppression on haul roads and gravel transport routes may be required.

The zircon product from the MSP will be loaded into containers and transported along existing roads to the port at Dakar. Most of these roads are sealed, so will generate little dust. Ilmenite product will be transported by rail rather than by road. If required, a magnetic concentrate stockpile will be located in a swale between dune ridges to reduce exposure to high winds. A sprinkler system (if required) will be installed to minimise entrainment during high wind speeds.

The mitigation measures to be used to reduce dust generated by road transport include low-speed driving in villages with unsealed roads; possible use of a water truck and dust suppressants on unsealed roads; and the construction of specific access tracks to project sites to avoid multiple tracks being used.

The sand dunes will be cleared prior to mining to allow the dredge to work. The extent of this clearance will be kept to a minimum to reduce the potential for wind-blown sand being entrained.

Following the passage of the dredge, the dunes will be re-formed and revegetated, if appropriate (if vegetated prior to mining), as soon as practicable (see Section 5.6.5).

Any concentrate stockpiles will be kept damp using spray systems, to reduce the potential for the wind to blow material from the stockpiles. Product stockpiles at the MSP will be stored undercover and will not be exposed to winds. Products (other than ilmenite) awaiting shipment at the port of Dakar will be stored in shipping containers to avoid dust being generated. Ilmenite will be stored undercover at the port in a bulk materials despatch warehouse, where it will be protected from wind.

5.6.10 Air Quality

The air quality objectives for the GCP are to prevent dust nuisance, ensure the health and safety of the community and minimise impacts on the natural environment.

Dust and exhaust emissions will be generated during construction and operation of the GCP, through transport along unsealed roads, clearing of vegetation prior to construction and mining, and excavation of sand for the initial mine construction. The potential for dust generation as discussed in Section 5.6.9 will be reduced during the wet season from July to October.

Engine exhaust emissions from plant and equipment are the other main source of air pollution from the GCP. These emissions will be monitored to ensure that they meet Senegal standards for air quality. Emissions of sulphur dioxide from the power station will be dependent on the composition of the heavy fuel oil or natural gas provided by suppliers. Emissions monitoring will be undertaken and an air dispersion model generated (if necessary) to determine whether there is likely to be any impact on nearby communities and the need for mitigation measures as a result of liquid fuel sulphur content.

5.6.11 General Waste Management

Waste will be generated at the GCP from exploration, construction, mining and mineral processing operations, maintenance, administration, procurement of supplies and equipment and general maintenance and operation. The main waste sources are listed in Table 5.4.

Table 5.4 Sources of Waste Materials Generated at GCP Site

Type of Waste	Source
Food scraps	Kitchens and mess halls
Hard plastics	Storage containers for foodstuffs, reagents and other supplies Other hard plastics including mouldings and equipment from various sources Storerooms, stock-yards, MSP, laboratory and the mess hall are the primary sources of hard plastics
Vegetation	Clearing for construction sites and mining activities includes: MSP site; dredge construction site; mine path; and access and service roads Vegetation from garden maintenance around MSP site and project areas
Glass	Storage containers for foodstuffs, reagents and other supplies Glass off-cuts from construction activities Broken windows from buildings and vehicles Storerooms, stock-yards, MSP, laboratory and the mess hall are the primary sources of glass
Metal	Metal off-cuts from construction activities including roofing, framing, etc. Storage containers for foodstuffs, reagents, fuel and other supplies, e.g. paint tins, fuel and oil drums Used drill rods and bits from exploration activities Used and damaged vehicles and vehicle parts
Processed timber	Maintenance workshops, storerooms and supply yards (packaging, pallets, crates/boxes, etc.) and as off-cuts from construction activities
Paper and cardboard	Waste paper produced from office activities Cardboard packaging for foodstuffs, reagents and other supplies. Storerooms, stock-yards and the mess hall are the primary sources of cardboard.
Tyres	Vehicles used on site, particularly haulage trucks and construction vehicles
Other non-hazardous materials	Various soft plastics, cellophane, foam, sponge and rubber. These materials are primarily used for food packaging, reagents, equipment and spare parts. The mess hall, storerooms and stock-yards are the primary sources of such material.
Hazardous materials	Batteries and dry cells Some laboratory wastes Medical wastes, including sharps, bandages, etc. Contaminated packaging material, contaminated safety gear, rags, etc. and contaminated soils and apparatus employed in clean up of a spill, e.g. absorbent mats/blankets, temporary bunds Tailings may be hazardous, depending on their level of radioactivity.
Sewage and grey water	Toilet facilities and showers, mess hall and laundry
Process wastewater	Process water from MSP and tailings stockpile Run-off from the process plant area resulting from: spills outside primary bunds, vehicle wash-bays, wash-down of process plant and machinery and precipitation
Fuels and degraded/spent oils	Fuel spilt outside bunded areas, hydraulic fluids, lubricating hydrocarbons, filters and absorbents, waste grease

Waste, particularly hazardous waste and sewage, that is not collected or is not properly disposed of, may have adverse effects on human and environmental health, unless appropriate management measures are implemented.

The waste management approach recommended is: reduce, re-use, recycle, and finally dispose. For example, waste production will be reduced by procuring supplies that produce less waste because of the way they are packaged or consumed; and installing equipment that minimises energy and water consumption and thereby produces less waste.

Recycling and re-use will be practised wherever possible. Although recycling and re-use opportunities are relatively limited in Senegal, scrap metal, timber and used oils and lubricants can all be recycled and/or re-used, these practices/processes have been established at MDL's Sabodala operation.

Any non-hazardous waste that cannot be re-used or recycled will be disposed of to an appropriate landfill facility established on site.

Hazardous waste disposal will be completed in a manner that minimises any long-term risk to employees, contractors, the local community and the environment. GCO will return hazardous waste items to the suppliers where possible. If on-site hazardous waste disposal is unavoidable, it will be completed in accordance with relevant material data safety sheets. If hazardous waste requires burial, it will be in a specifically designated landfill, constructed with a synthetic or compacted basal clay liner to minimise the long-term risk of contaminant escape.

All waste management facilities, both active and decommissioned, will be marked on project site maps to assist with site rehabilitation and closure planning. The maps will identify the area, volume and type of waste stored in each facility and will include facilities developed during exploration and construction as well as operation phases of the GCP. Further details on landfill sites are provided in the ESMMP (Section 8.5.1) (Appendix 2.1).

5.6.12 Hazardous Materials Management

Oil and hydrocarbons (e.g. heavy fuel oil, diesel, lubricants, and grease) are the only hazardous materials expected to be present on site. These materials are potential pollutants for the local soils and groundwater and require effective management to limit the possibility of spills or systemic leakage.

Hydrocarbons will be stored in tanks located in bunded, impermeable storage areas capable of containing 110% of the volume of the largest storage tank. Regular audits of hydrocarbon use and storage will be conducted to detect any unseen leakage. Operators will be trained in the appropriate handling, storage and use of hydrocarbons and provided with appropriate personal protective equipment. Vehicle maintenance bays, equipment lay-down areas and refuelling stations will be constructed on impervious surfaces and any potentially oily run-off from these areas will be contained by perimeter bunding or interception drains. Oily wastes will be removed from site and destroyed in accordance with applicable world standards as part of the fuel and lubricant contract for the site. This is currently the practice at MDL's other operation in Senegal.

5.6.13 Radiation

The radioactive elements, uranium and thorium can occur within the crystalline structure of heavy minerals such as zircon, rutile, ilmenite and monazite. The presence of these radioactive elements results in naturally occurring radioactivity, with levels depending on the quantity of radioactive elements present in the minerals.

When heavy minerals are distributed through the sand mass, the radiation they produce is considered to be at or below background levels. However, when the minerals are concentrated, their total radiation may reach levels that require management controls.

Analyses of Senegal zircon indicate that levels of its radioactive elements are comparable with other key producers in the world market (Table 5.5).

Table 5.5 Composition of Zircon Minerals

Company – Deposit	Zircon Grade	Uranium + Thorium (ppm)
GCO – Senegal[1]	Premium	281
	Foundry	481
Iluka - Eneabba, Western Australia[2]	Premium	440
Richards Bay Minerals - South Africa[2]	Prime	450
Namakwa – South Africa[2]	Premium	410
DuPont – Florida[2]	Premium	350
	Standard	350
CRL[2]	Premium	460

Sources: [1]Downer EDI (2009) [2]MDL (2006).

Analysis in 2006 by the Australian Nuclear Science and Technology Organisation (ANSTO) of Grande Côte zircon, rutile, leucoxene and ilmenite products showed low levels of radioactivity (<35 Bq/g) (ANSTO 2006). Two tailings samples (which will be produced by the MSP) assayed at <100 Bq/g radioactivity.

Material with radioactivity in excess of 100 Bq/g is considered radioactive (NSW Radiation Control Regulation 2003). Consequently, none of the mineral products or tailings assayed by ANSTO in 2006 is considered to be radioactive. GCO will request ANSTO to analyse the radioactivity of future product samples when these become available from test work being conducted by Downer EDI.

If the head-of-chain uranium or thorium activity concentration is less than 1 Bq/g in a mineral concentrate, then it is considered inherently safe (International Atomic Energy Agency 2004). ANSTO's results show that the rutile and ilmenite products have less than 1 Bq/g of radioactivity from head-of-chain uranium or thorium, and are therefore considered inherently safe. However, the zircon and leucoxene products and the tailings all have head-of-chain uranium or thorium radioactivity in excess of 1 Bq/g. Workers exposed to these materials will be required to wear dose recording badges as part of their personal protective clothing as is standard practice in all operations of this nature.

5.6.13.1 Strategy

The *Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing* (ARPANSA 2005) generally applies to mining operations where doses to workers are expected to exceed the public limit of 1 millisievert (mSv) pa, and doses to the critical group are likely to exceed some tens of microsieverts (µSv). The International Commission for Radiological Protection (ICRP) recommends that the additional dose above natural background and excluding medical exposure should be limited to 20 mSv pa averaged over five consecutive calendar years for radiation workers who are required to work under closely monitored conditions.

As a precautionary measure, workers in the mineral separation plant who are routinely exposed to potentially radioactive mineral products will be required to wear a badge that monitors their exposure to radiation. The badges will be assessed every three months and records of employees' exposure to radiation will be kept readily available for five years. After five years, the employee radiation exposure records will be archived in a secure location for a further 25 years, as these records need to be held for a minimum of 30 years.

Following future analyses of products and waste streams, GCO will develop radiation management plans to ensure that appropriate measures are taken to protect the health and safety of employees and visitors to the project facilities.

5.6.14 Transport and Traffic Safety

Transport of materials from Dakar to the dredge and MSP construction sites, will be via Thiès and Tivaouane, along 100 km of sealed road followed by approximately 25 km of recently bitumised road, which passes through several villages between Darou Khoudoss and Diogo (Figure 4.1). The same route will be used for truck transport of mineral products from the MSP to Dakar for export. Traffic associated with the GCP will increase the overall traffic volumes along these roads. The road through Diogo and nearby villages is often congested with traffic due to loading of market-garden produce onto trucks for transport to markets. In addition, local markets occur along the road, adding to traffic congestion.

In order to alleviate the traffic congestion and maintain a high level of safety for villagers, GCO is considering several options for transport associated with the construction and mining operations at Diogo, including: a bypass for Diogo and adjacent villages; provision of an off-road hardstand area for delivery of garden produce by carts and loading of trucks for transport to market; installation of speed humps; establishing signals; and raising awareness of villagers.

A site for the proposed hardstand area has been selected in consultation with the Diogo community. The ultimate choice of preferred transport options will depend on thorough analysis of the route and consultation with the affected community at Diogo.

Prior to the movement of special loads (e.g. oversize loads) along public roads, the relevant government authorities will be notified. All reasonable and practical measures required by the authorised government body will be implemented to minimise the risk of harm to the community and environment during transportation of special loads.

Hazardous materials such as hydrocarbons will be transported by a suitably licensed carrier, who will be responsible for management of risk associated with transport of hazardous materials; i.e. ownership transfer will occur at GCO's site. Furthermore, emergency response for spills or accidents during transport will be managed by the licensed carrier.

Access to the MSP site will be controlled by fencing and signage. All visitors to the MSP site will be directed by signage to the appropriate administration building for registration and site induction. Movement of mine vehicles and other traffic on the MSP site will be confined as far as practical to designated access roads. Movement of vehicles outside this network will be limited.

Movement of haulage trucks and other mine vehicles will be confined to a single designated access route between the mine site and the MSP. If the access route intersects tracks or roads used by the public, then signals will be installed and speed limits enforced to minimise the risk of accidents.

Rail transport will be established for ilmenite, by utilising the existing ICS rail spur some 25 km to the south of the MSP. This is essential for transporting the much higher volumes of ilmenite (up to 575,000 tpa compared to zircon (approximately 80,000 tpa). Rail transport will reduce the number of trucks transporting product to the Port of Dakar and may be used to transport liquid fuel (if used) to the MSP site. Any reduction in the number of trucks will alleviate potential dust and noise impacts associated with truck transport.

5.6.15 Biodiversity and Conservation

The GCP is located on sparsely vegetated and unvegetated sand dunes within the broader Niayes region, which has been the site of various revegetation or reforestation projects since the 1940s. These projects aim to stabilise dune sands and thereby to protect the niayes.

Approximately 50% of the project area consists mainly of savannah (native grassland with scattered and isolated shrubs and trees), while approximately 31% consists of plantations of filao (casuarinas) and eucalyptus. Approximately 17% of the project area consists of active dunes and the remaining 2% consists of gardens and habitation areas (data from Earth Systems 2007).

Native vegetation is used by local communities to provide foraging for stock, while plantations and native shrubs and trees are sources of wood for fuel and construction purposes. Some native trees, such as cashews and *Parinari macrophylla*, provide forest fruits for human consumption.

Eleven threatened flora species and eight endemic flora species have been identified in the mining concession area (Tropica 2005). However, detailed vegetation surveys have yet to be conducted on areas affected by the project to determine whether or not threatened flora species will be disturbed by the project. If such species are present in the areas affected by project operations, the Rehabilitation and Closure Plan will include provisions for re-establishing such species.

The Niayes area is considered poor in wildlife, especially terrestrial animals. The only endangered species recorded for the area are marine turtles, which use the beaches of the Grande Côte for nesting. No mining will take place in their nesting habitat.

Activities associated with the GCP have the potential to have adverse impacts on biodiversity through: clearing of vegetation, possible loss of fauna habitat, possible loss of individual protected flora species, possible exclusion of better-adapted local flora species from the revegetation program, and possible introduction and spread of weeds.

GCO is committed to protecting and managing the existing environment to help prevent further species degradation. This will be achieved through effective planning and management of site activities. GCO will strive to support and encourage activities aimed at increasing biodiversity within the region.

Where possible, GCO will locate infrastructure (including roads) away from potential areas of conservation value to ensure that overall impacts to vegetation and fauna habitat are minimised. GCO will work with the GRS to develop an appropriate management strategy for protecting any threatened flora species living within the GCP area. Vegetation clearing will be kept to the minimum required for efficient GCP operations. Where protected species and established trees are identified, GCO will endeavour to divert works (such as roads) to other areas that will have lower impact. However, this will not be possible on the MSP site, dredge construction site or the dredge path. In these areas, re-establishing protected species will be part of the Rehabilitation and Closure Plan, where required.

To reduce the possibility of collisions with wildlife during transport operations, GCO will limit vehicle speeds and night-time traffic.

5.6.16 Archaeology and Cultural Heritage

The only known cultural heritage material mapped within the mining concession area, is a "shelly heap". It occurs close to the coast in the approximate vicinity of Fass Boye (Tropica 2005). This site is outside the proposed mining area but its occurrence raises the possibility of chance finds of archaeological material during the dredging operation. The possibility of finding cultural heritage material was raised during community consultation for the EIES.

GCO will develop a chance find procedure (CFP) to deal appropriately with any cultural heritage material that may be discovered during the dredging operation. The CFP will comply with both GRS and international guidelines and will outline the procedure for dealing with any cultural heritage material found during the mining operation.

5.6.17 Energy and Emissions

Senegal is a party to the Kyoto Protocol, which came into force in Senegal on 16 February 2005. Senegal does not have binding emission reduction targets for the first period (2008–2012) of the Kyoto Protocol because it is a Non-Annex I country.

Under the Kyoto Protocol, Non-Annex I countries are currently not allowed to participate in the international emission trading market. However, under Kyoto mechanisms they can benefit from the participation in Clean Development Mechanism (CDM) projects (either bilaterally, with a participating Annex I country, or unilaterally with participation of only Non-Annex I countries).

Greenhouse gas (GHG) emissions from the proposed power station will be approximately 90,000 t CO_2-equivalent (CO_2e pa if heavy fuel oil is used or approximately 66,000 t CO_2e if natural gas is used. If the project produces more than 100,000 t CO_2e pa, then annual quantification and monitoring of greenhouse gas emissions may be necessary if the intent is to satisfy IFC Performance Standard 3, Clauses 10 and 11.

A secondary source of GHG emissions is the short-term clearing of vegetation for the purposes of dredging. This is expected to add less than 1,500 t of CO_2e pa to the emissions profile of the project. However, emissions from vegetation clearance will be offset by CO_2 sequestered by revegetation of the dunes, which will replace any vegetation removed prior to dredging.

The GHG emissions expected to be produced by the project will be refined following final design of the power generation plant. When the vegetation clearance and revegetation schemes are more fully developed, the amount of CO_2e likely to be released then sequestered by the vegetation will be assessed.

If the net CO_2e emissions are likely to be less than 100,000 tpa, then no reporting of GHG emissions will be undertaken.

The installation of a natural gas compatible power station also provides opportunity for utilisation of a local energy source with the added benefit of potential carbon credits under the clean development mechanism (CDM).

5.6.18 Visual Aspects

The mineral separation plant, power station and associated buildings will be constructed approximately 1.3 km east-south-east of the closest dwellings belonging to Diogo village. The buildings will be partly obscured by topography but some parts are likely to be visible from the village. Vegetation may be planted as a visual screen around the buildings. Community consultation indicates it is likely that these new buildings will cause little concern for most of the community, because they see the potential employment of the development as a positive opportunity.

The potential visual impact of night lighting for the mineral separation plant will be minimised by using directional lighting and installing lights according to Australian Standards. Lighting on the dredge will be hidden from direct view by the sand dunes surrounding the dredge site.

5.6.19 Cumulative Impact Assessment

A cumulative impact on the environment is one that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Issues with potential to have a cumulative impact due to the GCP are groundwater quality and quantity, noise, dust generation, and vegetation clearing. All these issues are important to the local communities who: depend on availability of groundwater for drinking water, irrigation and stock watering; currently enjoy rural noise levels; are at risk of suffering pulmonary diseases through increased dust generation; and depend on access to vegetation for fodder, fuel and timber. In addition, the clearing of vegetation from the dunes may increase the rate of dune migration onto arable land and may lead to an increase in the rate of disappearance of endemic flora species.

The closest industrial development to the proposed GCP is the phosphate mine and chemical works run by the Industries Chimiques du Senegal (ICS) at Taiba, approximately 20 km south of the MSP site. Land use surrounding the GCP is dominantly agrarian, with market gardening the primary income-producing activity and animal husbandry an important adjunct.

Cumulative impacts on groundwater quality may result from the use of agrochemicals and fertilisers as part of the revegetation program for mined areas of the GCP, from the discharge of treated sewage from the construction camp, from the disposal of general waste, and from the storage and use of hydrocarbons at the MSP. The quantities of fertiliser and agrochemicals used during revegetation will be monitored so that only those amounts directly utilised by the plants will be applied.

The sewage treatment system will be monitored to ensure that water discharged from the system meets wastewater discharge regulations. Waste materials will be disposed of in a waste disposal facility lined with laterite or equivalent impermeable material to minimise the possibility of groundwater pollution. Hydrocarbons will be stored in tanks in impermeable bunded areas and training in handling and spill prevention and control will be provided to relevant personnel to minimise accidental discharge. A monitoring bore will be installed adjacent to the fuel storage facility to monitor hydrocarbons in groundwater. A comprehensive groundwater monitoring program will be conducted during the mining operation to monitor any changes to groundwater quality, particularly around the dredge path.

Since the 1970s, rainfall to recharge the sand sheet aquifer has been lower than the previous 30 years. In the Niayes region, the groundwater table has declined over this period, probably largely due to reduced rainfall, but also partly due to increased usage by local farmers and communities. Since April 2006, baseline monitoring of the groundwater table has been conducted at numerous piezometers installed by GCO as part of the exploration drilling program for the GCP. In some areas, these monthly monitoring results indicate an average decline of approximately 0.20 m pa in the groundwater table, apparently the result of usage, evaporation and losses from the sand sheet aquifer not being totally replenished by infiltration following rainfall.

In order to minimise the cumulative impact of the GCP on the groundwater table in the sand sheet aquifer, most of water required for the project will be drawn from the deeper Maestrichtian aquifer, which is not connected to the surficial sand sheet aquifer. The Department of Management and Planning of Water Resources (Division de gestion et de planification des resources en eaux [DGPRE]) has modelled the groundwater resource in the Maestrichtian aquifer, on behalf of the national water company, to determine sustainable extraction rates. GCO has applied for a licence to pump from this aquifer and the application will be considered with regard to the model.

Mining the dune sands may redistribute any fines in the sequence and may alter the hydraulic properties (permeability, storage coefficient, transmissivity) of the sand sheet aquifer. Hydraulic properties will be investigated pre- and post-mining to detect any changes. If necessary, a new appropriate discharge limit for the sand sheet aquifer will be calculated and the DGPRE will be informed. Modelling of water requirements for the mining operation is being undertaken to understand the potential effects of the mining operation on the local groundwater table and to quantify the volume of make-up water required to maintain the local groundwater table.

The cumulative impact of noise from the GCP will be assessed as part of the noise assessment to be undertaken for the GCP. Appropriate mitigation strategies will be employed to ensure that noise level regulations at the nearest residence are met.

Strategies to reduce dust generation from traffic associated with the project will be implemented to reduce the possible cumulative impact of dust on the health of local communities along the unsealed sections of the transport route. The strategies may include watering of the road surface or use of non-toxic chemical dust suppressants. It is likely that a bypass road will be constructed for approximately 25 km from the MSP to avoid several villages along this section of the transport route.

The potential cumulative impact on vegetation of clearing for mining was discussed in the EIES (Tropica 2005), and mitigation strategies proposed to address potential adverse effects. These strategies included: mapping of vegetation pre-mining and identification of mature trees and rare species that might be avoided rather than removed; using existing tracks and roads wherever possible; when necessary, designing a single access track to minimise clearing and avoid established vegetation wherever possible; where required, developing and implementing a logging plan for equitable distribution of felled timber to local communities; developing a Rehabilitation and Closure Plan with seed collection, nursery establishment, timely planting and maintenance schedules; revegetating areas cleared for mining with local species; marking the area to be cleared and raising awareness about illegal clearing; raising awareness about rare and endemic species; and revegetating the perimeter of the MSP buildings.

The revegetation strategy aims to revegetate areas that were vegetated prior to being cleared for mining in a manner that minimises dune sand movement and re-establishes vegetation as quickly as possible, given the constraints of seasonally available rainfall. When selecting species for the revegetation program, consideration will be given to their rate of growth and their water consumption, as well as their provenance.

5.6.20 Rehabilitation and Closure

Rehabilitation and closure of the mine site will take place in two stages.

1. As the dredge progresses through the sand dunes, the landscape will be re-formed and revegetated behind it. This is ongoing closure.
2. When the dredge has finished working in the project area a program of activities for final closure will be undertaken.

Mine closure objectives for the GCP include:

- Landscape restored to be stable, compatible with surrounding landforms and similar to pre-mining topography, unless otherwise agreed with authorities.
- Vegetation re-established on those dunes that were vegetated pre-mining.
- All buildings, plant and infrastructure dismantled and removed unless otherwise agreed with authorities.
- Effects of mining on groundwater levels and quality monitored to quantify any adverse effects and provide guidance for remedial activities, if required.
- Any potential soil contamination investigated and remediated if necessary.
- Satisfactory completion of agreements with land users affected by or displaced by the mining operation.

The process of ongoing closure mainly involves re-formation of landforms and revegetation of sand dunes where there was vegetation pre-mining. These processes are described in Sections 5.6.6 and 5.6.5 respectively.

The activities to be undertaken for final closure include:

- Decommissioning, disassembling and removing the dredge, the mineral processing plant, the power generation plant, fuel storage facility, power lines, pipelines and pumping stations, water bores and other facilities, unless agreed otherwise with authorities.
- Rehabilitating sites previously used for project buildings and infrastructure.
- Rehabilitating the final dredge pond by infilling with sand from adjacent dunes or by creating a permanent wetland, with the final land use to be determined in consultation with authorities.
- Revegetating the areas disturbed by the mining project with similar vegetation to that which existed prior to mining, to achieve rehabilitation release criteria as agreed with authorities.
- Conducting a program of environmental monitoring during the decommissioning phase and for a period of time post-mining as agreed with authorities.

Preliminary criteria for mine closure will be determined in consultation with stakeholders as part of the Conceptual Closure Plan, which will be developed prior to construction of the GCP. The Conceptual Closure Plan will take into account the economic, social and environmental factors of the mining operation to ensure that GCO meets statutory requirements, provides a sustainable post-mining land use and ultimately achieves successful relinquishment of security bonds and mining leases.

5.7 Social Issues and Mitigation Measures

5.7.1 Land Use

The principal land use activities within the project area include horticulture, agro-pastoralism, and timber forest-product harvesting. Horticulture is practised in the dune depressions where groundwater is more readily accessible for irrigation. Land use within the proposed mining area and buffer zone is presented in Figures 5.2 and 5.3.

The Niayes, located on the eastern side of the dunes in the hinterland areas, are characterised by shallow basins, near-surface groundwater and soils often rich in humus and peaty sediments favourable for a wide range of horticultural crops (Touré and Seck 2005). Due to their rarity and the favourable nature of their soils, the Niayes are densely occupied. Some of the agricultural areas on the littoral dunes, which are also in depressions, are more marginal, often being further from the groundwater table and having less organic material in the soil.

Impacts on land use will primarily be associated with the disturbance of land for mining activities within the proposed dredge path and buffer zone. Key potential impacts of land loss include livelihood and nutrition impacts from the loss of agricultural production, impacts on access to agricultural land and community land, loss of local community timber and non-timber.

Under the current 10-year mine plan, the GCP has the potential to directly impact approximately 1,967 ha of land within the proposed mining area, including 907 ha of herbaceous, scrub and woodland, 944 ha of revegetated dune areas and 116 ha of agricultural land (Table 5.6; Appendix 2.6).

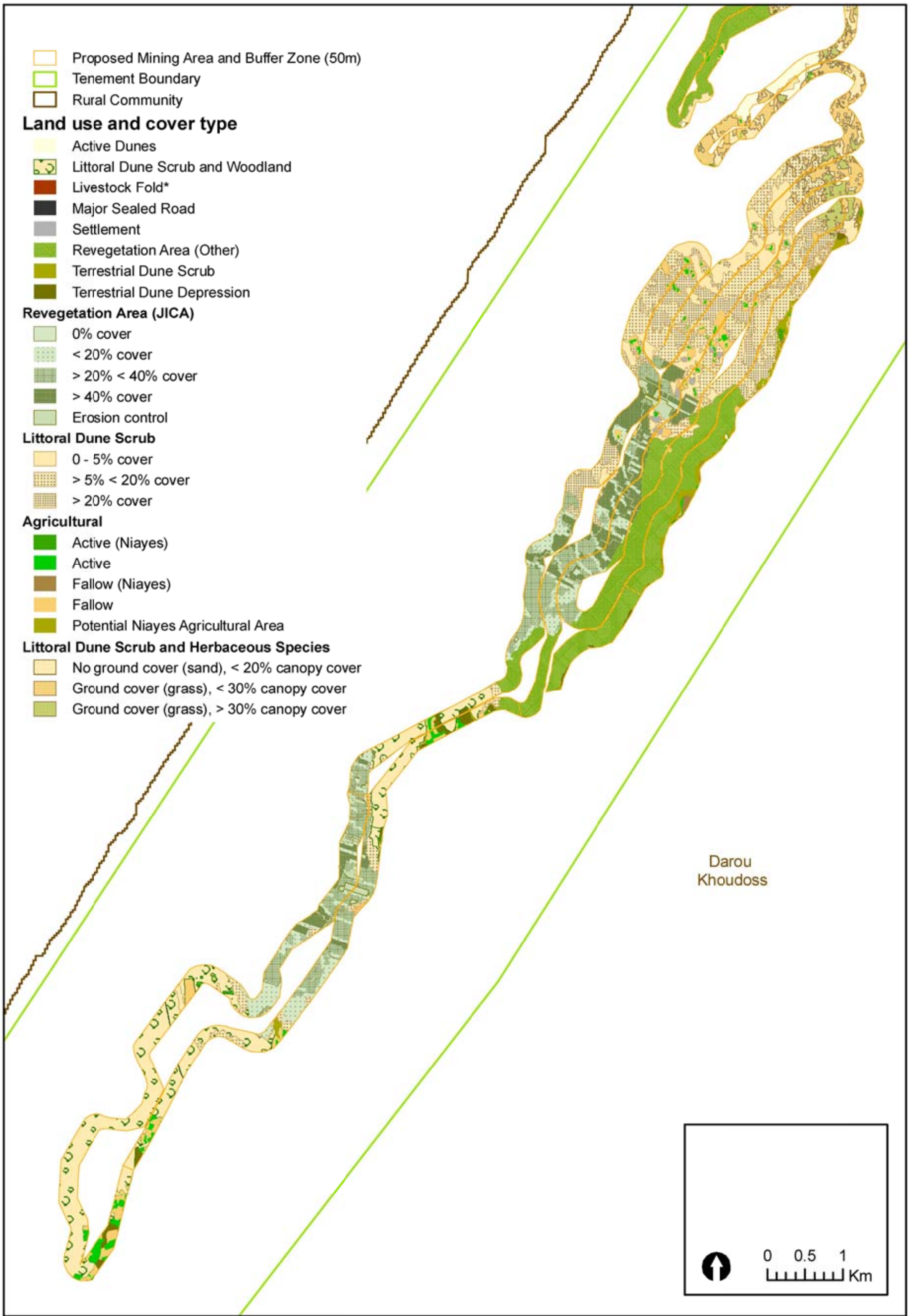
A further 589 ha will potentially be impacted within the 50 m buffer zone, including 282 ha of herbaceous, scrub and woodland, 253 ha of revegetated dune areas and 54 ha of agricultural land (Table 5.6; Appendix 2.6).

The extent to which agricultural areas are likely to be favourably or adversely impacted by potentially elevated groundwater levels associated with dredging activities is still to be fully confirmed by GCO. Agricultural areas likely to be most at risk include the niayes adjoining the littoral dune located along the eastern edge of the dredge path.

Settlements that will experience the most significant land loss will be those located inside the proposed dredge path, including those belonging to Diogo, Foth, Diourmel, and Thiakmat. There is also potential for impact to hinterland and coastal settlements who own land assets located inside the project area.

An assessment of land and assets that will potentially be affected by the positioning of other project facilities (e.g. proposed roads and railway) will need to be undertaken prior to construction.

Direct impacts on land loss will require mitigation through measures such as providing compensation for or replacement of agricultural land, maximising local employment and alternative livelihood development activities. Extensive stakeholder consultation will be required to develop suitable compensation and replacement land options. Options may include replacement land on the littoral dune or in the hinterland areas.

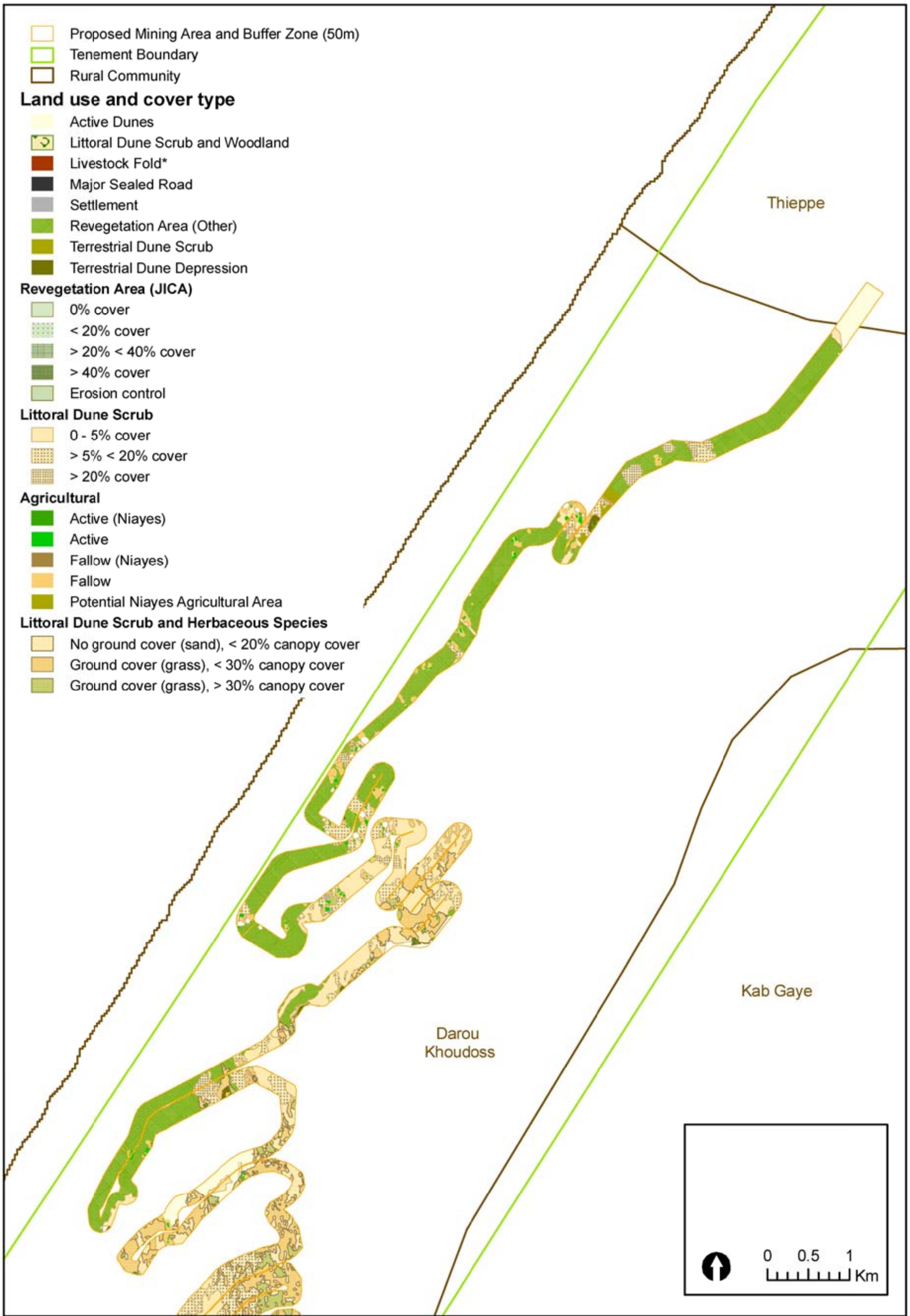


Note: Livestock "folds" on the littoral dunes are temporary in nature. Animal management practices are usually integrated with agricultural systems

FIGURE 5.2

Land Use and Vegetation Cover for the Proposed Mining Area and Buffer Zone for Years 1 to 7 of Mining

Source: Earth Systems Pty Ltd, Melbourne (2010)



Note: Livestock "folds" on the littoral dunes are temporary in nature. Animal management practices are usually integrated with agricultural systems

FIGURE 5.3

Land Use and Vegetation Cover for the Proposed Mining Area and Buffer Zone for Years 8 to 10 of Mining

Source: Earth Systems Pty Ltd, Melbourne (2010)

Impacts on forest resource use will require mitigation through measures such as progressive rehabilitation of the proposed mining area and prohibition of collection of forest resources by project staff.

Table 5.6 Summary of land areas potentially disturbed by the proposed GCP*

Land Type	Proposed Mining Area	Buffer zone	Sub-total
Agricultural Land			
Active (Littoral Dune)	33.9	18.6	**52.5**
Fallow (Littoral Dune)	86.3	32.3	**118.6**
Active (Niayes)	2.8	1.8	**4.6**
Fallow (Niayes)	3.8	2.8	**6.7**
Sub-total (agricultural land)	**126.8**	**55.5**	**182.3**
Pastoral Land			
Livestock fold**	0.05	0.02	**0.07**
Community Land			
Active Dunes	**39.3**	**16.2**	**55.5**
Littoral Dune Scrub and Herbaceous Species	**204.4**	**73.5**	**277.9**
Sand, <20% canopy cover	57.9	19.3	77.2
Ground cover (grass), <30% canopy cover	113.1	44.4	157.5
Ground cover (grass), >30% canopy cover	33.5	9.8	43.2
Littoral Dune Scrub and Woodland	**214.8**	**92.5**	**307.4**
Littoral Dune Scrub	**661.6**	**140.4**	**802.1**
0–5% cover	201.0	51.1	252.1
> 5% <20% cover	308.3	65.6	374.0
> 20% cover	152.3	23.7	176.0
Revegetation Area (JICA)	**381.1**	**84.2**	**465.3**
0% cover	30.4	5.4	35.9
<20% cover	98.9	26.7	125.6
>20% <40% cover	128.3	26.4	154.7
>40% cover	106.9	24.1	131.0
Erosion control	16.5	1.6	18.1
Revegetation Area (Other)	**563.1**	**169.4**	**732.5**
Terrestrial Dune Depression	**18.5**	**19.1**	**37.6**
Terrestrial Dune Scrub	**23.4**	**26.3**	**49.8**
Sub-total (community land)	**2106.3**	**621.6**	**2727.9**
Road			
Sealed Road	**0.4**	**0.2**	**0.6**
TOTAL	**2233.6**	**677.3**	**2910.9**

* Excludes settlement areas (see Section 3.1).

** Note that livestock "folds" on the littoral dunes are temporary in nature. Animal management practices are usually integrated with agricultural systems.

Development and implementation of a site-specific rehabilitation plan will also be a key management measure in restoring the productive value of lost agricultural land and forest resources.

There is likely to be negligible direct impact on land outside of the GCP development area assuming no adverse effects to groundwater resources, particularly in the Niayes adjacent to the proposed mine path.

5.7.2 Water Use

Hydrological modelling for the passage of the dredge past adjacent horticultural areas was completed by PSM Australia (2010) and is covered in detail in Volume 1, Section 8 Water Management and Hydrology.

Groundwater is of vital importance to the livelihood of the local communities and represents the principal source of water within the GCP development area. Groundwater, harvested from shallow wells, is used by settlements for agriculture, household consumption (e.g. washing, cooking, etc.) and stock watering (Figure 5.4). Groundwater is usually transported by hand to irrigate adjacent agricultural areas. Mechanically driven boreholes, varying in depth from a few metres to over 20 m can also be found in Niayes areas.

Household investment for a well or borehole (not common on littoral dunes) is typically in the order of 70,000 FCFA or 700,000 FCFA respectively.

Project development will result in the loss of approximately 609 community water sources located within the proposed mining area. A further 283 water sources will potentially be impacted within the buffer zone (Table 5.7; Appendix 2.6).

Other potential impacts on water resource use associated with the GCP include potential for changes in the availability of groundwater, risk of surface water and groundwater contamination, potential impacts of changes in groundwater levels on agricultural areas (particularly in the Niayes) and on the livelihoods of local communities within the GCP development area and in nearby areas.

Given the potential for significant impacts on water resource use and the critical importance of water resources in sustaining livelihoods of the local communities, minimising impacts on water quantity and quality will be a major objective of the GCP. Implementation of site-specific management and mitigation measures including installation of a series of groundwater monitoring bores, provision of alternative water sources and appropriate compensation where community assets are impacted are expected to minimise the potential impact of the GCP on groundwater and the livelihood of water users.

Project development may also result in potential benefits to local water users through the construction of new water resources associated with the GCP and through community development projects initiated by GCO. Water users in Diogo village are already benefiting from increased access to fresh water supply through the installation of a bore and windmill by GCO.

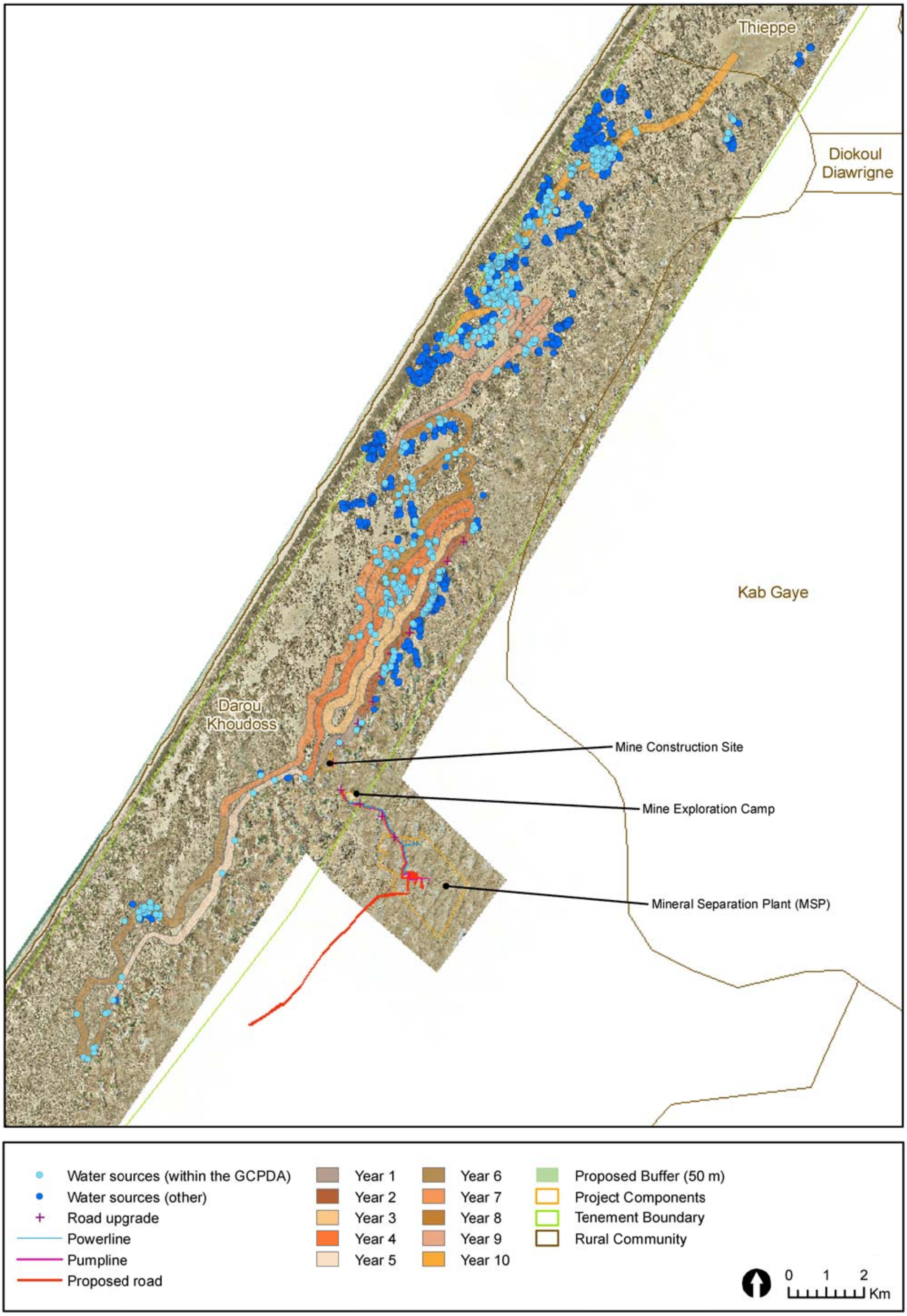


FIGURE 5.4

Water sources in the Grande Cote Project Area

Source: Earth Systems Pty Ltd, Melbourne (2010)

Table 5.7 Ground water infrastructure within the proposed mining area and buffer zone*

Settlement Cluster	Total No. of Water Sources	No. of Water Sources Inside Proposed Mining Area	% of Water Sources Inside Proposed Mining Area	No. of Water Sources Inside Buffer Zone	% of Water Sources Inside Buffer Zone
Foth^	272	77	28	46	17
Diogo hamlets^	35	25	71	8	23
Diourmel^	77	48	62	6	8
Darou Salam	N/A	1	N/A	1	N/A
DgV1	N/A	10	N/A	11	N/A
DiH24	N/A	2	N/A	2	N/A
DiH27	N/A	4	N/A	1	N/A
FoH2	N/A	3	N/A	1	N/A
FoH7	N/A	1	N/A	0	N/A
FoH11	N/A	3	N/A	0	N/A
FoH12	N/A	5	N/A	9	N/A
MB1	N/A	12	N/A	14	N/A
TiH01	N/A	5	N/A	0	N/A
Unknown	N/A	132	N/A	79	N/A
Total	**384**	**328**	**85**	**178**	**46**

* Based on 2007 baseline study data and field verification of key uncertainties identified from visual interpretation of 2009 aerial photography. Data presented includes wells, trenches and bores, but excludes cement holding basins.

^ Foth settlement cluster includes FoV1, FoH16, and FoH27 to 29. Diogo hamlets include DgH1 to DgH4. Diourmel hamlets include DiH14 to 20 and DiH30.

5.7.3 Economy and Employment

Households within the 2007 survey area are heavily reliant on cash income sourced from horticultural activities for the purchase of staple foods, supplementary foodstuffs, household items, and to manage emergencies such as medical expenses. Average annual household cash income for the settlement clusters on the littoral dune varied from 3M FCFA (~US$6,833) in Foth to 4.2M FCFA (~US$9,567) in Diourmel hamlets. There are few opportunities for inhabitants of the 2007 baseline study villages to be involved in any form of off-farm employment, with the exception of supply chain services for the horticultural sector (e.g. packaging, transportation and the supply of farming inputs). Lower-income households are large, have a greater number of dependants, and lack access to education.

Food, and in particular rice, represents the single most important cash expenditure item for rural households. After food, households devote the largest portion of income to farming inputs (seeds, fertilisers, pesticides, animal fodder); followed by clothing, medical treatment, and transport.

2007 baseline study information indicates that the attainment of education among the survey population is low, with approximately 29.5% of men and 45% of women within the proposed mining area and buffer zone describing themselves as being illiterate. There are also a limited number of residents with technical training. This could hinder the ability of local residents to achieve senior positions within the operation.

The GCP will be of benefit to the local community through the creation of economic and employment opportunities associated with both the project development and operation. Employment requirements for the GCP in the first instance will be associated with construction of the GCP and post this with permanent operations. Local communities are likely to benefit most from employment opportunities during the operations phase of the GCP as most of the construction workforce is likely to be sourced from Dakar or regional centres (e.g. Thiès). Operational roles in the area of rehabilitation are highly likely to provide scope for employment of local people, particularly those on the littoral dunes, given the skills available in this area.

Successful implementation of a preferential recruitment policy that favours those people whose land is directly impacted by the GCP, while maintaining established protocols re regional recruitment, will ensure that local residents are given priority and communities on the littoral dunes and in hinterland areas are considered equally.

As education, literacy and training levels improve over the life of the mine, it is likely that an increasing number of local workers will find themselves occupying more senior positions with the company. During final closure, employment opportunities will remain, although this is likely to be vastly reduced compared to the operational phase. However, the local workforce should then contain more skills, education and training with which to seek new opportunities.

The broad economic and employment impact is expected to be positive, although ensuring minimal impact on groundwater and agriculture as well as implementation of livelihood restoration measures will be important to ensuring that the GCP has a beneficial impact on local communities surrounding the GCP.

Monitoring of employment statistics and continuous consultation with local communities will ensure that the potential employment opportunities are realised and the preferential recruitment policy is effective. Establishment of a Community Development Program designed to support community development initiatives and alternative livelihood opportunities will also help to maximise the social benefits associated project development.

5.7.4 Population and In-migration

More than 80% of the sample population of the 2007 baseline study was born in their village of residence, with the exception of the inhabitants of the Diogo hamlets who migrated from within the Rural Community of Darou Khoudoss over five years ago (Table 5.8). The 2007 baseline study settlements had experienced effectively no in-migration within the five years previous to the study.

In earlier times, however, the area had experienced significant in-migration. Over the last 30 to 40 years, decreasing rainfall and increasing land desertification have forced hinterland communities to abandon rain-fed agriculture and migrate west to the Niayes, where they have been able to exploit groundwater for market gardening. Population in the last 30 years in the Niayes has more than doubled from 2.6M in 1976 to 5.7M in 2005 (IDRC 2001).

Today, land shortage is likely to restrict in-migration; however, settlements continue to absorb large numbers of transient farm labourers from both within Senegal, particularly Casamance, and also Guinea Bissau.

Table 5.8 Extent of In-migration to the 2007 Survey Area*

Settlement Cluster	% of Population Born in Their Village of Residence	% of Population Born in the Rural Community of Darou Khoudoss	% of In-Migration within the Last 5 Years by Households to their Village of Residence
Foth	83	86	0
Diourmel	86	87	0
Diogo hamlets	43	86	0
Hinterland sample	83	88	0
Coastal sample	84	91	0

* 2007 baseline study data.

In-migration into the GCP area is likely once construction begins, particularly for hinterland villages such as Diogo, which has more developed public infrastructure and greater commercial activity compared to the settlements located on the littoral dune. In-migration has the potential to increase pressure on land and water resource use, livelihood and impact on health.

The GCP will create employment and other economic opportunities that may lead to an increased population in the GCP area, particularly during construction.

Management of in-migration will require liaison with the government and local community. GCO's recruitment policy will discourage an influx of people to the area and, therefore, minimise adverse impacts. An In-migration and Population Management Strategy should also be developed for the GCP in conjunction with the local community and the Rural Community of Darou Khoudoss and Thieppe. During final closure, a net out-migration may occur, as people leave to seek other employment opportunities.

5.7.5 Ethnicity and Vulnerable Groups

Lower income households are large, have a greater number of dependants, and lack access to education. Among the poor certain groups deserve special attention as they are less likely to have equal access to the benefits of economic growth because of lack of education or health care and structural discrimination, e.g. women.

Households within the project area have been identified as vulnerable if they fall into one or more of the following categories: ethnic minority, no source of cash income, women headed household, five or more dependent household members or one or more household members are either terminally ill or disabled.

The project area consists of Peul and Wolof settlements with few other ethnic groups present. The Peul communities are the principal inhabitants of the littoral dune and thus project development has the potential to expose these groups, more than coastal and hinterland communities, to greater risks and severity of impacts.

Successful implementation of a preferential recruitment policy that favours those people whose land is directly impacted by the GCP will ensure that local residents are given priority and communities on the littoral dune and in hinterland areas are considered equally.

With reference to the World Bank Performance Standard on Indigenous People (2006), GCO will also need to ensure that it provides special consideration to the needs of the Peul, to ensure there is adequate opportunity for them to participate in, and benefit from, project-related activities that may help them fulfil their aspiration for economic and social development.

5.7.6 Community Health, Safety and Social Amenity

The primary potential impact on community safety is likely to be from accidents along project supply routes. Uncontrolled crossing of haul roads by people or livestock could result in potentially serious accidents involving vehicles using the roads.

The GCP is likely to result in an increase in the overall traffic volumes along the project transport route. The increase in the use of project roads may result in a concomitant minor increase in the risk of road accidents, which can impact community safety and increase the risk of spills of hazardous materials such as hydrocarbons. These risks will be minimised through careful management of transport operators and contractors, traffic safety measures and ongoing monitoring and adaptive management of accident rates, vehicle behaviour and noise and air quality along the project roads.

GCO is considering several options for project-related transport at Diogo to alleviate the traffic congestion and maintain a high level of safety for villagers, including a bypass for Diogo and adjacent villages. Rail transport is expected to reduce the number of trucks transporting product to Dakar. Likewise the use of natural gas has distinct advantages from a transport perspective in addition to emissions and operating cost perspectives.

Other community health and safety concerns include unauthorised access to project facilities, disease introduction (e.g. STIs) or exacerbation of existing diseases, and indirect impacts on health through increased pressures on food security associated with in-migration. The potential risks of exposure to radioactivity above natural background levels associated with mineral products and waste streams are expected to be minimal.

A variety of education programs and management measures will be required to ensure that risks to community health and safety associated with the GCP are effectively minimised.

Indirect impacts on health through potential increased pressures on local food security that may result from increased pressure on land and forest resources in the vicinity of the GCP development area associated with in-migration are expected to be minimised through implementation of a preferential employment policy and the development of alternative livelihood activities.

Potential impacts on the social amenity of local communities from noise and dust emissions as well as disturbance to visual amenity are not likely to be significant provided appropriate management and mitigation measures are successfully implemented.

5.7.7 Cultural Values and Heritage

Nearly all the settlements in the project area have either a mosque or a place of prayer – sites that are highly valued by the community. The mosque in Foth main village for example is an important focal point of religious practice for all surrounding hamlets on the dune (Plate 4.4). The tomb of the village founder is located adjacent to the temple. Villagers hold strong cultural ties to this settlement.

Dredging activities associated with the GCP will directly impact at least three cultural sites located within the proposed mining area (Table 5.9). These include two cemeteries (one of which is in the buffer zone), one mosque and a small Arabic school associated with Diogo hamlets.

The remainder of the cultural sites associated with settlements within the proposed mining area and buffer zone for years one to six of mining are located outside the GCP development area and are not likely to be directly disturbed by dredging activities.

Table 5.9 Summary of Cultural Sites of Settlements within the GCPDA*

Settlement Cluster	Inside Proposed Mining Area	Inside Buffer Zone
Foth^	0	0
Diogo hamlets^	3	0
Diourmel hamlets^	0	1
Total	**3**	**1**

* 2007 baseline study data adjusted for the current mine plan.

^ Foth settlement cluster includes FoH1, FoH16, FoH27 and Foh28. Diogo hamlets include DgH1 to DgH4. Diourmel hamlets include DiV01, DiH01, DiH04 to DiH06, DiH10 to DiH13, DiH15 to DiH16, DiH18 to DiH19, DiH22 to DiH24, and DiH33.

There is also potential for other cultural sites including abandoned cemeteries to be present in the project area in addition to those identified in the 2007 baseline survey. A key reason for this is the potential unwillingness of village informants to disclose information to outsiders regarding their cultural and spiritual sites. No detailed assessment of cultural values and heritage has as yet been undertaken for years seven to 10 of mining.

Implementation of appropriate management and mitigation measures, developed through close consultation with the local government and affected people, will ensure that potential impacts on these sites are minimised where possible. Development and implementation of a chance find procedure for managing the discovery of a site of cultural or spiritual significance will also reduce the risk of impact.

5.7.8 Resettlement and Livelihood Restoration

Households within the project area are heavily reliant on cash income sourced from horticultural activities for the purchase of staple foods, supplementary foodstuffs, household items, and to manage emergencies such as medical expenses. Project development will result in the disturbance of a significant portion of the land currently used by the local community for agricultural, livestock grazing and forest resources.

The GCP is likely to necessitate the relocation of 38 settlements belonging to the villages of Foth, Diourmel, Diogo and Thiakmat containing 209 households, approximately 1167 persons within the proposed mining area and buffer zone (Table 5.10).

Table 5.10 Settlements in the Proposed Mining Area and Buffer Zone for the Current 10-Year Mine Plan*

Settlement ID	Potential Resettlement Requirements		% of Habitation Area Disturbed	% of Community Land Disturbed
	No. Households	Population		
Foth Settlements				
FoH01	2	15	100	
FoH16	7	46	100	32
FoH27	10	88	100	
FoH28	7	74	100	
Sub-total	***26***	***223***	***100***	***32***
Diogo Hamlets				
DgH1	5	55	100	
DgH2	3	8	100	44
DgH3	6	28	100	
DgH4	1	7	100	
Subtotal	***15***	***98***	***100***	***44***
Diourmel Hamlets				
DiV01^	2	10	100	
DiH01^	13	42	100	
DiH04^	8	42	92	
DiH5[#,] ^^	6	32	38	
DiH06	1	8	100	
DiH10^^	6	17	61	
DiH11	7	39	100	
DiH12	5	15	100	19
DiH13	7	34	100	
DiH15 and DiH16^^	6	41	29	
DiH18	2	16	100	
DiH19	4	27	100	
DiH22^	4	7	100	
DiH23	8	28	100	
DiH24^	4	15	100	
DiH33[#]	4	25	100	
Subtotal	**87**	**397**	***88***	***19***
Thiakmat				
TiH01^^	4	18	24	
TiH02[#]	2	11	100	
TiH03[#]	16	88	100	
TiH13[#,] ^^	11	60	64	
TiH14[#,] ^^	2	11	<1	
TiH15[#,] ^^	3	18	4	
TiH16[#,] ^^	8	46	14	***7***
TiH17[#,] ^	4	25	100	
TiH18[#,] ^	8	42	100	
TiH19[#,] ^	4	25	100	
TiH20[#,] ^^	3	14	85	
TiH21[#,] ^	3	14	100	
TiH22[#, +,] ^^	14[#]	81	99	
Subtotal	***81***	***449***	***78***	***7***

* 2007 baseline study data adjusted for the current mine plan. Population does not include any new households or persons located within the GCPDA post the 2007 baseline survey.
# Population and household numbers have been estimated for settlements that were outside the scope of the 2007 baseline study, based on an average infrastructure/household and infrastructure/population ratio determined from 2007 survey data. Infrastructure was identified using from January 2008 satellite imagery.
^ Settlement area is located in both proposed mining area and buffer zone. Household and population data assumes that the entire population of a settlement intersected by the proposed mining area is inside the proposed mining area.
^^ Household population data assumes that the entire population of a settlement partially outside the buffer zone is within the buffer zone.

There are unlikely to be any direct impacts on settlements outside of these areas. Indirect impacts may include disturbance to social and cultural associations held with directly impacted settlements.

Unless properly mitigated, relocation will affect established production systems, livelihood and social cohesion, existing assets and community infrastructure. Social connections, particularly at the family level between the main village (e.g. Foth) and its associated hamlets are an important aspect of social cohesion and will require a consultative approach to avoid impacts.

As outlined in Appendix 2.6, the implementation of a Resettlement Action Plan (RAP) and Social Development Plan (SDP), developed with appropriate community and government consultation prior to construction, will reduce the significance of potential impacts associated with relocation as well as project-related impacts on the livelihood of the local community. A RAP will act as a strategic planning document for the GCP and outline in detail the procedures and actions that GCO will take to mitigate adverse effects, compensate losses and provide development benefits to persons and communities affected by the GCP. A SDP will provide a comprehensive strategy for the re-establishment and security of the livelihood of project-affected persons (PAPs). These plans will also provide a schedule of implementation to ensure appropriate mitigation of impacts.

Detailed government and community consultation will be required to fully define feasible relocation options. The successful rehabilitation of land potentially disturbed by the GCP would further mitigate impacts associated with relocation.

5.7.9 Compensation

The establishment of project compensation policies and entitlements for the GCP will need to be conducted in close consultation with government and community and in keeping with IFC and Senegalese requirements.

Appendix 2.6 outlines principles of compensation as well as a methodology for establishing entitlements and eligibility for compensation. It is recommended that these principles of compensation be used as the basis for developing potential compensation entitlement options for the GCP following review by the GCO management team. Four compensation categories have also been defined to assist in the understanding of likely compensation scenarios: a) permanent loss; b) semi-permanent loss, c) temporary loss; and d) temporary disturbance, as follows:

a) **Permanent loss** is when lands and/or assets are permanently transformed from their pre-mining use. When permanent loss is agreed, the land and/or asset owner is to be offered either the financial “replacement cost value”, a land swap of equal or greater productivity, or assets of equal or greater value at the time that the property is resumed by the project. The financial “replacement cost” will be sufficient to actually replace lost land and assets with land of equal productivity, or assets of equal value/quality/size.

b) **Semi-permanent loss** may occur when temporary loss of land occurs over a prolonged period such that the transformation of land from its pre-mining state may be considered 'semi-permanent' (i.e. the proposed mining area). Semi-permanent loss of land for any period greater than three years (and potentially up to 10 years) is likely to provide justification for replacement land to be provided.

Semi-permanent loss of land has therefore been assessed in the same manner as permanent loss. However, the time period of semi-permanent loss will vary significantly depending on the type of land to be disturbed (e.g. agricultural, scrub land, revegetation areas, etc.). Further definition of the time period of semi-permanent loss will need to take into account the results of rehabilitation trials and the outcomes of community and government consultation.

c) **Temporary loss** may occur when land is resumed during mine construction, though returned during the mine operational phase. The landowner is offered a "rental (or subsistence) allowance" for the period of loss. The "rental allowance" is equivalent to the lost productive value of the land at the local market value for the year in which the compensation is paid.

d) **Temporary disturbance** may occur in areas adjacent to construction activities, where the owner will still enjoy access to and use of their property, though that access and use may be disturbed by Project activities. Depending on the severity of disturbance, the land owner may be offered a "disturbance allowance" for the period of disturbance. The "disturbance allowance" would be sufficient to cover the economic loss incurred by the disturbance.

Compensation procedures and entitlements are proposed in Appendix 2.6 for disturbance to housing, property assets, agricultural land, community land, and livelihood restoration.

Procedures and actions that GCO will take to compensate losses and provide development benefits to persons and communities affected by the GCP will be documented in a RAP (see Appendix 2.6).

5.7.10 Community and Government Consultation

At this stage in the assessment process, only preliminary consultation with community and government has been undertaken. Post-funding, GCO will need to undertake extensive consultation with government, local authorities and project-affected persons (PAPs) regarding management and mitigation of potential project impacts, resettlement options and alternatives, livelihood restoration options and development opportunities, and compensation measures.

In particular, extensive consultation will be required during the preparation of the RAP and SDP to confirm viable resettlement options and alternatives for each village and establish a pathway for resettlement and livelihood restoration.

Preparation of a Public Consultation and Disclosure Plan (PCDP) that details the methodology for conducting stakeholder consultation and documenting the results of consultation activities will also be a key step in the consultation process. Effective public consultation and disclosure with PAPs and other stakeholders is essential to the success of the GCP. Effective implementation of a PCDP will aid in the establishment of sound relationships with the local community and other key stakeholders as well as help build broad community support for the GCP through ongoing dialogue and meaningful participation.

5.7.11 Community Development Opportunities

Establishment of a Community Development Program designed to support community development initiatives and alternative livelihood opportunities will help to maximise the social benefits associated with project development and compensate for livelihood and land loss associated with the GCP.

As part of the Community Development Program, a Community Development Fund will need to be set up to support the establishment of alternative livelihood opportunities and other community development initiatives.

GCO has already initiated several community development projects to improve community health including the installation of a bore and windmill at Diogo to ensure fresh water supply and in 2006 commenced an ongoing (annual) malaria eradication program in the settlements within close proximity to the MSP.

Scope for further community development initiatives, with the support of a Community Development Fund, may include:

- Supporting improvements in health care facilities and health education campaigns available to the general population.
- Supporting improvements to education infrastructure and services in the local communities.
- Assisting improvements in agricultural practices and “food security” (e.g. optimisation and intensification of non-impacted agricultural and other productive land).

Community contributions will need to focus on the promotion of development activities that are sustainable in the long term, in that their resulting benefits will continue after mining activities have ceased. Consultation with the local community, government and other stakeholders will be required to develop and implement community development initiatives that will be appropriate and beneficial to the communities within the project area as well as to determine how best to allocate community development funds.

Livelihood restoration and improvement measures, including allocation of funds from the Community Development Fund and community education programs will be addressed in a SDP (see Appendix 2.6).

5.8 Emergency Preparedness and Response

The storage, use and handling of hydrocarbons at the GCP are considered to be the main hazard potentially requiring an emergency response. An Emergency Response Plan – Environment (Appendix 2.5) has been prepared for the GCP focussing primarily on hydrocarbons. As the project develops, GCO will undertake regular environmental risk assessments to identify potential environmental emergency situations that may arise and that need to be included in the Emergency Response Plan.

Hydrocarbons will be stored in above-ground tanks in bunded, impermeable areas to minimise environmental impact in the event of a spill or leak. Emergency response staff will be trained in the proper use of safety equipment and spill response materials and in safe disposal of hydrocarbon-contaminated materials.

6 MEASUREMENT AND EVALUATION

An environmental management system (EMS) will be written to identify the procedures to measure and evaluate and decide on appropriate mitigation measures for environmental and social impacts from the Grande Côte Operations project.

6.1 Environmental Monitoring and Measurement

Environmental monitoring for the GCP is documented in the Environmental and Social Monitoring Manual (ESMM) (Appendix 2.4). Baseline monitoring will be conducted prior to construction to establish existing environmental values. During construction and operation of the project, regular monitoring will detect any adverse changes that require action. Following cessation of mining, monitoring of various aspects will be continued for at least 12 months post-mining as part of the requirements for mine closure.

Groundwater quality monitoring, to establish baseline groundwater quality and to monitor changes in groundwater quality, will be conducted at the dredge pond construction site, in the dredge pond, in monitoring bores alongside and within the dredge path, in a monitoring bore beside the fuel storage facility, in two monitoring bores up-gradient and down-gradient of the landfill site, and in a monitoring bore located approximately 50 m down-gradient of the discharge point for the sewage treatment plant. Details of parameters to be monitored are included in the ESMM (Appendix 2.4). Groundwater quality in wells and bores used by the community in the vicinity of the dredge path are being monitored prior to construction to establish baseline groundwater quality.

The potential for acid sulphate generation from oxidation of humic material in the mined sand (tailings) is being assessed. If necessary, acid sulphate generation will be monitored by regular testing of the dredge pond, which will collect some of the water draining from the tailings.

Any discharge water from the process water pond at the MSP will be monitored for general water quality parameters. Inlet and outlet water from the sewage treatment plant will be monitored monthly.

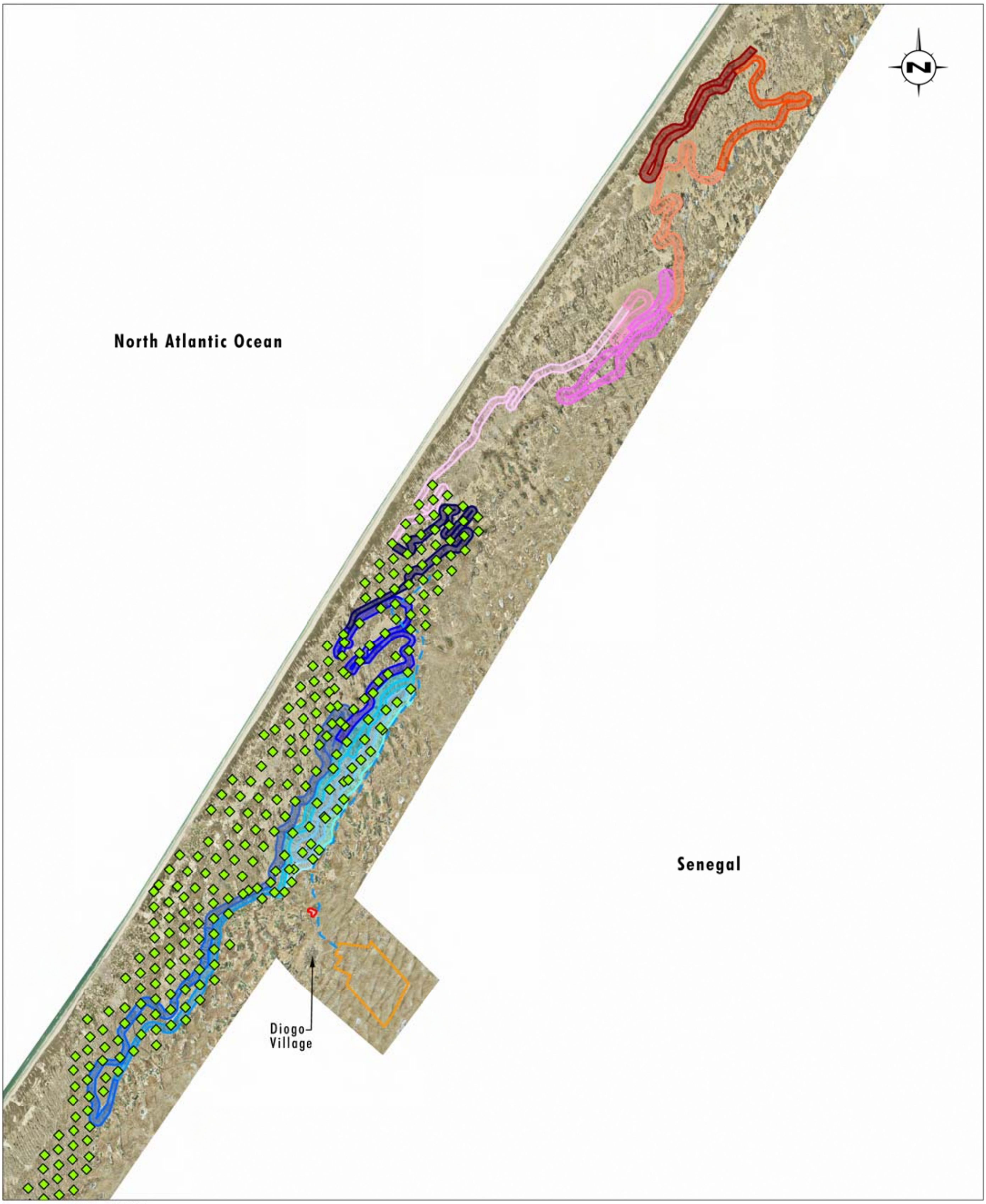
Groundwater table monitoring is being conducted in a comprehensive suite of piezometers established as part of the exploration drilling program (Figure 6.1). Baseline monitoring of the groundwater table for the GCP since April 2006 has shown an average decline of approximately 0.2 mpa in some areas, while there is apparently no decline in other areas. Groundwater table monitoring will continue during the mining project and for at least 12 months after mining has ceased.

Groundwater quality monitoring will also take place at the GCP site. A proposed program for the baseline monitoring, production monitoring and post-closure monitoring of groundwater quality has been developed for the project site.

The groundwater quality monitoring will occur in four stages:

1. Baseline monitoring will be designed to understand the pre-project groundwater quality. Later groundwater quality monitoring will be compared with the baseline monitoring to understand how the project and other land-use activities have affected groundwater quality.

Umwelt
Environmental Consultants



Source: MDL (2010)
Note: Dredge Path Package as Received from MDL May 2010

0 2.0 4.0 8km
1:175 000

Legend

MSP Site
GCO Exploration Camp
Powerline along Dredge Path
Piezometer Location

Proposed Dredge Path

Year 1	Year 6	Year 11
Year 2	Year 7	Year 12
Year 3	Year 8	Year 13
Year 4	Year 9	Year 14
Year 5	Year 10	Year 15

FIGURE 6.1

Piezometers established by GCO to monitor Groundwater Table

2. Production monitoring will be designed to provide early detection of any changes in groundwater quality during the operation of the project.
3. Closure monitoring will be designed to provide a snapshot of the groundwater quality at the time the mine closes.
4. Post-closure monitoring will be designed to provide an ongoing record of groundwater quality when the project has been completed.

Heavy minerals have naturally occurring radioactivity. Tailings from separation of the saleable minerals from the heavy mineral concentrate will be returned to the mine site via pipeline for disposal in the dredge pond, below the water table, and subsequently for incorporation in the re-formed landscape. Following incorporation of these tailings, a surface radioactivity survey will be conducted to ensure that the radioactivity at 1 m above the ground surface does not exceed background radioactivity levels.

Workers exposed to heavy minerals at the MSP will wear radiation monitoring badges to measure their exposure to radiation at all times. Although the radiation levels are expected to be within acceptable limits, regular assessment of the radiation monitoring badges will be necessary to ensure that workers are not exposed to unacceptable radiation levels.

The topography of the proposed mining area has been mapped using aerial photography. This mapping provides accurate topographic contours that can be compared with the post-mining landform to ensure that it approximates the pre-mining topography.

In order to minimise waste production from the GCP and to maximise recycling and reuse of waste materials, a waste inventory will be compiled and monitored. Quantities of oil brought to the site and used oil retained for recycling will be monitored to ensure that the maximum possible amount of used oil is recycled.

The Rehabilitation and Closure Plan for the GCP will include a comprehensive monitoring system to ensure that timely replanting, weed control and maintenance are conducted. General parameters to be monitored may include: area of progressive revegetation; seedling survival rate; annual plant growth; vegetation diversity; and areas of weed infestation. Photo-points will be established to record vegetation pre-mining and to monitor progress with revegetation post-mining. Anticipated monitoring regimes are documented in the ESMM (Appendix 2.4).

Baseline noise monitoring will be conducted as part of the noise assessment required to develop a noise model for the MSP. Once the MSP is operational, noise monitoring will be conducted to ensure that noise emissions from operations at the MSP meet the noise guidelines for the nearest residential receivers. If community complaints indicate that noise emissions from the construction or operation of the GCP are causing nuisance or health impacts, GCO will undertake noise monitoring and investigate ways in which noise emissions can be reduced to ameliorate adverse noise impacts.

Dust raised by traffic at the MSP and on transport routes will be monitored by visual inspection and dust-control measures will be implemented when necessary. Any records of community concerns about dust will provide another means of monitoring dust nuisance.

All emissions from the MSP will pass through a bag house to ensure that particulate matter is trapped and emissions to the air meet Senegal’s air emission standards for particulate matter. Stack emissions will be monitored for particulate matter every three months or at a frequency linked to the life of the bags in the bag house.

Baseline air quality measurements and dispersion modelling will be undertaken to estimate potential ground level concentrations of sulphur dioxide in the vicinity of the power station, and assess whether or not the emissions will have a significant impact on the ambient air quality. Emissions from the power station will be monitored at start-up, then quarterly for the first year of operation. Subsequent monitoring will be on an annual basis. If there is a change in the fuel supply contract, monitoring will be conducted at that time to ensure that emissions continue to meet Senegal standards.

6.2 Social Monitoring

Baseline monitoring of socio-economic and health/nutrition status at the village/community level will be completed prior to commencement of GCP construction activities. Social impact monitoring will be required to identify and quantify the direct and indirect impacts of the GCP on the local community. Social monitoring will also ensure that existing management and mitigation measures are effective, and will identify the need for improved or additional measures.

Regular monitoring (i.e. on a monthly basis) of local workforce statistics, compensation payments, local goods and services procured by the GCP, training programs and any incidents (e.g. road accidents involving mine staff, mine vehicles and local villagers) that affect the local communities or workforce will be carried out. In addition, programs to monitor the presence of malarial mosquito larvae in the dredge pond and the occurrence of HIV/AIDS in the workplace and local community will be established.

Annual monitoring of socio-economic and health/nutrition status at the village/community level will be conducted to highlight any changes from baseline conditions. Annual monitoring will include monitoring of population growth rate, extent of in-migration, birth and death rates, local attitudes toward the project and the incidence of significant infections and health statistics.

All community grievances filed with the company should also be recorded and addressed at management meetings. Community grievance reports should include the name of the complainant, details of the complaint, date that the complaint was made, name of GCO staff member recording the complaint and the details and date of any action taken.

In addition to the monitoring measures outlined above, monitoring and evaluation will be essential to ensure successful implementation of a resettlement and livelihood restoration program. Monitoring and evaluation of resettlement and livelihood restoration will also allow the project to identify and quantify impacts of the project, including any resulting benefits.

6.3 Inspections

GCO will inspect all Project facilities on a monthly basis, and review environmental and social performance against the Continuous Improvement Targets listed in the ESMMP on a quarterly basis. Key performance indicators will be developed over time as the operation matures to enable environmental and social performance to be assessed objectively and quantitatively. Indicators will likely be developed in the following broad areas:

- Groundwater management.
- Transport management.
- Control of erosion (wind erosion).
- Management of tailings.

- General waste management.
- Dust and noise management.
- Radiation management.
- Rehabilitation and revegetation success.
- Socio-economic status and health/nutrition in the local community.

Summary results of the inspections and performance reviews will be compiled in the quarterly and annual reports submitted to the Department of Mines and Geology (Direction des Mines et de la Géologie) in Dakar.

6.4 Audits

GCO will regularly commission routine internal and independent external audits of the environmental management system (EMS). Audits will investigate:

- The appropriateness of the ESMMP to the current development stage and operating practices of the project.
- Workforce awareness of the ESMMP and associated plans.
- The performance of managers and operators in implementing and maintaining the ESMMP strategies.
- Whether sufficient time, resources and expertise are available to implement the ESMMP.
- The effectiveness of the operation's environmental management system in improving environmental performance and reducing environmental risk.

All audit recommendations will be discussed with the relevant departmental managers and the environmental superintendent.

Independent external audits will be conducted on an annual basis for the first two years of operation. The frequency of subsequent audits will be based on the results of the first two.

6.5 Evaluation of Compliance

Evaluation of compliance with guidelines and legal requirements will be undertaken as part of the annual reporting to the government departments.

6.6 Record Keeping

A range of information to support the environmental management system will be developed specifically for the GCP and once the project commences, this material will be available on site. This information includes the reports prepared as part of the environmental and social impact assessment (EIES) process.

A library of hard copies of data and background information, including the EIES and all supporting reports, will be maintained in the environment department on site.

The site Environment Department will also maintain computer-based databases that include the following:

- Environmental legislation, standards and guidelines.
- Groundwater monitoring information.
- Corrective action database.
- Results of environmental/social investigations and trials.
- Site materials inventory: quantities, locations and types of materials (such as stockpiles of tailings, slimes, topsoil, etc.) for environmental management and rehabilitation purposes.
- Pre-mining vegetation mapping, including:
  - Details of threatened species identified in areas to be cleared.
  - Nursery inventory: the amounts and species of seeds and seedlings available for revegetation and anticipated rehabilitation requirements.
- Rehabilitation undertaken and status.
- Incident reporting (including community complaints) and response records.

The databases will be readily accessible to relevant personnel to allow timely and informed decisions to be made.

The administration superintendent will be responsible for maintaining a database of personnel induction and training records.

7 REVIEW AND CONTINUAL IMPROVEMENT

The environmental management system will be reviewed by senior GCO management at regular intervals to ensure that it remains appropriate, adequate and effective in managing environmental issues and impacts. The reviews will seek to identify opportunities for improvement and the need for any changes to the environmental management system, including the environmental and social objectives and targets. Reports documenting the reviews will be retained.

The review will encompass:

- Results of internal audits and evaluations of compliance with guidelines and legal requirements.
- Results of external audits.
- Complaints.
- The extent to which environmental objectives and targets have been met.
- The status of corrective and preventive actions.
- Any follow-up actions from previous reviews.
- Changes to legal or other requirements relating to environmental aspects of the operation.
- Recommendations for improvement.

As a result of the review, management will document decisions and actions related to possible changes to environmental policy, objectives, targets and other elements of the environmental management system, consistent with the commitment to continual improvement.

8 GLOSSARY OF TERMS

Definitions obtained from Macquarie Dictionary online at:

http://www.macquariedictionary.com.au

Neolithic Period.– the later Stone Age or New Stone Age, characterised by well-finished polished implements of flint and other stone; it includes the Holocene (or Recent) Epoch of the post-glacial period, until the beginning of the Bronze Age.

Palaeolithic – the earliest part of the Stone Age, the Old Stone Age, characterised by implements of chipped stone; it includes the Pleistocene geological epoch.

Polygamy – the practice or condition of having more than one spouse at one time.

Polygyny – the practice or the condition of having more than one wife at one time.

Propagules – any plant matter used to propagate a plant; in asexual reproduction, a woody stem, leaf, etc., and in sexual reproduction, a seed.

Tumuli – plural of tumulus – a mound of earth over a tomb.

9 ABBREVIATIONS

Abbreviation	French	English
AGEC		Australian Groundwater and Environmental Consultants
AMOP		Annual Mining Operations Plan
ANSTO		Australian Nuclear Science and Technology Organisation
ARPANSA		Australian Radiation Protection and Nuclear Safety Agency
AS		Australian Standard
CBD		Convention on Biological Diversity
CDM		Clean Development Mechanism
CFCs		Chlorofluorocarbons
CFP		Chance find procedure (for cultural heritage items)
CITES		Convention on International Trade in Endangered Species
CR	Communaute Rural	Rural Community
CRDP		Community Relations and Development Plan
DAT	Direction de l'Aménagement du Territoire	Department of Territory Development
DEEC	Direction de l'Environnement et des Etablissements Classés	Department of Environment and Classified Establishments
DEFCCS	Direction des Eaux, Forêts, Chasses et Conservation des Sols	Department of Water, Forests, Hunting and Soil Conservation
DFS		Definitive Feasibility Study
DGPRE	Division de Gestion et de Planification des Resources en Eaux	Division of Management and Planning of Water Resources
DH	Direction de l'Horticulture	Department of Horticulture
DMG	Direction des Mines et de la Géologie	Department of Mines and Geology
DS	District Sanitaire	Health District
EIES	Etude d'Impact Environnemental et Social	Environmental and Social Impact Assessment
EHS		Environmental Health and Safety
EMS		Environmental Management System
EPCM		Engineering, procurement, construction management
EPFI		Equator Principles Financial Institution
ERP-E		Emergency Response Plan – Environment
ESMMP		Environmental and Social Management and Monitoring Plan
ESMM		Environmental and Social Monitoring Manual
ESMS		Environmental and Social Management System
FCFA	Franc CFA	CFA franc
GCO		Grande Côte Operations
GCP		Grande Côte Project
GCPDA		Grande Côte Project Development Area
GEF		Global Environment Facility
GHG		Greenhouse Gas

Abbreviation	**French**	**English**
GIE	Groupe d'intéret économique	Economic Interest Groups
GRS	Gouvernement Republique Sénégal	Government of the Republic of Senegal
HFO		Heavy Fuel Oil
HM		Heavy Minerals
HMC		Heavy Mineral Concentrate
ICRP		International Commission for Radiological Protection
ICS	Les Industries Chimiques du Sénégal	Senegal Chemical Industries
IFAN	Institut Fondomentale Afrique National	Fundamental Institute for Black Africa
IFC		International Finance Corporation
IM		Induction Manual
IUCN		International Union for Conservation of Nature
JICA		Japan International Cooperation Agency
KL	Kilolitres	Kilolitres
MDL		Mineral Deposits Limited
MEM	Ministère de l'Energie et des Mines	Ministry of Energy and Mines
MEPN	Ministère de l'Environnement et de la Protection de la Nature	Ministry of Environment and Nature Conservancy
MSDS		Material Safety Data Sheet
MSP		Mineral Separation Plant
NA		Not Analysed
NORM		Naturally occurring radioactive materials
OHS		Occupational Health and Safety
PAEP		Plan of Action for Farmers' Entrepreneurship
PAP		Project-affected Person
PCB		Polychlorinated Bi-Phenyl
PCDP		Public Consultation and Disclosure Plan
PCR		Physical cultural resource (archaeology or cultural heritage)
PGIES	Projet de Gestion Intégrée des Ecosystèmes du Sénégal	Project of Integrated Management of Senegal Ecosystems
PGRN	Plan de gestion des ressources naturelles	Natural Resources Management Plan
PGS	Plan de gestion sociale	Social Management Plan
PHSS	Plan Hygiène–Santé–Sécurité	Hygiene–Health–Safety Plan
PNAE	Plan National d'Action pour l'Environnement	National Plan of Action for the Environment
PPAH		Pollution Prevention and Abatement Handbook
PRL	Programme de Restauration du Littoral	Program for Restoration of the Littoral
PS		Performance Standard
PSM		Pells Sullivan Meynink
PVC		Poly vinyl chloride
RAP		Resettlement Action Plan
RC		Reverse circulation
RNC	Réserve Naturelle Communautaire	Community Nature Reserve
SDP		Social Development Plan

Abbreviation	French	English
SOP		Standard Operating Procedure
STI		Sexually Transmitted Infection
TBD		To be developed
TSAP		Traffic Safety Awareness Program
UNESCO		United Nations Educational Scientific and Cultural Organisation
WHIMS		Wet high-intensity magnetic separator

10 REFERENCES

Agence Nationale de la Statistique et de la Demographie (ANSD) (2006). Resultats de Troisieme Recensement General de la Population et de l'Habitat – (2002). Report National de Presentation.

Alizés (2006). *Plan Local d'Hydraulique et d'Assainissement realize dans la Communauté Rurale de Thieppe,* Région de Louga. Alizés Programme. October 2006.

ARPANSA (2005). Code of Practice and Safety Guide Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing (2005) Radiation Protection Series Publication No. 9, August 2005. Australian Radiation and Nuclear Safety Agency, Australian Government. Australian Nuclear Science and Technology Organisation (ANSTO) (2006). Technical Memorandum: AM/TM/2006_11_30. Subject: Grande Côte Zircon Project – Radioactivity Analysis. *Prepared by* Doug Collier.

Bielenberg, C and Allen, H. (1995). How to Make and Use the Treadle Irrigation Pump. (Intermediate Technology).

BRGM (1983). Hydrogeological Study M'Boro-Lompoul Sector Senegal prepared by D Fohlen and Y Lemordant. Bureau de Recherches Géologiques et Minières, Orléans, France.

Calytrix Consulting Pty Limited (2008). Radiation exposure in the transport of mineral sands. Report for the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA).

De Bon, H., Faye, F. and Pages, J. (1997). Development of vegetable cropping systems in the Niayes zone of Senegal. Experimental Agriculture 33 (1): 83–90.

Downer EDI (2009). MS.09/82041/1

Earth Systems (2007). Land, Asset and Livelihood Baseline Study – Grande Côte Zircon Project Final Report. *Prepared for* Mineral Deposits Limited Senegal.

Earth Systems (2009) Land, Asset and Livelihood Baseline Study – Grande Côte Project Draft Report. *Prepared for* Mineral Deposits Limited Senegal. Earth Systems (2010). Land, Asset and Livelihood Impact Assessment and Management Strategy Draft Report. *Prepared for* Grande Côte Operations SA.

EMRC (2009). Mineral Deposits Limited Grande Cote Zircon Project Post-Mining Rehabilitation Operations – General Considerations, Suggested Approach and Recommended Design of Rehabilitation Trials. Prepared by Environmental Management and Research Consultants, December 2009.

Global Environment Facility (2002). Senegal National Report – Phase 1: Integrated Problem Analysis. GEF MSP Sub-Saharan Africa Project (GF6010-0016) "Development and Protection of the Coastal and Marine Environment in Sub-Saharan Africa".

Grigsby, WJ (2004). The gendered nature of subsistence and its effect on customary land tenure. Society and Natural Resources 17:207–222.

Groupement O C Cacoub et Associes (2006). Nouvelle Ville Centre Politique et Administratif du Senegal. *Prepared for* Republique du Senegal, April 2006.

Grande Côte Operations (2009). GC Project Wells Chemistry 20100113. (Unpublished analytical results).

GCO Senegal S.A.R.L. (2006). Grande Côte Zircon Feasibility Study – Mining Convention. March 2006.

International Atomic Energy Agency (2004). IAEA Safety Standards Series – Application of the Concepts of Exclusion, Exemption and Clearance. Safety Guide No. RS-G-1.7.

International Development Research Centre (IRDC) (2001).Cités Horticoles en Suris? L'agriculture urbaine dans les grandes Niayes au Senegal. Edited by Safiétou Touré Fall and Abdou Salam Fall. March 2001. http://www.idrc.ca/en/ev-9429-201-1-DO_TOPIC.html

IFC (International Finance Corporation) (2006). The 'Equator Principles' – an Industry Approach for Financial Institutions in Determining, Assessing and Managing Environmental & Social Risk in Project Financing.

Mineral Deposits Limited (2006). Senegal Grande Côte Zircon Project Feasibility Study 2006. *Prepared for* MDL Senegal S.A.R.L.

Ministere de l'Economie et Finances (2005). Service Regional de Thiès – Situation de Economique et Sociale Annee 2004.

Museum of Thiès (2009). History of Thiès Region. Available online: http://museedethies.petitecote.com/thies-paleolithique.htm

PSM Australia Pty Ltd (2004). Preliminary Assessment of Mineral Sands Mining Impacts on the 'Sand Sheet' Aquifer, Senegal. *Prepared by* PSM for Mineral Deposits Limited. Report No. 235.01.

PSM Australia Pty Ltd (2006). Grande Côte Mineral Sands Operation A Preliminary Assessment of Makeup Water Requirements. *Prepared by* PSM for Mineral Deposits Limited. Report No. 280.01.

PSM Australia Pty Ltd (2010). Grande Côte Mineral Sands Mining – Water Requirements and Regional Groundwater Impacts. Prepared by W.J.C. Meynink and PSM Australia Pty Ltd for Mineral Deposits Limited. Report No. 349.01.

Rural Community of Darou Khoudoss (2004). Local Development Plan for the Rural Community of Khossanto, Government of Senegal, UNDP.

Sall, M. and Vanclooster, M. (2009). Assessing the well water pollution problem by nitrates in the small scale farming systems of the Niayes region, Senegal. Agricultural Water Management 96: 1360–1368.

Touré, O and Seck, SM (2005). Family and commercial farming in the Niayes area of Senegal. International Institute for Environment and Development (IIED) Drylands Programme. Issue Paper No. 133. March 2005.

Tropica (2005). Etude d'Impact Environnementale et Social Projet Zircon de la Grande Côte. *Prepared for* Mineral Deposits Limited Senegal S.A.R.L. by Tropica Environmental Consultants.

Umwelt Australia Pty Limited (2009). Emergency Response Plan – Environment *Prepared for* Grande Côte Operations.

Umwelt Australia Pty Limited (2010A). Grande Côte Project Environmental and Social Management and Monitoring Plan. *Prepared for* Grande Côte Operations.

Umwelt Australia Pty Limited (2010B). Grande Côte Project Environmental and Social Monitoring Manual. *Prepared for* Grande Côte Operations.

Umwelt Australia Pty Limited (2010c). Proposed Groundwater Quality Monitoring Plan – Grande Côte. *Prepared for* Grande Côte Operations.

United Nations Development Program (UNDP) (2006). Human Development Report 2006: Senegal Statistics. Retrieved 7 June 2007. http://hdr.undp.org/hdr2006/statistics/countries/data_sheets/cty_ds_SEN.html

WHO (2008). Guidelines for Drinking-water Quality (Third Edition incorporating the first and second addenda). World Health Organization, Geneva.

World Bank Group (2006). Performance Standard 7 – Indigenous People, April 30 2006. Retrieved December 2009. http://www.ifc.org/ifcext/sustainability.nsf/AttachmentsByTitle/pol_PerformanceStandards2006_PS7/$FILE/PS_7_IndigenousPeoples.pdf